Regulations and Curriculum for

Bachelor of Technology (B.Tech.) in Robotics & Artificial Intelligence

Version 2022.03

NITTE
(Deemed to be University)

(Established under Section 3 of UGC Act, 1956)
Placed under Category ‘A’ by MHRD, GoI | Accredited with ‘A+’ Grade by NAAC

Regulations and Curriculum for

Bachelor of Technology (B. Tech.)

Choice Based Credit System (CBCS)
Effective from AY 2022-23

NITTE
(Deemed to be University)

(Deemed to be University under Section 3 of UGC Act, 1956)
(Placed under Category 'A' by MHRD, Govt. of India, Accredited with 'A+' Grade by NAAC)
University Enclave, Medical Sciences Complex, Deralakatte,
Mangaluru – 575 018, Karnataka INDIA
Tel: +91-824-2204300/01/02/03, Fax: 91-824-2204305
Website: www.nitte.edu.in E-mail: info@nitte.edu.in

VISION

To build a humane society through excellence in the education and healthcare

MISSION

To develop
Nitte (Deemed to be University)
As a center of excellence imparting quality education,
Generating competent, skilled manpower to face the scientific and social challenges with a high degree of credibility, integrity, ethical standards and social concern

Regulations and Curriculum
B.Tech. Degree Programs
Choice based Credit System
(CBCS)

Effective from

Academic Year

2022 – 2023

Curriculum for Acquiring Professional Skills (CAPS)

With Scheme of Teaching & Examination

REGULATIONS: 2022

COMMON TO ALL

B.Tech. DEGREE PROGRAMS

CHOICE BASED CREDIT SYSTEM

(CBCS)

Version 2022.03

Choice Based Credit System (CBCS)

1. Choice for the selection of courses during each semester
2. Choice in planning the academic activities by selecting desired number of courses per semester
3. Balanced curriculum with engineering, science, humanities, and management courses.
4. Project based learning (PBL) which focusses on experiential learning
5. Opportunities to study inter-disciplinary courses.
6. Enabling slow learners by offering important courses in all semesters.
7. Optional Summer semester
8. Opportunity to get associated in research projects to acquire research experience
9. Value addition with Honors / Minor credentials.

Curriculum for Acquiring Professional Skills (CAPS)

1. Practicing outcome-based education (OBE) where Courses made student-centric rather than teacher-centric
2. Provisions for courses integrated with Lab/ PBL component
3. Focus on experiential learning
4. Ability enhancement and skill development courses as per National Education Policy (NEP) 2020
5. Focus on Industry Internship and Research Internship
6. Students to work on real world/interdisciplinary problems in major project
7. Importance is given to creativity, innovation, and development of entrepreneurship skills

Key Information

Program Title	Bachelor of Technology Abbreviated as B.Tech.
Short description	Four-year, eight semester Choice Based Credit System (CBCS) type of Undergraduate Engineering Degree Program with English as medium of instruction.
Program Code	14ENGR11D2
Revision version	2022.03 These regulations may be modified from time to time as mandated by the policies of the University. Revisions are to be recommended by the Board of Studies for Robotics & AI and approved by the Academic Council.
Effective from	09-03-2024
Approvals	• Approved in the 51st meeting of Academic Council of NITTE (Deemed to be University), held on 19-09-2022 and vide Notification of NITTE (DU), N(DU)/REG/AC-NMAMIT/2022-23/233 dated 12-10-2022. • Notification of Nitte (DU), N(DU)/REG/AC/-SA/2022-23/909 dated 24-04-2023. • Approved in the 54th Academic Council meeting of NITTE (Deemed to be University), held on 24.06.2023 and vide Notification of Ref: N(DU)/REG/AC-NMAMIT/2022-23/1264 dated 18.07.2023. • Approved in the 56th Academic Council meeting of NITTE (Deemed to be University), held on 23.02.2024 and vide Notification Ref: N(DU)/REG/AC-NMAMIT/2023-24/925 dated 09.03.2024.
Program offered at	NMAM Institute of Technology, Off -Campus Centre, Nitte, 574110, Karkala Taluk
Grievance and dispute resolution	All disputes arising from this set of regulations shall be addressed to the Board of Management. The decision of the Board of Management is final and binding on all parties concerned. Further, any legal disputes arising out of this set of regulations shall be limited to jurisdiction of Courts of Mangalore only

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PREAMBLE

NMAM Institute of Technology (NMAMIT) was established in 1986 and is located at Nitte and off-campus center of NITTE (Deemed to be University), accredited by National Assessment & Accreditation Council (NAAC) with 'A+' grade. NMAMIT is recognized by the All-India Council for Technical Education (AICTE), New Delhi.

The Bachelor of Technology (B. Tech.) Programs focus on Pursuing Excellence, Empowering people, and Partnering in Community Development. Out of eleven UG Programs i.e., Artificial Intelligence & Machine Learning (AM), Artificial Intelligence & Data Science (AD), Biotechnology (BT), Computer & Communication Engineering (CC), Computer Science & Engineering(CS), Civil Engineering(CV), Electronics & Communication Engineering (EC), Electrical & Electronics Engineering (EE), Information Science & Engineering (IS), Mechanical Engineering(ME) and Robotics & Artificial Intelligence (RI), all seven eligible UG Programs i.e., BT, CS, CV, EC, EE, IS and ME are accredited by NBA, New Delhi under Tier - I category till 30th June 2025.

The curriculum is jointly approved by members of the Board of Studies (BoS) and Academic Council drawn from academia, Industry, Alumni, and working professionals from Industry, and has been designed to integrate hands-on practical training with the concepts of theory courses to enhance the learning experience.

The Curriculum focuses on students Acquiring Professional Skills (CAPS) through rigorous theoretical training using innovations in pedagogy, experiential learning, active learning, collaborative learning, critical thinking, project planning, Project Based Learning (PBL), Ability enhancement courses for skill-building, effective communication, professional practice, creativity & innovation and developing entrepreneurial skills.

The focus of the Institution is to impart Quality Education to generate competent, Skilled, and Humane Manpower to face emerging Scientific, Technological, Managerial and Social Challenges with Credibility, Integrity, Ethics, and Social Concern.

In the present scenario, students wish to make plans for a bright future. However, student aspirations and industry demands are highly diverse. Employers expect the graduates possess multi-disciplinary competency, Information and Communication Technology (ICT), and leadership skills. In this context, NMAMIT offers the opportunity to the students to select the courses of their choice and helps them in grooming to have well-rounded personalities and become industry ready.

Efforts have been made to make the syllabus compliant with international professional societies.
As part of providing quality engineering education, at NMAMIT, Nitte, it has initiated the Choice Based Credit System (CBCS) into its academic curriculum. By this, the students can register for courses of their choice and alter the pace of learning within the broad framework of academic courses and credit requirements. CBCS allows students to plan for their academic load and alter it as they progress in learning. Students also have the option of choosing courses from a pool of courses within each classification. Ample options are given to choose interdisciplinary courses from other programs which will help the student to develop additional skills. Slow learners will also be benefitted since important courses are offered in all semesters. This arrangement helps the

students to re-register and clear the backlog courses in the subsequent semester. Suitable provisions are made for fast learners to associate them with research activities of faculty members and contribute to research beyond the working hours.

A faculty advisor helps the student in identifying the courses to be studied in each semester based on program requirements, course prerequisites, student's interest in various disciplines, past academic performance, and courses offered by the departments.

Learning becomes more 'experiential' by carrying out labs associated with theory, mini-projects, and Project Based Learning (PBL) as a part of many courses which enhances the capability of students in understanding and apply Engineering /Technology concepts to solve real life-problems. Hence students will develop the ability to apply the gained knowledge in multi-disciplinary projects and be able to take up major projects based on real-world problems and come up with better solutions while addressing social concerns.

REGULATIONS

COMMON TO ALL B.Tech. (CBCS) DEGREE PROGRAMS OF NITTE (Deemed to be University)

1. INTRODUCTION

1.1 The general regulations are common to all B.Tech.(CBCS) Degree Programs conducted at the NMAM Institute of Technology (NMAMIT), off-campus center of NITTE (Deemed to be University) and shall be called “B.Tech. Regulations”.

1.2 The provisions contained in this set of regulations govern the policies and procedures on the Registration of students, imparting instructions of courses, the conduct of the examination & evaluation, certification of student performance, and all amendments related to the said Degree program(s).

1.3 This set of Regulations, on approval by the Academic Council and Governing Council, shall supersede all the corresponding earlier sets of regulations of the B. Tech Degree program of NITTE (Deemed to be University) along with all the amendments thereto, and shall be binding on all students undergoing the Graduate Degree Program(s) (Choice Based Credit System) conducted at the NMAMIT, Nitte with effect from its date of approval. This set of Regulations may evolve and get modified or changed through appropriate approvals from the Academic Council / Governing Council from time to time and shall be binding on all stakeholders (The Students, Faculty, Staff of Departments of NMAMIT, Nitte). The decisions of the Academic Council/ Governing Council shall be final and binding.

1.4 To guarantee fairness and justice to the parties concerned given the periodic evolutionary refinements, any specific issues or matters of concern shall be addressed separately, by the appropriate authorities, as and when found necessary.

1.5 The Academic Council may consider any issues or matters of Concern relating to any or all the academic activities of Engineering courses for appropriate action, irrespective of whether a reference is made here in this set of Regulations or otherwise.

1.6 The program shall be called **Bachelor of Technology,** abbreviated as B.Tech. (Program Specialization).

2. ELIGIBILITY FOR ADMISSION

Sl. No	Program	Duration	Eligibility
1	B. Tech.	4 years	Passed 10+2 examination with Physics/ Mathematics / Chemistry/ Computer Science/ Electronics/ Information Technology/ Biology/ Informatics Practices/ Biotechnology/Technical Vocational subject as per Table-1 Obtained at least 45% marks (40% marks in case of candidates belonging to reserved category) in the above subjects taken together.
2	B.Tech. (Lateral Entry to Second year)	3 years	Passed Minimum THREE years / TWO years (Lateral Entry) Diploma examination with at least 45% marks (40% marks in case of candidates belonging to reserved category) in relevant branch of Engineering and Technology. (The University will offer suitable bridge courses such as Mathematics, Physics, Engineering drawing, etc., for the students coming from diverse backgrounds to prepare Level playing field and desired learning outcomes of the program)

Table-1
Academic Level and Credit Framework for admission to Bachelor of Technology (B.Tech.) degree program

Sl. No.	Academic Level	Desired Entry Qualifications at different levels.	NHEQF / NSQF Level at Exit	Unified Credit Level (UCF) at Exit
1	12^{th} Std.	-	4	4
2	First Year B.Tech. Degree	12^{th} Completed (NHEQF /UCF level 4 completed)	5	4.5
3	Second Year B.Tech. Degree	A candidate with a Diploma in the appropriate branch of Engineering /Equivalent Vocational or Technical Program with NHEQF level 5/UCF level 4.5 completed	6	5

2.1 Qualifications from foreign countries

Candidates with qualifications from educational institutions outside of India may be admitted to the program(s) subject to the establishment of equivalence by the university. The Program Committee will evaluate and establish the eligibility of such candidates.

3. PROGRAM PATHS, EXIT OPTIONS, AND DURATION OF THE B. TECH. PROGRAM

3.1 Program paths, exit options

Sl. No	Academic Level	Entry Level Qualifications	Qualifications at Exit	NCrF Level
1	1st yr. of UG Degree	A candidate completing 10+2 years with Diploma of Vocation or passed 12th std. or equivalent vocational training with NCrF level 4	**UG Certificate***	4.5
2	2nd yr. of UG Degree	A candidate with Diploma in appropriate branch of Engineering/ UG Certificate/ Equivalent Vocational or Technical Program NCrF level 4.5	**UG Diploma* (Engg.)**	5.0
3	3rd yr. of UG Degree	A candidate with 10+3+1/12+2/ UG Diploma (Engg.) in appropriate domain with NCrF level 5	**B. Sc (Engg.)***	5.5
4	Final yr. of UG Degree	A candidate with 3 yrs. Bachelor degree in Vocation / B.Sc. (Engg.) with NCrF level 5.5	**B. Tech (on completion of 160 credits with a minimum CGPA of 5)**	6
	Final yr. of UG Degree with Honours	A candidate with 3 yrs. Bachelor degree in Vocation / B.Sc. (Engg.) with NCrF level 5.5	**B. Tech (Honors)** 178 credits (Additional 18 credits over and above 160 credits in the same discipline	6
	Final yr. of UG Degree with a minor in (Other Discipline).	A candidate with 3 yrs. Bachelor degree in Vocation / B.Sc. (Engg.) with NCrF level 5.5	**B. Tech with Minor** 178 credits. Additional 18 credits over and above 160 credits in other disciplines	6

***It is mandatory to earn 10 credits through Internship/Training/Specialised courses before the award of Qualifications at Exit.**

3.2 Duration of the B. Tech. program

(a) The B. Tech Program shall extend over a period of a total duration of 4 years for students admitted during the first year of the program.

(b) The total duration shall be 3 years for students admitted to the second year under the lateral entry scheme.

(c) The maximum period which a student can take to complete a full-time academic program is eight years / Six years for Lateral entry diploma students for B.Tech.

(d) Each year shall have the following schedule with 5 ½ days a week. Suggested break down of Academic Year into Semesters

1.	No. of Semesters / Year	There are three semesters in an academic year. Two Main semesters (Odd, Even) followed by a summer semester. Normally the Odd Semester will be from August to December and Even Semester from January to May during a calendar year. The optional summer semester is offered during the vacation period of the even semester. The summer semester is offered considering the demand for such courses of needy students, subject to the availability of time, faculty, and other resources under a fast-track mode as the available instructional days during even semester vacation periods are less. However, the number of instructional hours needed to cover the syllabi shall be maintained (equivalent to that in the regular semester) with a greater number of instruction hours per week. (Note: The summer semester is primarily to assist slow learners and/or failed students in the main semesters. The summer semester may be used to arrange Add-On courses for other students and/or for deputing them for practical training elsewhere)
2.	Semester Duration	Main semester (Odd, Even) each 20 Weeks; Summer Semester 8 Weeks
3.	Academic Activities (Weeks)	**ODD / EVEN Semester** Registration of Courses & Course Work (16) Examination Preparation and Examination (04) Total (20) **Summer Semester** Registration of Courses & Course Work (05) Examination Preparation and Examination (03) Total (08) **Declaration of results:** 02 weeks from the date of the last examination **Inter-Semester Recess:** After each Main Semester (02) **Total Vacation:** 10 weeks (for those who do not register for the summer semester) and 4 weeks (for those who register for the summer semester)

(Note: In each semester, there will be provision for students to register for courses at the beginning, dropping of courses in the middle, and withdraw from courses towards the end, under the advice of a faculty member. These facilities are expected to enhance the learning capabilities of students, minimizing their chances of failure in courses registered and ensuring their better monitoring by Faculty Advisors).

A candidate shall be allowed a maximum duration of eight years from the first semester of admission to become eligible for the award of a Bachelor's degree.

The calendar of events in respect of the program shall be fixed by the Institution from time to time, but preferably in line with the suggested academic calendar of the NITTE (Deemed to be University).

4. DEGREE PROGRAMS

4.1 Undergraduate B. Tech. Degree Programs are offered in the following disciplines by the respective program hosting departments listed below:

i)	Biotechnology Engineering	(BT)
ii)	Computer Science & Engineering	(CS)
iii)	Computer Science & Engineering (Cyber Security)	(CB)
iv)	Civil Engineering	(CV)
v)	Electronics & Communication Engineering	(EC)
vi)	Electronics Engineering (VLSI Design and Technology)	(VT)
vii)	Electrical & Electronics Engineering	(EE)
viii)	Information Science & Engineering	(IS)
ix)	Mechanical Engineering	(ME)
x)	Artificial Intelligence and Machine Learning Engineering	(AM)
xi)	Computer and Communication Engineering	(CC)
xii)	Robotics and Artificial Intelligence Engineering	(RI)
xiii)	Artificial Intelligence and Data Science	(AD)
Other teaching departments are –		
i)	Chemistry	(CY)
ii)	Humanities	(HU)
iii)	Management and Social Sciences	(MG)
iv)	Mathematics	(MA)
v)	Physics	(PH)

4.2 The provisions of these regulations shall apply to any new discipline that may be introduced from time to time and appended to the above list.

5. CREDIT SYSTEM

In the Credit System, the course work of students is unitized, and each unit is assigned one credit after a student completes the teaching-learning process as prescribed for that unit and is successful in its assessment.

5.1 Credit Definition: The following widely accepted definition for credit can provide good flexibility to the students and strengthens CBCS under the University. Here, one unit of course work and its corresponding one credit (while referring to the main semester) shall be equal to:

- Four-credit theory courses shall be designed for 50 hours of the Teaching-Learning process.
- Three-credit theory courses shall be designed for 40 hours of the Teaching-Learning process.
- Two-credit theory courses shall be designed for 25 hours of the Teaching-Learning

process

- One credit theory course shall be designed for 15 hours of the Teaching-Learning process

The above figures shall also be applicable in the case of the summer semester. Other student activities which are not demanding intellectually, or which do not lend to effective assessment, like practical training, study tours, and attending guest lectures shall not carry any credit.

5.2 Credit Assignment and Lower & Upper Limits for Course Credits Registration in a Semester

All courses comprise of specific Lecture/Tutorial/Practical/Project (L-T-P-J) schedule. The course credits are fixed based on the following norms.

Lecture / Tutorials / Practical:

- 1-hour Lecture per week is assigned 1.0 Credit.
- 2-hour Tutorial session per week is assigned 1.0 Credit.
- 2-hour Lab. Session/project work per week is assigned 1.0 credit.

For example,

- A theory course with L-T-P schedule of 3-2-0 hours will be assigned 4.0 credits.
- A laboratory practical course with L-T-P schedule of 0-0-2 hours will be assigned 1.0 credit.
- Calculation of Contact Hours / Week – A Typical Example

  Example:

  An LTP-C of 2-2-2-4 means 2 instructional units based on classroom lecture (L), one instructional unit of the tutorial (T), and one laboratory (P) based instructional unit all delivered during a calendar week and repeated for the entire duration of the semester to earn 4 credits (C) after passing the course.
- As advised by the faculty advisor, a student may register, between a minimum of **16 credits and up to a maximum of 28 credits.**

The maximum number of credits a student can register during a summer semester shall be 16. However, in special cases, the student may be permitted to register additional credits with the approval of the Department Undergraduate Committee (DUGC). There is no minimum number of credits fixed for course registration during the summer semester.

6 REGISTRATION

6.1 Every student after consulting his/ her Faculty Advisor in the parent department shall register for the approved courses (core and elective) to earn credits for meeting the requirements of a degree program at the commencement of each Semester on the days fixed for such registration and notified in the academic calendar. Students who fail to register on or before the specified date will be allowed to register within one week of the last date by paying a late fee. Such courses together with their grade and credits earned will be included in the grade card issued by the University at the end of each semester, like ODD, EVEN, and summer and it forms the basis for determining the student’s performance in that semester.

6.1.1 Each course will be identified by a unique Course Code of seven alpha-numerals (two alphabets followed by 5 digits). The alphabets reflect the discipline to which the course belongs. The first numeral (after the alphabet) indicates the learning level (based on prerequisites) of the course, and the rest of the three numerals indicate a running serial number. Each course also has its version to track the revisions carried out in its syllabus over time as represented by the last numerical separated by a hyphen (-). Example: EE1001-1 represents the course offered by EE Dept., Level-1, course serial number is 001 and the version is 1.

6.2 Mandatory Pre-Registration for higher semester

To facilitate proper planning of the academic activities of the Semester, the students must declare their intention to register for courses of higher semesters (3rd and above) at least two weeks before the end of the current semester choosing the courses offered by each department in the next higher semester which is displayed on the Department Notice Board at least 4 weeks before the last working day of the semester.

Registration to a higher semester is allowed only if the student fulfills the following conditions

- Satisfied all the academic requirements to continue with the program of studies
- Cleared all Institute, hostel, and library dues and fines, if any, of the previous semester
- Paid all required fees of the Institute and the hostel for the current semester
- Has not been debarred from registering on any specific grounds by the Institute.

6.3 Registering for Backlog Courses

6.3.1 Students who have not cleared a course (Theory/ Lab/ project) are shown with “F” grade. A course having an ‘F’ grade will be considered as a backlog and it has to be re-registered in the subsequent semesters. F-graded courses are eligible to register for the next level course (pre-requisite is met).

6.3.2 Re-registration fee will be as per the university norms existing at the time of re-registration. When a course is re-registered, the evaluation marks of that course shall be treated as canceled/ reset.

6.3.3 To provide an early opportunity for students to clear their backlog of courses, efforts will be made to offer as many courses as possible during Odd, Even and summer semesters.

7 ADD/DROP/AUDIT OPTIONS

7.1 Registration of courses

Each student shall have to register for course work at the beginning of a semester within 2 to 3 days of commencement after discussing with the course teacher and under faculty advice. The permissible course load is to be either average credits (20) or to be within the limits of minimum (16) and maximum (28) credits.

7.2 DROP-option

During a specified period in the middle of a semester student’s performance in CIE is reviewed by the faculty advisor. Following a poor performance by a student, he/she can be facilitated to drop identified course(s) (up to the minimum credits specified for the semester). Such course(s) will not be mentioned in the Grade card. Such courses are to be re-registered by these students and taken up for study at a later point in time.

7.3 Withdrawal from courses (Letter Grade "W")

During a specific period specified towards the end of the semester, a student's performance in CIE is reviewed by the faculty advisors. Following a poor performance by a student in the identified course (s) he/she is advised to withdraw from such course(s) (up to the minimum credits specified for the semester) with a mention in the Grade card (Grade "W"). Such courses to be re-registered by these students and taken up for study at a later point in time.

7.4 AUDIT-option (Letter Grade "U")

A student can register for courses for audit only, to supplement his/her knowledge and/or skills. The audit courses shall not be considered in determining the student's academic performance (SGPA and CGPA) in the semester. "U" grade is awarded to such courses and will be reflected in the grade card on satisfying the attendance requirements and CIE requirements. The candidate need not appear for SEE in such courses. However, CORE courses shall not be made available for audit.

8 COURSE STRUCTURE:

8.1 Types of courses

A "Course" is defined as a unit of learning that typically lasts one semester, led by one or more teachers, for a fixed roster of students. A course has identified course outcomes, modules/units of study, specified teaching-learning methods, and assessment schemes. A course may be designed to include lectures, tutorials, practical, laboratory work, field work, project work, internship experiences, seminars, self-study components, online learning modules, etc. in any combination

The following types of courses are included in the B. Tech. program:

(a) **Humanities, Social Sciences, and Management Courses (HSMC):** These are common courses for all disciplines.

(b) **Basic Science Courses (BSC):** Physics, Chemistry, and Mathematics: These are mandatory for all disciplines.

(c) **Engineering Science Courses (ESC):** Basics of Electrical/ Electronics/ Civil/ Mechanical/ Computer Engineering, etc. These are mandatory for all disciplines.

(e) **Professional Core Courses (PCC):** These are the professional Core Courses, relevant to the chosen specialization/ branch. The core courses shall be compulsorily studied by students, and it is mandatory to complete them to fulfill the requirements of a Program.

(f) **Professional Elective Courses (PEC):** These are professional Electives, relevant to the chosen specialization/branch and can be chosen from the pool of courses. It shall be supportive to the discipline providing extended scope/enabling exposure to some other discipline /domain and nurturing student proficiency skills

(g) **Open Elective Courses (OEC):** These are the Elective Courses from other technical areas and/ or emerging fields. Students of other departments shall opt for these courses for fulfilling the eligibility and prerequisites mentioned in the syllabus.

(h) **Integrated Professional Core Courses (IPCC):** It refers to Professional Theory Core Course Integrated with Practical of the same course. Credit for IPCC shall be 04 considering L: T: P as 3:0:1 or L: T:P as 2:1:1, (where L, T, and P represent credits not hours per week)

(i) **Holistic Education Courses (HEC):** These courses are designed to look into the emotional, social, ethical and academic needs of students in an integrated learning format. It helps in the engagement of all aspects of the learner including body, mind and spirit.

(j) **Vocational Education Courses (VEC):** These courses are designed to prepare students for jobs that are based on manual or practical activities, traditionally non-academic related to a specific trade, occupation or vocation.

(k) **Emerging Technology Courses (ETC):** These courses are designed to teach students about developing technologies that will be available within the next five to ten years and are expected to create significant social or economic effects.

(l) **Programming Language Courses (PLC):** These courses are designed to teach students languages that can be used to communicate with computers for developing and working on different applications.

(m) **University Core Courses (UCC): These are compulsory core courses with common course codes across all the disciplines**

i. **Project Work (PROJ):** Provide experiential learning opportunities for students. Students are required individually, or in a small group, to select and complete a project that may include review, design, development, curation, analysis, etc. with the application of skills and knowledge relevant to the area of study. Mini-project and Project work carried out at the parent Institution, or any university / Government recognized organization without affecting the regular class work

ii. **Internship (INT):** The internship (a form of experimental learning) program is a workplace-based professional learning experience that offers supervised exposure to real-life work experience in an area related to the field of study or career interest. An internship may be undertaken at a workplace such as an industry/R&D organization/Government organization, or any other reputed organization/ institution recognized for the purpose by the University. The internship program not only helps fresh pass-outs in gaining professional know-how but also benefits corporate sectors. The internship also enhances the employability skills of the student passing out from Technical Institutions

(n) **Mandatory Non-Credit Courses (MNC):** These courses are mandatory, without the benefit of a grade or credit, passing each mandatory course is required to qualify for the award of a degree.

- Assessment of these courses is conducted in the college and will include Continuous Internal Evaluation (CIE). University Semester End Evaluation (SEE) may not be necessary for these courses.
- A minimum of 40% of the prescribed marks of CIE and SEE (If any) are required to secure a passing grade in these courses.
- The ‘PP’ grade is awarded for a Pass in the course and the ‘NP’ grade is awarded for a Fail in the course. In case an ‘NP’ grade is awarded, the student has to re-register for the same course wherein he has no alternative options.
- The “PP” and “NP” grades do not carry grade points and are hence not included in the Semester Grade Point Average (SGPA) and Cumulative Grade Point Average

(CGPA) computations. However, such non-credit mandatory courses are required to be included in the students' performance records (transcript) with Pass or Fail (PP or NP).

- Courses that come under this category are the following.
  - Engineering Visualization, Employability Skill Development, Environmental Science, Kannada etc.

(o) **Ability Enhancement Courses (AEC)** These courses are designed to help students to enhance their skills in language, communication, personality development, etc. They also promote a deeper understanding of courses like social sciences, ethics, culture, human behavior human rights, and the law. Ability Enhancement Courses are based upon the content that leads to Knowledge enhancement.

8.2 Typical Breakdown for the B.Tech. Degree Curriculum:

Sl. No.	Course Category	Credit Range	Suggested Credits
1.	Basic Science Courses (BSC)	18-23	22
2.	Engineering Science Courses (ESC)	10-15	13
3.	Emerging Technology Courses (ETC)	03-05	03
4.	Programming Language Courses (PLC)	03-05	03
5.	Professional Core Courses (PCC)	52 - 58	55
6.	Professional Elective Courses (PEC)	12-18	15
7.	Open Elective Courses (OEC)	6	6
8.	Humanities, Social Sciences and Management courses (HSMC)	09-15	12
9.	Ability Enhancement Courses (AEC)	9	9
10.	Mandatory Non-credit Courses (MNC)	Non-Credit	0
11.	Holistic Education Courses (HEC)	2	1
12.	Vocational Education Courses (VEC)	1	1
13.	Project Work (PROJ) (UCC)	10-12	10
14.	Internship (INT) (UCC)	8-12	10
15.	Note: **Student can register between 16 to 28 credits per semester**		**160**
	Total minimum Credits to be earned: 160		

8.2.1 The Department Undergraduate Committee (DUGC) will discuss and recommend the exact credits offered for the program for the above components, the semester-wise distribution among them, as well as the syllabi of all undergraduate courses offered by the department from time to time before sending the same to the Board of Studies (BOS). The BOS will consider the proposals from the departments and make recommendations to the Academic Council for consideration and approval.

8.3 The earned Credit Requirements for the B.Tech. Degree is 160.

Degree is awarded by prescribing the total number of credits to be earned, rather than by using t h e program duration, giving flexibility to a student to plan their career.

8.4Program structure and suggested Course offerings

I SEMESTER													
Sl. No.	Course and Course code		Course Title	Teaching Dept.	Teaching Hours/Week			Examination				Credits
					Theory Lecture	Tutorial	Practical/Drawing	Duration in hr	CIE Marks	SEE Marks	Total Marks	
					L	T	P					
1.	BSC	MA1001-1	Matrix Algebra & Calculus	MA	3	0	0	3	50	50	100	3
2.	BSC	PH1001-1	Engineering Physics	PH	3	0	2	3	50	50	100	4
3.	ESC	CV1001-1	Elements of Civil Engineering	CV	3	0	0	3	50	50	100	3
4.	ESC	EC1001-1	Basic Electronics	EC	3	0	0	3	50	50	100	3
5.	ESC	ME1001-1	Engineering Skill Development Practice	ME	0	0	2	2	50	50	100	1
6.	ESC	ME1002-1	Computer Aided Engineering Graphics	ME	0	2	2	3	50	50	100	2
7.	HSMC	HU1001-1	Technical English	HU	1	0	2	3	50	50	100	2
8.	HSMC	HU1002-1	Constitution of India and Professional Ethics	HU	1	0	0	1	50	50	100	1
9.	MNC	UM1001-1	Skill Development Lab Group- A	Any Dept.	0	0	4	0	0	0	0	0
				TOTAL	**14**	**2**	**12**	**21**	**400**	**400**	**800**	**19**

II SEMESTER

Sl. No.	Course and Course code		Course Title	Teaching Dept.	Teaching Hours/Week			Examination				Credits
					Theory Lecture	Tutorial	Practical/ Drawing	Duration in hr	CIE Marks	SEE Marks	Total Marks	
					L	T	P					
1.	BSC	MA1003-1	Differential Equations and Laplace Transforms	MA	3	0	0	3	50	50	100	3
2.	BSC	CY1001-1	Engineering Chemistry	CH	3	0	2	3	50	50	100	4
3.	ESC	CS1001-1	Problem-Solving through Programming	CS	3	0	2	3	50	50	100	4
4.	ESC	EE1001-1	Basic Electrical Engineering	EE	3	0	2	3	50	50	100	4
5.	ESC	ME1003-1	Elements of Mechanical Engineering	ME	3	0	0	3	50	50	100	3
6.	AEC	BT1001-1	Biology for Engineers	BT	1	0	0	1	50	50	100	1
7.	AEC	CS1002-1	IT Skills	CS	1	0	2	3	50	50	100	2
8.	MNC	CV1002-1	Environmental Science	CV	1	0	0	1	50	50	100	0
9.	MNC	UM1002-1	Skill Development Lab Group B	Any Dept.	0	0	4	0	0	0	0	0
				TOTAL	**18**	**0**	**12**	**20**	**400**	**400**	**800**	**21**

Mandatory Internship-I*								
1.	INT	UC1001-1	Internship – I	Mandatory Intra Institutional Internship of duration (80 - 90 Hours) to be completed during I & II Semesters. *The grades will be included in the IV semester grade card (Refer 11.5.2 for details)	100	--	100	2

III SEMESTER														
Sl. No.	**Course and Course code**		**Course Title**	**Teaching Dept.**	**Teaching Hours/Week**				**Examination**				**Credits**
					Theory Lecture	**Tutorial**	**Practical/ Drawing**	**PBL**	**Duration in hr**	**CIE Marks**	**SEE Marks**	**Total Marks**	
					L	**T**	**P**	**J**					
1.	BSC	MA2001-1	Statistics and Probability Theory	MA	3	0	0	0	03	50	50	100	3
2.	IPCC	RI2006-1	Introduction to Robotics	RI	3	0	2	0	03	50	50	100	4
3.	IPCC	RI2001-1	Analog and Digital Circuits	RI	3	0	2	0	03	50	50	100	4
4.	PCC	RI2106-1	Drive Systems for Robot	RI	2	0	2	✓	03	50	50	100	3
5.	PCC	RI2105-1	Data Structures and Algorithms	RI	3	0	0	0	03	50	50	100	3
6.	PCC	RI2603-1	Data Structures and Algorithms Lab	RI	0	0	2	0	03	50	50	100	1
7.	HSMC	HU1004-1	Universal Human Values	HU	1	0	0	0	01	50	50	100	1
8.	AEC	ME1654-1	Innovations and Design Thinking	ME	1	0	0	0	01	50	50	100	1
9.	MNC	HU1003-1	Kannada (Balake / Samskrithika)	HU	1	0	0	0	-	50	00	50	0
TOTAL					**17**	**0**	**8**	**-**	**20**	**450**	**400**	**850**	**20**

Course prescribed to lateral entry Diploma holders admitted to III semester of Engineering programs													
10	MNC	MA1012 -1	Bridge course - Calculus & Differential Equations	MA	3	0	0	0	-	100	0	100	0

IV SEMESTER

Sl. No.	Course and Course code		Course Title	Teaching Dept.	Teaching Hours/Week				Examination				Credits
					Theory Lecture	Tutorial	Practical/ Drawing	PBL	Duration in hr	CIE Marks	SEE Marks	Total Marks	
					L	T	P	J					
1.	BSC	MA2005-1	Linear Algebra and its Applications	MA	3	0	0	0	03	50	50	100	3
2.	IPCC	RI2002-1	Design of Robotic Components	RI	3	0	2	0	03	50	50	100	4
3.	IPCC	RI2005-1	Introduction to Object-Oriented Programming	RI	3	0	2	0	03	50	50	100	4
4.	PCC	RI2111-1	Smart Mobile Robots	RI	2	0	2	✓	03	50	50	100	3
5.	PCC	RI2109-1	Microcontroller and its Application	RI	3	0	0	0	03	50	50	100	3
6.	PCC	RI2604-1	Microcontroller Lab	RI	0	0	2	0	03	50	50	100	1
7.	HSMC	HU2001-1	Enhancing Self Competence	HU	2	0	0	0	03	50	50	100	2
8.	VEC	RI2551-1	Department specific Vocational Education Course (Motion Control using PLC)	RI	0	0	2	0	03	50	50	100	1
9.	HEC	HU1005-1	Essence of Indian Culture	HU	1	0	0	0	-	50	00	50	0
10.	UCC	UC1001-1	Internship – I (Activity based Internship)	RI	Mandatory Intra Institutional Activity based Internship of 2 weeks duration (80 - 90 h) to be completed during the vacations of I & II Semesters. Lateral entry students have to complete the Internship - I during the vacation of III semester					100	00	100	2
TOTAL					**16**	**2**	**10**	**-**	**24**	**550**	**400**	**950**	**23**

Course prescribed to lateral entry Diploma holders admitted to III semester of Engineering programs													
11	MNC	MA1014-1	Bridge course - Discrete Mathematics & Numerical Methods	MA	3	0	0	0	-	100	0	100	0

V SEMESTER														
Sl. No.	Course and Course code		Course Title	Teaching Dept.	Teaching Hours/Week				Examination					Credits
					Theory Lecture	Tutorial	Practical/ Drawing	PBL	Duration in hr	CIE Marks	SEE Marks	Total Marks		
					L	T	P	J						
1.	IPCC	RI2007-1	Kinematics and Dynamics of Robot	RI	2	2	2	0	3	50	50	100		4
2.	IPCC	RI2008-1	Image Processing and its Application	RI	3	0	2	0	3	50	50	100		4
3.	PCC	RI2101-1	Artificial Intelligence and Machine Learning	RI	2	2	0	0	3	50	50	100		3
4.	PCC	RI2601-1	AI and ML Lab	RI	0	0	2	0	3	50	50	100		1
5.	PEC	RI2XXX-1	Professional Elective-I	RI	3	0	0	0	3	50	50	100		3
6.	HSMC	HU1006-1	Introduction to IPR	Any Dept.	1	0	0	0	1	50	50	100		1
7.	AEC	RIx6xx-1	Program Specific Ability Enhancement Course	RI	1	0	2	0	3	50	50	100		2
		ME1659-1	Research Methodology	Any Dept.	2	0	0	0						
8.	AEC	HU1007-1	Social Connect & Responsibility	Any Dept.	1	0	0	0	1	50	50	100		1
9.	AEC	UM1003-1	Employability Skill Development	RI	1	0	0	0	-	50	00	50		1
TOTAL					**14/15**	**6**	**8/6**	**-**	**20**	**450**	**400**	**850**		**20**

VI SEMESTER

Sl. No.	Course and Course code		Course Title	Teaching Dept.	Teaching Hours/Week				Examination				Credits
					Theory Lecture	Tutorial	Practical/ Drawing	PBL	Duration in hr	CIE Marks	SEE Marks	Total Marks	
					L	T	P	J					
1.	IPCC	RI2003-1	Micro Aerial Robots	RI	2	2	2	0	3	50	50	100	4
2.	PCC	RI2102-1	Control Engineering	RI	3	0	0	0	3	50	50	100	3
3.	PCC	RI2602-1	Control Engineering Lab	RI	0	0	2	0	3	50	50	100	1
4.	PEC	RIxxxx-1	Professional Elective – II [Group-1]	RI	3	0	0	0	3	50	50	100	3
5.	PEC	RIxxxx-1	Professional Elective -III [Group-2]	RI	3	0	0	0	3	50	50	100	3
6.	OEC	XXX5XX-1	Open Elective –I	Any Dept.	3	0	0	0	3	50	50	100	3
7.	HSMC	MG1003-1	Management & Entrepreneurship	Any Dept.	3	0	0	0	3	50	50	100	3
8.	AEC	HU1008-1	Life Skills for Engineers	Any Dept.	1	0	0	0	1	50	50	100	1
TOTAL					**17**	**4**	**4**	**-**	**22**	**400**	**400**	**800**	**21**

VII SEMESTER

Sl. No.	Course and Course code		Course Title	Teaching Dept.	Teaching Hours/Week				Examination				Credits
					Theory Lecture	Tutorial	Practical/ Drawing	PBL	Duration in hr	CIE Marks	SEE Marks	Total Marks	
					L	T	P	J					
1.	IPCC	RI2004-1	Industry 4.0 and IOT	RI	2	2	2	0	3	50	50	100	4
2.	PCC	RI2605-1	Robot Programming and Simulation Lab	RI	0	0	2	0	3	50	50	100	1
3.	PEC	RIXXXX-1	Professional Elective -IV [Group-1]	RI	3	0	0	0	3	50	50	100	3
4.	PEC	RIXXXX-1	Professional Elective – V [Group-2]	RI	3	0	0	0	3	50	50	100	3
5.	OEC	XXX5XX-1	Open Elective –II	Any Dept.	3	0	0	0	3	50	50	100	3
6.	HSMC	MG1002-1	Financial Management	Any Dept.	3	0	0	0	3	50	50	100	3
7.	HEC	HU1009-1	Indian Knowledge Systems	Any Dept.	1	0	0	0	-	50	00	50	1
8.	UCC	UC2002-1	Major Project Phase I	RI	-	-	4	-	-	100	00	100	2
TOTAL					**15**	**02**	**8**	**-**	**18**	**450**	**300**	**750**	**20**

<table>
<tr><th colspan="15">VIII SEMESTER</th></tr>
<tr><th rowspan="3">Sl. No.</th><th rowspan="3" colspan="2">Course and Course code</th><th rowspan="3">Course Title</th><th rowspan="3">Teaching Dept.</th><th colspan="4">Teaching Hours/Week</th><th colspan="4">Examination</th><th rowspan="3">Credits</th></tr>
<tr><th>Theory Lecture</th><th>Tutorial</th><th>Practical/ Drawing</th><th>PBL</th><th rowspan="2">Duration in hr</th><th rowspan="2">CIE Marks</th><th rowspan="2">SEE Marks</th><th rowspan="2">Total Marks</th></tr>
<tr><th>L</th><th>T</th><th>P</th><th>J</th></tr>
<tr><td>1.</td><td>UCC</td><td>UC2001-1</td><td>Internship- II
(Societal internship and Research/Industry Internship)</td><td></td><td colspan="4">Mandatory Societal internship for 2 weeks (80 – 90 h) and Research Internship / Industry Internship of 6 weeks (240 – 270 h) or Research Internship / Industry internship for a total of 8 weeks (320 – 360 h)to be completed in one/two stretches during the vacation periods between IV to VII semesters</td><td>3</td><td>50</td><td>50</td><td>100</td><td>8</td></tr>
<tr><td>2.</td><td>UCC</td><td>UC3001-1</td><td>Major Project Phase II</td><td></td><td colspan="4">Student should carry out project in research institute/industry/intra institute Canter of Excellences. Two contact hours /week for interaction between the project guide and students.</td><td>3</td><td>100</td><td>100</td><td>200</td><td>8</td></tr>
<tr><td colspan="5">TOTAL</td><td>-</td><td>-</td><td>-</td><td>-</td><td>6</td><td>150</td><td>150</td><td>300</td><td>16</td></tr>
</table>

List of Vocational Education Courses (VEC)	
Code	**Elective Course Title**
RI2551-1	Motion control using PLC
RI2552-1	Metrology and Measurement

Open Electives offered to other branch students by the Department [OEC]	
Course Code	**Course Title**
RI2501-1	Autonomous Mobile Robots
RI2502-1	Medical Robotics
RI2503-1	PLC Control of Hydraulic and Pneumatic Circuits

Program Specific Ability Enhancement Course (AEC)	
Code	Title
RI2651-1	Data Acquisition and Measurements
RI2652-1	Engineering Economics
RI2653-1	PLC Control of Hydraulic and Pneumatic Circuits

List of Professional Elective Courses [PEC]			
Group-1		**Group-2**	
Automation Stream			
Code	**Elective Course Title**	**Code**	**Elective Course Title**
RI2201-1	Automation in Manufacturing Systems	RI2301-1	Digital Manufacturing
RI2202-1	CNC Machining	RI2302-1	Intelligent Manufacturing
RI2203-1	Industrial Automation and Control	RI2303-1	Mechatronics
RI2204-1	Medical Robotics	RI2304-1	Robot Gripper Design
RI2205-1	Micro-Electro-Mechanical Systems		
Signal Processing and Programming Stream			
Code	**Elective Course Title**	**Code**	**Elective Course Title**
RI2211-1	Data Visualization	RI2311-1	Augmented Reality and Virtual Reality
RI2212-1	Introduction to MATLAB Programming	RI2312-1	Computer Vision
RI2213-1	Mobile Application Development	RI2313-1	PLC and SCADA
RI2214-1	Virtual Instrumentation	RI2314-1	Signal Processing
Artificial Intelligence Stream			
Code	**Elective Course Title**	**Code**	**Elective Course Title**
RI2221-1	Cloud Computing	RI2321-1	Autonomous Vehicles
RI2222-1	Design and analysis of Algorithms	RI2322-1	Basics of Natural Language processing
RI2223-1	Machine Learning with Python	RI2323-1	Business Analytics
RI2224-1	Managing Information System		

8.5 Eligibility for submission of Project Work Report

8.5.1 Project work during the 8th semester shall be taken up batch-wise and report can be submitted for evaluation only on completion of a minimum of **122 credits** and for Diploma lateral entry students (those who have joined the second year B.Tech.) the same is **88 credits.**

8.5.2 Project work can be carried out as domain-specific /interdisciplinary under the guidance of faculty/ faculty members. They can also opt for an advanced Internship or research Internship in an Industry / Research Institution/Center of excellence.

8.5.3 Project viva-voce examination shall be conducted individually.

8.6 ELECTIVES

8.6.1 A candidate shall take electives in each semester from groups of electives, commencing from the 5th semester.

8.6.2 The minimum number of students to be registered for any Elective offered shall not be less than fifteen (15) and should not exceed forty (40).

8.6.3 A candidate shall opt for his/her choice of electives and register for the same at the beginning of each of the 5th to 7th semesters if pre-registration is not done. The candidate is permitted to opt for a change of elective within 15 days from the date of commencement of the semester as per the academic calendar of the college.

9 ATTENDANCE REQUIREMENT:

9.1 Each semester is considered as a unit and the candidate has to put in a minimum attendance of 85% in each subject with a provision of condoning 10% of the attendance by the Principal for reasons such as medical grounds, participation in University level sports, cultural activities, seminars, workshops, and paper presentation.

9.2 The basis for the calculation of the attendance shall be the term prescribed by the institution by its calendar of events. For the first semester students, the same is reckoned from the date of admission to the course.

9.3 The students shall be informed about their attendance position in the first week of every month by the College so that the students shall be cautioned to make up for the shortage.

9.4 A candidate having a shortage of attendance (<75%) in any course(s) registered shall not be allowed to appear for SEE of such course(s). Such students will be awarded an **'N' grade** in these courses.

9.5 He/she shall have to repeat those course(s) with an 'N' grade and shall re-register for the same course(s) core or elective, as the case may be when the particular course is offered next either in a main (odd/even) or summer semester.

9.6 Attendance in CIE and SEE:

Attendance in all examinations both CIE and SEE of each course registered shall be compulsory and there shall not be any provision for re-examinations. Any student against whom any disciplinary action is pending shall not be permitted to attend any SEE in that semester.

10 WITHDRAWAL FROM THE PROGRAM

10.1 Temporary Withdrawal

a) A student who has been admitted to a degree program of the college may be permitted once during the course to withdraw temporarily, for one semester, on the grounds of prolonged illness or grave calamity in the family, etc., provided –

i. The student applies to the College within 6 weeks of the commencement of the college stating fully the reasons for withdrawal together with supporting documents and endorsement from his parent/guardian.

ii. The College is satisfied with the genuineness of the case and that even by considering the expected period of withdrawal, the student can complete the program requirements (160 credits) within the time limits specified by the university.

iii. The student does not have any dues or demands at the College / University including tuition and other fees as well as library material.

iv. A student availing of temporary withdrawal shall be required to pay such fees and/or charges as may be fixed by the college until his/her name appears on the student's roll list. The fees/charges once paid shall not be refunded.

v. A student will be entitled to avail of the temporary withdrawal facility only once during his/her studentship. However, any other concession for the concerned student shall have to be approved by the academic council.

10.2 Permanent Withdrawal

Any student who withdraws the admission before the closing date of admission for the Academic Session is eligible for the refund of the deposits only. Fees once paid will not be refunded on any account.

Once the admission for the year is closed, the following conditions govern withdrawal of admissions.

i) A student who wants to leave the College for good will be permitted to do so (and take a Transfer Certificate from the College, if needed), only after clearing all other dues if any.

ii) Those students who have received any scholarship, stipend, or other forms of assistance from the College shall repay all such amounts.

iii) The decision of the Principal of the College regarding the withdrawal of a student is final and binding.

11 EVALUATION SYSTEM

11.1 The Academic Performance Evaluation of a student shall be according to a Letter Grading System, based on the Class Performance Distribution.

11.2 The Letter grades O, A+, A, B+, B, C, P, and F indicate the level of academic achievement, assessed on a decimal (0-10) scale.

11.3 The Letter grade awarded to a student in a course, for which he has registered shall be based on his performance in quizzes, tutorials, assignments, etc., as applicable, in addition to two mid-semester examinations and one semester-end examination. The distribution of weightage among these components may be as follows.

Semester End Examination (SEE)		:	50% (50 marks)
Continuous Internal Evaluation (CIE)		:	50% (50 marks)
CIE for Non-PBL Courses			
i)	Quizzes, Tutorials, Assignments, Seminars, etc.	:	10 marks
ii)	Mid-semester Examinations	:	40 marks
CIE for PBL/IPCC Courses			
i)	Project Based Learning (PBL)	:	50 marks
ii)	Mid-semester Examinations	:	40 marks
iii)	Quizzes, Tutorials, Assignments, Seminars, etc.	:	10 marks
60% weightage for theory + 40% weightage for PBL/Practical			

Any variation, other than the above distribution, requires the approval of the pertinent DUGC and Academic Council.

11.4 The letter grade awarded to a student in a 0-0-P (Practical) course, is based on an appropriate continuous evaluation scheme that the course instructor shall evolve, with the approval of the pertinent DUGC and the performance in SEE held on the specified period in a semester.

11.5 **Evaluation Scheme** *(Refer to Appendix-B for detailed evaluation guidelines)*: The course Instructor shall announce in the class and/or display at the Notice board/faculty door/website the details of the Evaluation Scheme, including the distribution of the weightage for each of the components and method of conversion from the raw scores to the letter-grades within the first week of the semester in which the course is offered so that there are no ambiguities in communicating the same to all the students concerned.

11.5.1 **Internship:** Mandatory Internship is in two parts. Internship-I (2 weeks) and Internship-II (8 weeks)

11.5.2 **Internship-I**

11.5.2.1 All the students admitted to the 1st semester of engineering programs shall have to undergo Internship-I of 02 weeks (or 80 to 90 hrs duration) during the first year. The internship shall include Inter / Intra Institutional activities. A viva – voce examination (Presentation followed by question-answer session) shall be conducted during the 2nd semester (for lateral entry students, during the 3rd semester) and the prescribed credit shall be included in the 4th-semester grade card.

11.5.2.2 All the students admitted to the 3rd semester of Engineering programs (Lateral Entry Category) shall have to undergo a mandatory internship of 02 weeks (during the 3rd semester or the intervening period of the 3rd and 4th semesters). The internship shall include Inter/Intra Institutional activities.

11.5.2.3 The internship shall be considered as a head of passing and shall be considered for the award of a degree. Those, who do not take up / complete the internship shall be declared to fail and shall have to complete it during subsequent University examinations after satisfying the internship requirements. (The faculty coordinator or mentor has to monitor the student's internship progress and interact to guide them for the successful completion of the internship).

11.5.2.4 Procedure for the Evaluation of Internship-I

a) Students should submit the reports immediately on completion of the Internship to the respective mentors

b) The Examination of the internship will be carried out by the mentor

c) The Internship-I shall be slated for 100 marks CIE only and will not have SEE.

d) Internship-I marks are based on CIE marks (25 marks for the first presentation, 25 marks for the second presentation, and 50 marks for the report and final presentation).

e) A Viva-Voce examination is conducted during I/II/III Semesters (Presentation followed by question-answer session) and the prescribed credit shall be included in the IV semester grade card.

11.5.3 Internship-II

11.5.3.1 All the students admitted to engineering programs shall have to undergo Internship-II of 08 weeks during the second and third year of their Engineering studies.

11.5.3.2 During the intervening period of the IV & V semesters and VI & VII semesters, students shall be ready for industrial experience. Therefore, they shall choose to undergo 8 weeks Internship involving Innovation / Entrepreneurship/ or short-term (about 2 weeks) societal-related activities and 6 weeks Industry Internship.

11.5.4 **Project work evaluation:** The evaluation of CIE of the project work shall be based on the progress of the student in the work assigned by the project supervisor, periodically evaluated by him/her together with a department committee constituted for this purpose. Seminar presentation, project report, and final oral examination conducted by the project evaluation committee at the department level shall form the SEE of the project work.

11.5.5 In the case of other requirements, such as seminar, field work, or comprehensive viva voce, if any, the assessment shall be made as laid down by the DUGC/Academic council.

11.5.6 There shall be no re-examination for any course in the credit system.

However, students

- who have abstained from attending CIE or SEE without valid reasons ("N" grade), or
- who have failed (F grade) to meet the minimum passing standards prescribed for CIE and/or SEE or
- who have been detained for shortage of attendance or who have withdrawn (W grade) who have dropped any course shall be required to re-register for such course(s) and go through CIE and SEE again and obtain a grade equal to or better than "P" Grade in each case.
- While such students should re-register for the same course(s) if core, they can re-register for the alternative course(s) from among the elective courses, as the case may be. The re-registration shall be possible when the particular course is offered again either in a main (Odd/Even) or summer semester.

11.6 Qualifying standards

Evaluation Method	Qualifying Standard
Sessional (CIE)	Score: ≥40% (≥20 marks)
Terminal (SEE)	Score: ≥40% (≥20 marks)
For securing a final Pass	Total **40 % of the Course maximum marks (100)** i.e., the sum of the CIE and SEE marks prescribed for the Course is desired.

11.7 Grading System

The letter grade awarded to a student for his/her performance in a course is based on Absolute Grading.

11.7.1 Absolute Grading – Letter Grade and its range

The grade point scale for absolute grading

Marks Range (%)	Grade Point	Letter Grade	Descriptor
90 & above	10	O	Outstanding
80-89	9	A+	Excellent
70-79	8	A	Very Good
60-69	7	B+	Good
55-59	6	B	Above Average
50-54	5	C	Average
40-49	4	P	Pass
00-39	0	F	Fails
Absent	0	F	Absent

CGPA	Classification
7.00-& above	**First Class with Distinction**
6.00-6.99	**First Class**
5.00-5.99	**Second Class**
CGPA < 5.00*	**Academic Probation / Non-compliance**

* If a student secures CGPA< 5.0 at any point time during his/her studies, he/she will be on Academic Probation/Noncompliance (refer to sections 14.2 and 17.3 for more details.)

i) **Grade "N":** A candidate having a shortage of attendance (<75%) in any course(s) or CIE marks less than 40% shall not be allowed to appear for SEE of such course(s). Such students will be awarded an 'N' grade in these courses with a grade point of 0.

ii) The grade points are given above help in the evaluation of credit points earned by the student in a course as the credit points are equal to the number of credits assigned to the course multiplied by the grade points awarded to the student in that course. This shall be used in Arriving at the credit index of the student for that semester, as it is the total of all the credit points earned by the student for all the courses registered in that semester.

11.8 Earning of Credits

A student shall be considered to have completed a course successfully and earned the credits if he/she secures an acceptable letter grade in the range of O-P. The letter grade "F" in any course implies the failure of the student in that course and no credits earned.

11.8.1 The Transitional Grades "I", "W" and "X" would be awarded by the teachers in the following cases. These would be converted into one or the other of the letter grades (O-F) after the student completes the course requirements.

11.8.2 **Grade "I"**: To a student having attendance ≥85% and CIE ≥70%, in a course, but remained absent from SEE for valid & convincing reasons acceptable to the College, like:

i) Illness or accident, which disabled him/her from attending SEE.

ii) A calamity in the family at the time of SEE required the student to be away from the College.

iii) However, the committee chaired by the Principal is authorized to relax the requirement of CIE ≥ 70% if the student is hospitalized or advised long-term rest after discharge from the hospital by the Doctor.

iv) Students who remain absent for Semester End Examinations due to valid reasons and those who are absent due to health reasons are required to submit the necessary documents along with their request to the Controller of Examinations to write Makeup Examinations within 2 working days of that examination for which he or she is absent, failing which they will not be given permission.

11.8.3 **Grade "W":** To a student having satisfactory attendance at classes, but withdrawing from that course before the prescribed date in a semester under Faculty Advice

11.8.4 **Grade "X":** To a student having attendance ≥85% and CIE ≥70%, in a course but SEE performance could result in an F grade in the course. **(No "F" grade will be awarded in this case, but the student's performance record is maintained separately).**

11.9 Summer / Fast Track semester

11.9.1 The students who have satisfied CIE and Attendance requirements for the course/s and obtained an F grade in SEE are permitted to appear directly in ensuing examination/s as backlog paper/s. The students need not re-register for such course/s in the summer / fast track semester. In case the student wishes to improve CIE/ he/she has to re-register for the summer / regular semester as and when offered next.

11.9.2 The student who obtains required attendance and CIE in the summer semester, but obtains an 'F' grade in SEE; is permitted to appear for SEE subsequently as backlog course/s. The student need not repeat the course for Attendance and CIE.

11.9.3 The course/s for which the student does not possess satisfactory attendance and CIE score shall be marked as 'N' on the Grade sheet. Such students are not permitted to SEE for the Courses marked as ‘N’ on the Grade sheet. The students have to re-register only for course/s marked as ‘N’ in the summer/ subsequent semester whenever that course is offered and obtain the required CIE and attendance. Subsequently, they are eligible to appear for SEE in such course/s.

11.9.4 Courses with Transitional Grades viz "W”, "I", and "X" are also eligible to register in the summer semester in case they wish to improve their score in CIE.

11.9.5 All courses may not be offered in the summer semester. It is the discretion of the University to offer the courses based on the availability of resources. The Institutes shall notify timetable for the summer semester well in advance.

11.9.6 Summer Semester is optional; it is for the student to make the best use of the opportunity.

11.9.7 A student is permitted to register for a maximum of 16 credits in the Summer / fast track semester.

11.9.8 A student has to choose those courses which are offered by the Institution in a given summer Semester.

11.9.9 In the summer semester, each course needs to be offered for the required number of lectures/ tutorial/ laboratory hours as prescribed in the syllabus.

11.10 Grade Card

Each student shall be issued a Grade Card at the end of each semester. This will have a list of all the courses registered by a student in the semester, together with their credits, the letter grades with grade points awarded. Only those courses registered for credit and having grade points shall be included in the computation of the students’ performance like SGPA and CGPA and the courses are taken for audit will not form part of this computation. The results of mandatory courses, which are of the non-credit type shall also be reflected in the Grade card as PP (for Passed) or NP (for not passed). **Each UG student shall have to obtain the grade PP in each mandatory course to qualify for the Degree awarded by the university.**

11.11 Re-evaluation and paper seeing.

Re-evaluation is permitted only for theory papers. The University, on receiving application within the stipulated time and remittance of a prescribed fee for re-evaluation, shall permit re-evaluation for the course/s applied. The marks obtained after re-evaluation shall be the final marks awarded.

11.12 The Make-Up Examination

The Make-Up Examination facility would be available to students who may have missed attending the SEE of one or more course(s) in a semester for valid reasons and given the “I” grade; Also, students having the “X” grade shall be eligible to take advantage of this facility. **The makeup examination would be held as per dates notified in the Academic Calendar during the summer semester.** However, it would be possible to hold a makeup examination at any other time in the semester with the permission of the Academic Council of the College. In all these cases, the standard of makeup examinations shall be the same as the regular SEE for the course(s).

a) All the "I" and "X" grades awarded to the students would be converted to appropriate letter grades after the make-up examinations. Any outstanding "I" and "X" grades after the last scheduled make-up examinations shall be automatically converted to "F" grades.

b) All the "W" grades awarded to the students would be eligible for conversion to the appropriate letter grades only after the concerned students re-register for these courses in a main/ Summer semester and fulfill the passing standards for their CIE and (CIE+SEE).

11.13 Rules for grace marks

11.13.1 Grace marks up to 1% of the maximum total marks of the courses for which he/she is eligible and have registered (non-credit courses excluded) in the examination or 10 marks whichever is less shall be awarded to the failed course(s), (with a restriction of a maximum of 5 marks per course) provided on the award of such grace marks the candidate passes in that course(s).

11.13.2 No grace marks for change of grade point.

12 EVALUATION OF PERFORMANCE

The overall performance of a student will be indicated by two indices:

SGPA; which is the Semester Grade Point Average, and CGPA which is the Cumulative Grade Point Average.

SGPA for a semester is computed as follows.

$$SGPA = \frac{\sum[(Course\ Credits) \times (Grade\ Point)]\ \text{(for all courses in that semester)}}{\sum[Course\ Credits]}$$

CGPA is computed as follows:

$$CGPA = \frac{\begin{array}{c}\sum[(Course\ Credits) \times (Grade\ Point)] \\ \text{(for all courses excluding those with F grades until that semester)}\end{array}}{\begin{array}{c}\sum[Course\ Credits] \\ \text{(for all courses excluding those with F grades until that semester)}\end{array}}$$

13 COMMUNICATION OF GRADES

The SGPA and CGPA respectively, facilitates the declaration of academic performance of a student at the end of a semester and the end of successive semesters. Both would be normally calculated to the second decimal position.

14 REQUIREMENTS FOR VERTICAL PROGRESSION (PROMOTION / ELIGIBILITY TO HIGHER SEMESTERS)

14.1 All students are promoted to the next semester or year of their program, irrespective of their academic performance.

14.2 However, at any stage of his/her study, if a student reaches a CGPA below 5.00, the student will be on Academic Probation and is permitted to register for a maximum of 16 credits during odd semester of an academic year. However, the student has the choice to re-register for the courses/courses in which he/she has obtained an 'F'/ 'N' grade.

14.3 A Student shall be declared fail if he/she

(i) Has not satisfied the CIE requirements of any Course/s.

(ii) Has not appeared for the SEE even after satisfying the attendance and CIE requirements.

14.4 Vertical Progression for regular students who have taken admission to the first year:

Normally a student is expected to complete a minimum of 85% of credits by the end of the 7th semester. However, **for submission of B.Tech. Major Project in 8th semester, the student should have completed at least 122 credits.**

14.5 Vertical Progression in case of Diploma students admitted to Second year (lateral entry):

14.5.1 Lateral entry students should complete at least 85% of credits by the end of the 7th semester. However, for **submission of B.Tech. Major Project in 8th semester, the student should have completed at least 88 credits.**

14.5.2 Diploma students should register for mandatory non-credit Mathematics Courses Bridge Courses (i) Calculus and Laplace Transforms and (ii) Probability and Differential Equations prescribed during III and IV semesters respectively. They shall attend these bridge course classes during the respective semesters to satisfy attendance and CIE requirements.

14.5.3 Completion of Mathematics Courses Bridge Courses (i) Calculus and Laplace Transforms and (ii) Probability and Differential Equations shall be mandatory for the award of the degree.

14.6 Termination from the program

A student shall be required to withdraw (discontinue) from the program and leave the college on the following grounds.

i) Failure to secure a minimum CGPA of 5.0 at the end of the 8 years (6 years for lateral entry students).

ii) Failure to earn 160 credits (120 for lateral entry students) in 8 years (6 years for lateral entry students) of duration from the year of admission including the duration of temporary withdrawal (leave of absence).

iii) Absence from classes for more than **six weeks at a time** in a semester without leave of absence being granted by competent authorities.

iv) Failure to meet the standards of discipline as prescribed by the college from time to time.

15 AWARD OF CLASS

Sometimes, it would be necessary to provide equivalence of these averages, viz., SGPA and CGPA with the percentages and/or classes awarded as in the conventional system of declaring the results of university examinations. This can be done by prescribing certain specific thresholds in these averages for Distinction, First Class and Second Class. This can be seen in the following Table.

Percentage Equivalence of Grade Points (For a 10-Point Scale)

Grade Point	Percentage of Marks*	Class
≥ 7.00	≥ 70%	First class with Distinction
≥ 6.00	≥ 60%	First Class
5.0 ≥ CGPA <6.00	50≥ Percentage < 60%	Second Class

Percentage * = (CGPA) x 10

16 APPEAL FOR REVIEW OF GRADES

a. The entire process of evaluation shall be made transparent and the course instructor shall explain to a student why he/she gets whatever grade he/she is awarded, if and when required. A mechanism for the review of grades is incorporated into the evaluation system. However, before appealing for such review, a student shall first approach the concerned course Instructor and then the concerned DUGC, with the request to do the needful; and only in situations where satisfactory remedial measures have not been taken, the student may then appeal to the Department Academic Appeals Boards (DAAB) before the date specified in Academic Calendar, by paying the prescribed fees.

b. The fee for such an appeal will be decided by the Senate from time to time. If the appeal is upheld by DAAB, then the fee amount will be refunded to the student.

17 AWARD OF DEGREE

17.1 (1) B.Tech. Degree

a) Students shall be declared to have completed the Program of B.Tech. degree and is eligible for the award of degree provided the students have undergone the stipulated Course work of all the semesters under the Scheme of Teaching and Examinations and have earned the prescribed number of credits (160 credits for regular students registered for 4-year degree programs & 120 for lateral entry students).

b) For the award of a degree, a CGPA≥5.00 at the end of the Program shall be mandatory.

c) Completion of Additional Mathematics I and II shall be mandatory for the award of degree to lateral entry diploma students.

d) Earning of Activity Points:

i. Every student entering 4-year degree program should earn 100 activity points & every student entering 4-year degree program through Lateral Entry should earn 75 activity points as per the AICTE Activity Point Program for the award of an Engineering degree

ii. The activities can be spread over the years (duration of the program) at any time during the semester weekends and holidays, as per the interest & convenience of the students from the year of entry to the program.

iii. The Activity Points earned shall be reflected on the student’s eighth-semester Grade Card.

iv. Activity Points (non-credit) do not affect SGPA/CGPA and shall not be considered for vertical progression.

v. In case students fail to earn the prescribed activity Points before the commencement of 8th-semester examinations, the eighth-semester Grade Card shall be issued only after earning the required activity Points. Students shall be admitted for the award of a degree only after the release of the Eighth semester Grade Card.

17.2 Honours/ Minors Degree

17.2.1 B.Tech. (Honours) Degree

i. Students must earn a minimum of 18 additional credits in his/her major program discipline entitles a student to get an 'Honours' credential.

ii. Students have to pay additional fees for all the courses registered for 'Honours'

iii. Students with a minimum of 7.5 CGPA and no backlog at the end of the 4th semester will qualify for registering for courses under the 'Honours credential.

iv. Students shall register for 'Honours' courses from the 5th semester onwards.

v. Students should register for additional courses and plan to take courses that are prescribed under that 'Honours' list as per 'pre-requisite' courses to earn the 'Honours' credential.

vi. Students who wish to acquire an 'Honours' credential need to carry out 'Honours' course registration along with their regular semester course registration.

vii. He/she accumulates credits by registering for the required courses, and if the requirements for 'Honours' are met within the prescribed minimum time limit of the program, the 'Honours' will be awarded along with the degree.

viii. Also, the student should meet the following **requirements to become eligible for the 'Honours award.**

- Minimum CGPA of 7.5 in this major discipline at the end of the 8th semester
- Minimum CGPA of 7.0 in the registered 'Honours' courses

ix. In case a student withdraws from the 'Honours' registration in the middle of the program, the 'Honours' courses completed will be converted to 'Audit' courses and indicated accordingly in subsequent Grade Sheets and Consolidated Grade Sheets.

x. It must be noted that the 'Honours' award will be mentioned in the Degree Certificate as **"Bachelor of Technology in (specialization) with Honours".**

xi. This fact will also be reflected in the Consolidated Grade Sheet under a separate heading 'Honours' with similar details shown for other credited courses and the CGPA for 'Honours' will be indicated at the end of the list of courses under 'Honours'.

xii. The grades obtained in the courses credited towards the 'Honours' award are not counted and shall not influence the GPA/ CGPA of the 'program' student has registered.

17.2.2 Minor Degree

i. Students have to earn a min of 18 additional credits from the courses focused on discipline other than his/her major program discipline entitles a student to get a 'Minor' credential.

ii. Students have to pay additional fees for all the courses registered for 'Minor'.

iii. Students with a minimum of 5.0 CGPA and no backlog at the end of the 3rd semester will only qualify for registering for the course under the 'Minor' credential.

iv. Students shall register for 'Minor' degree courses from the 4th semester onwards.

v. All Departments will offer 'Minors' in their varied disciplines and will prescribe what set of courses and/or projects is necessary for earning a minor in that discipline.

vi. Students should register for additional courses and plan to take courses that are prescribed under that 'Minors' list as per 'pre-requisite' courses to earn the 'Minor' credential

vii. If any of the courses listed under the 'minor' option is a course listed under his/her curriculum as PCC then the student cannot opt for that 'Minor', since all minor courses need to be earned as additional courses to his/her program curriculum and depts decision is final and binding

viii. Students who wish to acquire a 'Minor' can register for 'Minor' courses along with their regular semester course registration.

ix. Also, the student should have a minimum **CGPA of 5.0 in the 'Minor' courses registered to become eligible for the Minor credentia**l. This fact will also be reflected in the Consolidated Grade Sheet under a separate heading 'Minor in (specialization)'.

x. If the course requirements for a particular 'Minor' are met within the prescribed minimum time limit of the program, the minor will be awarded along with the degree, and it will be mentioned in the **Degree Certificate as "Bachelor of Technology in (Major discipline) with Minor in (specialization)."**

xi. In case a student withdraws from the 'Minor', the 'Minor' courses completed, will be converted to 'Audit' courses and indicated accordingly in subsequent Grade Sheets and Consolidated Grade Sheets.

xii. The grades obtained in the courses credited towards the 'Minor' award are not counted and shall not influence the GPA/ CGPA of the program the student has registered for.

17.2.3 Additional norms for Honours/Minors

i. Students shall register for additional courses to earn Honours/Minors in consultation with their Class Advisor from the list of courses suggested by the DUGC.

ii. DUGC may recommend Massive Open Online Courses (MOOCs)/SWAYAM/NPTEL courses to students who wish to register for Honours/Minors after justifying and establishing the equivalence of the curriculum. The decision of DUGC should be communicated to the Dean of Academics and Controller of Examinations for seeking approval.

iii. A maximum of 40% credits prescribed for Honors/Minors may be earned through MOOCs/SWAYAM/NPTEL

iv. Students may choose to take up additional course work, from the MOOCs courses list suggested by various departments (which can be from SWAYAM/NPTEL) with proctored examinations as approved by the University and complete the same before the last working day of the VIII semester with a final score (online assignments: 25 % + Proctored examination: 75 %) leading to the following certificates: Completed the course (40-59)– ELITE (60 to 75 %) or ELITE + SILVER (76 to 89 %) or ELITE + GOLD (≥ 90 %)

v. In case, in MOOCs (ex: Coursera), there is no proctored examination, the University will conduct a SEE as deemed to be fit for the award of Credits

vi. The Credit equivalence for online courses shall be as follows –

- 4 weeks of online course duration – 1 credit (approx. 13-14 hours)
- 8 weeks of online course duration – 2 credits (approx. 26-28 hours) and
- 12 weeks of online course duration – 3 credits (approx. 39-42 Hours)

17.3 Noncompliance

17.3.1 Noncompliance of CGPA ≥ 5.00 at the end of the Program

a) Students, who have completed all the courses of the Program but do not have a CGPA ≥ 5.00 at the end of the Program, shall not be eligible for the award of the degree.

b) In the cases of 17.3 (1), a student shall be permitted to appear again for SEE in course/s (other than Internship, Technical seminar, Project (Mini and Major), and Laboratories) of any Semester/s without the rejection of CIE marks for any number of times, subject to the provision of a maximum duration of the Program to make up the CGPA equal to or greater than 5.00 for the award of the Degree.

c) Students shall obtain written permission from the Controller of Examinations to reappear in SEE to make up the CGPA equal to or greater than 5.00.

d) In case, the students earn improved grade/s in all the reappeared course/s, the CGPA shall be calculated considering the improved grade/s. If it is ≥5.00, the students shall become eligible for the award of the degree. If CGPA <5.00, the students shall follow the procedure laid in 17.3.1 (b).

e) In case, the students earn improved grade/s in some course/s and the same or lesser than the previously earned pass grade/s in the other reappeared course/s, the CGPA shall be calculated considering the improved grade/s and the pass grades earned before the reappearance. If it is ≥5.00, the students shall become eligible for the award of the degree. If CGPA<5.00, the students shall follow the procedure laid in 17.3.1 (b).

f) In case, the students earn improved grade/s in some courses and fail in the other reappeared course/s, the CGPA shall be calculated by considering the improved grade/s and the previously earned pass grade/s of the reappeared course/s in which the students have failed. If it is≥5.00, the students shall become eligible for the award of the degree. If CGPA <5.00, the students shall follow the procedure laid in 17.3.1 (b).

g) In case, the students fail (i.e., earns an F grade) in all the reappeared course/s, pass grade/s of the course/s earned by the students before reappearance shall be retained. In such cases, the students shall follow the procedure laid in 17.3.1 (b).

17.3.2 Noncompliance with Project/ Mini project

The project/mini project shall be considered as a head of passing and shall be considered for the award of degree. Those, who do not take up/complete the mini-project shall be declared to fail in that course and shall have to complete the same during subsequent University examinations after satisfying the Mini-project requirements.

17.3.3 Noncompliance of Internship

All the students of B. Tech shall have to undergo mandatory Internship-I and Internship-II for a total of 10 weeks to earn a total of 10 credits in parts during the vacations at the end of the 1/2/3 academic year. The evaluation of Internship shall be during IV and VIII semesters. The internship shall be considered mandatory for the award of a degree. Those, who do not take up/complete the internship shall be declared to fail in that Course and shall have to complete the same during subsequent University examinations after satisfying the internship requirements.

The maximum duration for a student for complying with the Degree requirements is 16 – semesters from the date of first registration for his/ her first semester (8 years from the date of admission to the first year, (12 semesters / 6 years from the date of admission for lateral entry student)).

18 GRADUATION REQUIREMENTS AND CONVOCATION

18.1 A student shall be declared to be eligible for the award of the degree if he/she has

a) Fulfilled "Award of Degree" Requirements
b) No Dues to the College, Departments, Hostels, Library, Central Computer Centre and any other centers
c) No disciplinary action is pending against him/her.

18.2 The award of the degree must be recommended by the Governing council

18.3 **Convocation:** Degree will be awarded to the students who have graduated during the preceding academic year. Students are required to apply for the Convocation along with the prescribed fees, after having satisfactorily completed all the degree requirements (refer to "Award of Degree") within the specified date to arrange for the award of the degree during convocation.

19 AWARD OF PRIZES, MEDALS, CLASS & RANKS

19.1 For the award of Prizes and Medals, the conditions stipulated by the Donor may be considered as per the statutes framed by the University for such awards. Sometimes, it would be necessary to provide equivalence of these averages, viz., SGPA and CGPA with the percentages and/or Class awarded as in the conventional system of declaring the results of University examinations. This can be done by prescribing certain specific thresholds in these averages for Distinction, First Class, and Second Class as described in Section 15.

19.2 An attempt means the appearance/registration of a candidate for an examination in one or more courses either in part or failing a particular examination.

19.2.1 A candidate who fails/remains absent (after submitting exam application) in the main examination and passes one or more subjects/courses or all subjects/courses in the supplementary/Make-up examination such candidates shall be considered as taken more than an attempt.

19.3 Merit Certificates and University Medals/ will be awarded based on overall CGPA, governed by the specific selection criteria that may be formulated by the University for such Medals / Awards

19.3.1 Only those candidates who have completed the Program and fulfilled all the requirements in the minimum number of years prescribed (i.e., 3 years for Diploma lateral entry students or 4 years for students who joined after the 12^{th} standard) and who have passed each semester in the **first attempt** are eligible for the award of Merit Certificates and /or University Medals.

19.3.2 Candidates with W, N, I, X & F grades and who passes the courses in the subsequent/supplementary/make up examinations are not eligible for the award of

Gold Medal or Merit Certificate.

20 CONDUCT AND DISCIPLINE

20.1 Students shall conduct themselves within and outside the premises of the College in a manner befitting the students of an Institution of National Importance.

20.2 As per the order of the Honorable Supreme Court of India, ragging in any form is considered a criminal offense and is banned. Any form of ragging will be severely dealt with.

20.3 The following acts of omission/ or commission shall constitute a gross violation of the Code of Conduct and are liable to invoke disciplinary measures:

i. Ragging.
ii. Lack of courtesy and decorum; indecent behavior anywhere within or outside the campus.
iii. Willful damage or stealthy removal of any property/belongings of the College/Hostel or fellow students/citizens.
iv. Possession, consumption, or distribution of alcoholic drinks or any kind of hallucinogenic drugs.
v. Mutilation or unauthorized possession of Library books.
vi. Noisy and unseemly behavior, disturbing studies of fellow students.
vii. Hacking in computer systems (such as entering into another Person's area without prior permission, manipulation and/or Damage of computer hardware and software, or any other Cybercrime, etc.).
viii. Plagiarism of any nature.
ix. Any other act of gross indiscipline as decided by the Senate from time to time.
x. Use of Mobile in the college Academic area.
xi. Smoking in College Campus and supari chewing.
xii. Unauthorized fundraising and promoting sales.
xiii. Commensurate with the gravity of the offense the punishment may be: reprimand, expulsion from the hostel, debarring from an examination, disallowing the use of certain facilities of the College, rustication for a specified period or even outright expulsion from the College, or even handing over the case to appropriate law enforcement authorities or the judiciary, as required by the circumstances.

20.4 For an offense committed in (i) a hostel (ii) a department or a classroom and (iii) elsewhere, the Chief Warden, the Head of the Department, and the Dean (Academics), respectively, shall have the authority to reprimand or impose fine.

20.5 All cases involving punishment other than reprimand shall be reported to the principal.

20.6 Cases of adoption of unfair means and/or any malpractice in an examination shall be reported to the Controller of Examinations for taking appropriate action.

20.7 **Note:** Students are required to be inside the examination hall 20 minutes before the commencement of the examination. This is applicable for all examinations (Semester end/Supplementary/makeup) henceforth. Students will not be allowed inside the examination hall after the commencement, under any circumstances.

****

APPENDIX - A

Definitions, terminology, and abbreviations

1. **Nitte DU / University**
   a. Refers to Nitte (Deemed to be University)

2. **BoM**
   a. Refers to Board of Management of Nitte (Deemed to be University)

3. **BoS**
   a. Refers to the Board of Studies in Mechanical Engineering

4. **Institute/Institution**
   a. Refers to NMAM Institute of Technology, Nitte

5. **Program**
   a. A range of learning experiences over a specified period, leading to the award of a degree/diploma/certificate. A program is completed when the courses that make up the program are completed, and other requirements as specified in the program regulations are met.

6. **Course**
   a. A unit of learning that typically lasts one semester, led by one or more teachers, for a fixed roster of students. Often referred to as a “subject”. A course has identified course outcomes, modules/units of study, specified teaching-learning methods, and assessment schemes. A course may be designed to include lectures, tutorials, practical, laboratory work fieldwork, project work, internship experiences, seminars, self-study components, online learning modules, etc. in any combination.

7. **Semester**
   a. An academic session, usually of 16 weeks duration, with a minimum of 90 working days during which coursework and assessments are to be completed. Typically, two semesters make up an academic year, with the first of these referred to as the Odd Semester and the second as the Even Semester.

   b. An additional short semester (usually 8 weeks) may be offered between an even semester and subsequent odd semester (in the interval between two academic years) and is termed a summer semester. The summer semester is offered to enable students to register for:
      i. Fast-tracked courses required for clearing backlog courses
      ii. Fast-tracked courses for earning additional credit / completing non-credit mandatory requirement
      iii. Value added courses
      iv. The courses offered in summer semesters are bound by the same regulations as that of regular semesters, except that they are run at an accelerated pace to provide the required contact hours and conduct assessments within the 8 weeks.

8. Credit

a. A unit by which the course work is measured. It determines the number of hours of formal learning (contact hours) required per week. Credits are calculated based on the concept of "notional learning time". Notional learning time is the number of hours that a learner is expected to spend, on average, to achieve the specified learning outcomes of the course. This may comprise a variable combination of scheduled learning activities, (lectures, seminars, labs, etc.) and self-directed learning time (reading required before classes, working on assignments, examination preparation, and completion of assessments).

9. Credit equivalence of notional learning time for different types of activities

a. The credit values assigned to various teaching-learning activities are as follows:

Type of teaching-learning	Nature of activity	No. of contact hours per week equivalent to one credit	The total number of contact hours over a 16-week semester is equivalent to one credit
Lectures / Seminars / synchronous virtual classes / synchronous webinars	Scheduled instruction	1:1	16
Tutorials	Scheduled instruction	2:1	32
Supervised Demonstrations /Laboratory sessions / Studio / Workshops / Workplace simulation / Skill Practice Sessions	Scheduled instruction	2:1	32
Supervised Field visits/community visits/Internships	Scheduled instruction	3:1	48
Scheduled self-directed study (individual or group)	Scheduled instruction	2:1	32
Asynchronous E-Learning modules (structured self-directed study	Independent learning	2:1	32
Student Seminar	Independent /small group learning	2:1	32
Project work/dissertation	Independent /small group learning	3:1	48
Internship for credit	Industry placement/ Research Internship	3:1	48

10. Choice-based credit system (CBCS)

A program structure for higher education requires students to earn a minimum of credits by completing various types of courses, including electives, which facilitate a student to have some freedom in selecting his/her own choices, within as well as across disciplines.

11. Course Registration

Refers to formal registration of the Courses in the study every semester (Credits and Audit) by every student under the supervision of a faculty advisor. The institution will maintain records of the same and communicate them to the University.

12. Learning outcomes

a. Program Outcomes (PO) - Statements defining the skills, knowledge, and attitude that graduates of a program will be able to demonstrate upon completing the program
b. Course Outcomes (CO) - Statements defining the skills, knowledge, and attitude that students will be able to demonstrate upon completing the course. COs are mapped to the POs such that attaining the course outcomes leads to the attainment of program outcomes.
c. Attainment of POs-COs is mapped to the POs such that attaining the course outcomes leads to the attainment of program outcomes.

13. Evaluation

For all courses, the evaluation will be based on both formative assessment (Continuous Internal Evaluation, CIE) and summative assessment (Semester End Evaluation, SEE). Weightage for CIE and SEE will be 50% each

13.1 Continuous Internal Evaluation (CIE)

Refers to the periodic and continuous *formative assessment* of students' performance during the semester by the teacher(s) of the course to provide timely feedback to students and for guiding "course corrections" by the teachers. The assessment methods may include tests, quizzes, assignments, project evaluations, portfolio evaluations, seminar assessments, etc. CIE will have a weightage of 50% in the determination of the final grading of the course.

13.2 Semester End Evaluation (SEE)

Refers to a *summative assessment* that covers the entire course syllabus, conducted by the University, at the end of the semester. Appropriate assessment methods aligned with the learning domain and teaching-learning methods are to be used. CIE will have a weightage of 50% in the determination of the final grading of the course.

14. Grading

Course Grade refers to a qualitative measure of performance of a student in each course, based on the percentage of marks secured in Continuous Internal Evaluation (CIE) and Semester End Evaluation (SEE). A Letter grade is awarded for each course.

15. Semester Grade Point Average (SGPA)

Refers to the measure of a student's academic performance in a semester. It is calculated based on the credits and the grades obtained in the courses offered in the semester.

16. Cumulative Grade Point Average (CGPA)

Refers to the measure of the cumulative performance of a student in all the previous semesters and is computed from the 2nd semester onwards. It is calculated based on the credits and the grades obtained in all the courses taken.

17. Academic Bank of Credits (ABC)

The Academic Bank of Credits is a national-level facility for “credit transfer”. It is provided by the Ministry of Education, Govt. of India, to promote the flexibility of the curriculum framework and interdisciplinary/multidisciplinary academic mobility of students across the Higher Education Institutions in the country. The banking and redemption of credits through ABC will be governed by the University’s guidelines.

APPENDIX-B

Evaluation Guidelines

CIE and SEE details for various types of courses

1. **Theory: PCC/IPCC/PEC/OEC**
   1.1. **Scheme of examinations: CIE+SEE =50+50=100 marks**
   1.2. **Continuous internal evaluation (CIE):**

1.2.1. CIE (PCC/PEC/OEC)

Type of Questions	Questions to be set (Can have sub-questions a and b)	Questions to Be answered	Marks per question	Total marks
Mid Sem Exam-1				
40% of the total syllabus (Unit-1) (15 Teaching hours)				
Descriptive Part-1	2	1	10	10
Descriptive Part-2	2	1	10	10
Mid Sem Exam-2				
40% of the total syllabus (Unit-2) (15 Teaching hours)				
Descriptive Part-1	2	1	10	10
Descriptive Part-1	2	1	10	10
TASKS				
TASK	The task comprises 5 class tests/quizzes/assignments conducted for each unit for a max mark of 10. All tests/quizzes/Assignments are compulsory			10
Maximum Marks				**50**

1.2.2 CIE (IPCC/PBL)

Type of Questions	Questions to be set (Can have sub-questions a and b)	Questions to be answered	Marks per question	Total marks
Mid Sem Exam-1				
40% of the total syllabus (Unit-1) (15 Teaching hours)				
Descriptive Part-1	2	1	10	10
Descriptive Part-2	2	1	10	10
Mid Sem Exam-2				
40% of the total syllabus (Unit-2) (15 Teaching hours)				
Descriptive Part-1	2	1	10	10
Descriptive Part-1	2	1	10	10
Task	The task comprises 5 class tests/quizzes/assignments conducted for each unit for a max mark of 10. All tests/quizzes/Assignments are compulsory.			10
Maximum Marks				**50**
60% weightage, converted to 30 marks				
Practical/Project Based Learning (PBL)				
Practical/PBL	Practical/PBL (comprises of implementation of theoretical concepts through projects/problem solving)			**50**
40% weightage, converted to 20 marks				
Maximum Marks [30 (Theory)+ 20 (Practical/PBL)]				**50**

1.2.3 Semester End Evaluation (SEE): 3 Hours Duration

Type of Questions	Module & Teaching hours	Questions to be set (Can have sub-questions a, b, and c)	Questions to be answered	Marks per question	Total marks
MCQ	Entire Syllabus	10 or 20	All Questions	2 or 1	20
Descriptive	• Unit-1 • 15 teaching hours	3	2	16	32
Descriptive	• Unit-2 • 15 teaching hours	3	2	16	32
Descriptive	• Unit-3 • 10 teaching hours	2	1	16	16
				Maximum Marks	**100**
SEE Marks with 50% Weightage					**50**

1.2.4 CIE & SEE for various types of courses

Sl. No.	Courses		Evaluation scheme			
			CIE (Minimum eligibility marks 40% of Max marks		SEE (Minimum Passing marks 40 % of Max marks)	
			Max Marks	Min eligibility marks required	Max Marks	Minimum passing marks required
1	Integrated Professional Core Course (IPCC)	Theory	30	12	50	20
		Practical	20	08	---	---
		Total	50	20	50	20
2	PCC with PBL component	Theory	30	12	50	20
		PBL component	20	08	--	--
		Total	50	20	50	20
3	PCC/PEC/OEC		50	20	50	20
4	Laboratory		50	20	50	20
5	Drafting		50	20	50	20
6	Mini Project		100	40	---	---
7	Inter/Intra Institutional Internship (2 weeks)		100	40	---	---
8	Industrial/Govt./ NGO/MSME/ Rural Internship/ Innovation / Entrepreneurship (In single or two stretches =Total of 8 weeks)		100	40	100	40
9	Research Internship/ Advanced Industry Internship/Project work		100	40	100	40
10	Seminar		100	40	---	---

All university examinations (SEE) shall be conducted for a maximum of 100 marks. For assigning the letter grade the university examination marks secured by a student, except in the case of serial no. 06, 07, and 10 shall be reduced to 50 marks and added to CIE marks. If the total marks result in a fraction during reduction, it shall be rounded off to the nearest higher value.

2 Laboratory/Practical Course

2.1 Split-up of Marks for evaluation of Practical for 50 CIE marks and 50 SEE marks.

2.2 Split-up of Marks for evaluation of Laboratory work:

2.2.1 Laboratory in-charge faculty will follow rubrics given in the Tables below for an evaluation of laboratory courses

2.2.2 In the case of Practical, the IA marks shall be based on laboratory observation, records, viva, and at least one practical test.

2.2.3 Continuous Evaluation in every lab session will be done using the format mentioned in the Table to evaluate PO9 (Individual and teamwork) and PO10 (Communication).

2.2.4 Rubrics used for continuous Evaluation of **laboratory courses involving experiments with hardware**

Lab conduction and Record			**Lab Internal Assessment**		
Split-up: **60% (30 Marks) of Maximum CIE marks (50).** Each experiment is to be evaluated for conduction with an observation book and record write-up (**30 marks per experiment).** The final marks for conduction and record are the average of all the specified experiments in the syllabus.			Split-up: **40% (20 Marks) of Maximum CIE marks (50). One test of 20 Marks** In the test, conduction of the experiment and acceptable result with viva-voce will carry a weightage of 60% per experiment, with the rest 40% for procedural knowledge and regularity of the student.		
Rubrics per experiment	**Marks Distribution**	**Remarks**	**Rubrics**	**Marks distribution**	**Remarks**
Circuit	02	Evaluation of Record write-up to include weightage for submission on time, neatness, etc.	Write-up	04	
Design	02		Conduction	10	
Procedure	02				
Conduction	06				
Viva	06				
Record write-up	12		Results	06	
Total Marks	30		**Total Marks**	20	

2.2.5 Split-up of Marks used for continuous Evaluation of laboratory involving experiments with software

Rubrics for Split up of Marks	Methodology / Process Steps per Experiment	Marks
#R1	Observation, Write up of Procedure / Algorithm/ Program execution, and Conduction of experiment	12
#R2	Viva – Voce	06
#R3	Record writing	12
	Total Marks for each experiment	30
#R4	Internal Test: Lab Internal Assessment (i) Write-up of Procedure/Program/Algorithm (ii) Conduction/Execution (iii) Viva-Voce	 04 10 06
	Total Marks	20

3. Internship and Evaluation

3.1 Introduction

The rise in global competition has prompted organizations to devise strategies to have a talented and innovative workforce to gain a competitive edge. Developing an internship policy is an impactful strategy for creating a future talent pool for the industry. The internship (a form of experiential learning) program not only helps fresh pass–outs in gaining professional know-how but also benefits corporate sectors. The internship also enhances the employability skills of the student passing out from Technical Institutions.

The following list provides a brief illustrative overview of the knowledge, skills, work habits, and character traits commonly associated with 21st-century skills and to be acquired by graduates:

- Critical thinking, problem solving, reasoning, analysis, interpretation, and synthesizing information.
- Scientific literacy and reasoning, the scientific method.
- Research skills and practices, interrogative questioning.
- Creativity, artistry, curiosity, imagination, innovation, and personal expression.
- Information and communication technology (ICT) literacy, media and internet literacy, data interpretation and analysis, and computer programing.
- Oral and written communication, public speaking and presenting, listening.
- Economic and financial literacy, entrepreneurial skills.
- Global awareness, multicultural literacy, humanitarianism.
- Environmental and conservation literacy, ecosystems understanding.

- Civic, ethical, and social-justice literacy.
- Leadership, teamwork, collaboration, cooperation, and facility in using virtual workspaces.
- Perseverance, self-direction, planning, self-discipline, adaptability, initiative.
- Health and wellness literacy, including nutrition, diet, exercise, and public health and safety.

The internship experience will augment the outcome-based learning process and inculcate various attributes mentioned above in a student in line with the graduate attributes defined by the NBA as well as NEP 2020

Following are the intended objectives of internship training.

(i) Expose Technical students to the industrial environment, which cannot be simulated in the classroom, and hence create competent professionals in the industry.

(ii) Provide possible opportunities to learn, understand and sharpen the real- time technical/managerial skills required at the job.

(iii) Expose to the current technological developments relevant to the subject area of training.

(iv) Use the experience gained from the industrial internship in discussions held in the classrooms.

(v) Create conditions conducive to the quest for knowledge and its applicability on the job.

(vi) Learn to apply technical knowledge in real industrial situations.

(vii) Gain experience in writing reports on technical works/projects.

(viii) Expose students to the engineer's responsibilities and ethics.

(ix) Familiarize with various materials, processes, products, and their applications along with relevant aspects of quality control and safety measures.

(x) Promote academic, career, and/or personal development.

(xi) Expose the students to future employers.

(xii) Make students available to the industry for employment.

(xiii) Understand the psychology of the workers and their habits, attitudes, and approach to problem-solving.

(xiv) Understand the social, economic, and administrative considerations that influence the working environment of industrial organizations.

3.2 Academic credit framework for the internship and project work undergone as part of the B.Tech. program.

- A minimum of 20 credits of Internship/ Entrepreneurial activities / Project work/ Seminar and Inter/ Intra Institutional Training may be counted towards B. Tech. degree program
- Here, 1 credit is equivalent to a minimum of 40-45 hours of work. Therefore, a full-time intern is expected to spend 40 - 45 hours per week on Internship, Training, Project work, Seminar activities, etc. This will result in about 800 to 900 hours of total internship and project duration for the B. Tech program.
- To derive the benefits of an internship, it is introduced in two/ three stages of the B.Tech. program.
- Internships may be full-time or part-time; they are full-time during the summer vacation and

part-time during the academic session. The curriculum is flexible to adjust internship duration. Therefore, opportunities must be provided for experiences that cannot be anticipated when planning the course.

- The departments have the flexibility to schedule internships, Project work, Seminars, etc. according to the availability of the opportunities. However, the suggested minimum requirement regarding Internship duration and credits are as given in Table -B1.

Table-B1 Suggested Credit Framework for Internship and Project work

Sl. No.	Title	Schedule	Duration	Activities	Credits
1	Internship-I	Ongoing First-year academic session/ Summer vacation after 2nd Semester/ vacation during 3^{rd} semester (for lateral entry students	02 weeks	Inter/ Intra Institutional Activities (Evaluation in 4^{th} semester)	02
2	Internship-II	a) Summer vacation after 4th Semester	02-04 weeks	Industrial/Govt./ NGO/ MSME/ Rural Internship/ Innovation / Entrepreneurship/ social internship	---
		b) Summer vacation after 6th Semester	04-06 weeks	Industrial/Govt./ NGO/ MSME/ Rural Internship/ Innovation / Entrepreneurship	
		c) Total of a) and b) at the beginning of the 8th semester	08 weeks	Evaluation in 8^{th} Semester	08
3	Project work	6^{th} Semester	6 hours/week	Mini -Project	02
		8th Semester	16 weeks	Extended Industry Internship /Research Internship/ Project work	10
				Report preparation and writing	
				Seminar	01
Total Credits					**23**

Table-1 states that during the ongoing/ summer vacations after the 2nd Semester, students are required to be involved in Inter/ Intra Institutional Activities viz; Training with higher Institutions; Soft skill training organized by Training and Placement Cell of the respective institutions; contribution at incubation/ innovation /entrepreneurship cell of the institute; participation in conferences/ workshops/ competitions, etc.; Learning at Departmental Lab/ Tinkering Lab/ Institutional workshop; Working for consultancy/ research project within the institutes and Participation in all the activities of Institute's Innovation Council for eg: IPR workshop/Leadership Talks/ Idea/ Design/ Innovation/ Business Completion/ Technical Expos, etc.

During the summer vacation after the 4th/ 6th semester, students are ready for industrial experience. Therefore, they may choose to undergo Internship / Innovation / Entrepreneurship related activities. Students may choose either to work on innovation or entrepreneurial activities resulting in start-up or undergo internship with industry/NGO/ Government organizations/ Micro/ Small/ Medium enterprises to make themselves ready for the industry.

3.3 Internship Supervision

i) The internship shall be carried out under the supervision of a faculty mentor. The faculty mentor/guide should,

ii) Serve as a teacher, mentor, trainer, critic, leader, and boss.

iii) Provide sufficient time to guide the interns. (Interns are students or a trainee who does a job to gain work experience)

iv) Play a vital role, along with the Training and Placement Officer, in providing internship opportunities for the students.

v) Exhibit qualities such as leadership, strong communication skills, and patience.

vi) Provide a letter of recommendation in due consultation with students and the industrial organization (if possible) where the internship is intended to be carried out, endorsed by the authority (Principal/Institution Internship Coordinator).

3.3.1 Each faculty mentor shall supervise the students/Student batches allotted to them. Often, the supervision may be by an external expert. In such cases, the faculty mentor shall jointly guide the student/s without causing miscommunications/embarrassment to either side.

3.3.2 Depending on the activity taken up by the students, the internship shall be carried out individually or in batches having not more than three students.

3.3.3 Faculty Mentor, along with the external expert, shall scrupulously evaluate the work of an individual student or students of a batch and maintain the relevant documents.

3.3.4 For allotment of CIE marks, the institutions shall prepare the rubrics for each activity offered by the institution as given in Table - B2. The marks shall be allotted by the Internship committee designated by HOD in consultation with the mentors.

3.3.5 For all activities conducted by the institution, the attendance of the students shall be maintained by the faculty and maintained in their respective departments.

3.4 Internship-I (Activity based Internship)

While intra-activities are within the institution, inter-activities shall be between the concerned institution and neighboring institutions. Intra and Inter activities are the activities that are the impetus to learning techniques. It adds to the comprehensive growth of the mind and associated activities.

As the students are on the verge of learning technical aspects and have a limited period of internship, it is preferable to expose students to polygonal activities instead of one type of activity. Therefore, activities completed by the students shall not be one type of activity but can be few within the period of the internship. In this regard, Intra and Inter-Institutional activities shall be completed under the supervision of a faculty on a self-learning basis.

The faculty have to kindle the latent abilities of the students, encourage, guide, supervise and shape them to achieve the desired result. Therefore, a learning agenda in the form of specific learning objectives and outcomes shall be prepared before the start of the internship.

Whatever the activity/activities that are/are done under Intra and Inter-Institutional activities, should ignite the inquisitiveness to learn, enhance the knowledge, thinking ability and imagination, planning, application of mind, execution ability, innovation attitude, listening and understanding, vocabulary, personal expression, public speaking, written communication, oral presentation of the subject matter, acquire leadership qualities and teamwork requirements, responsiveness, ethics, etc.

3.4.1 List of proposed activities

a. Activities concerned with the works of Indian scholars like Charaka and Susruta, Aryabhata, Bhaskaracharya, Chanakya, Madhava, Patanjali, Panini, and Thiruvalluvar, among numerous others
b. Activities such as training with higher Institutions or Soft skill training
c. Contribution at incubation/ innovation /entrepreneurship cell of the institute.
d. Learning at Departmental Lab/Tinkering Lab/ Institutional workshop.
e. Working for consultancy/ research projects within the institute.
f. Learning MS Word, Excel, Microsoft equations, MS drawing tools, MS Powerpoint, etc.
g. Coding.
h. Mini projects using commercially available assembled electronic products.
i. Debates, quizzes, and group discussions: On technical topics already studied (both in Kannada and English).
j. Essay competitions: Both in Kannada and English on technical topics already studied.
k. Survey and study of published literature on the assigned topic: Technical paper survey, Preparation of synopsis. Exposure to technical paper publications.
l. Photography.
m. Short film production: Contemporary aspects, technical aspects, etc.
n. Internship in Disaster Management.
o. Solar energy connected activities that help the common man.
p. Working with Smart City Administration.
q. Hackathon (it is a design sprint-like event in which computer programs and others involved in software development, including graphic designers, interface designers, project managers, and others, often including domain experts collaborate intensively on software projects).
r. Industrial Safety, Fire Safety, Electrical Safety, Chemical Process Safety, Food Safety, etc.
s. Internship and project work in Indian Knowledge System related Areas/Topics.
t. Industrial visits to Small Scale Industries/ Factories/ Cottage Industries/substation visits etc., and submission of the report.

3.5 Documents to be submitted by Students for Internship Evaluation

3.5.1 Student's Diary

The main purpose of writing a daily diary is to cultivate the habit of documenting and to encourage the students to search for details. It develops the student's thought process and reasoning abilities. The students shall record in the daily training diary the day-to-day account of the observations, impressions, information gathered, suggestions given, if any, and activities carried out. It should contain sketches and drawings related to the observations made by the students. The daily training diary should be signed after every day or at least twice a week by the faculty/ in charge of the section (external expert) where the student has been working.

Student's Diary should be submitted by the students along with attendance records. It shall be evaluated based on the following criteria:

i) Regularity in the maintenance of the diary.
ii) Adequacy and quality of information recorded.
iii) Drawings, sketches, and data were recorded.
iv) Thought processes and recording techniques were used.
v) Organization of the information

3.5.2 Internship report

After completion of the Internship, the student shall prepare, with a daily diary as a reference, a comprehensive report in consultation with the mentor/s to indicate what he/she has observed and learned in the training period along with the internship outcomes. The training report should be signed by the mentor. The Internship report shall be evaluated based on the following criteria and/or other relevant criteria about the activity completed.

i) Originality.
ii) Adequacy and purposeful write-up.
iii) Organization, format, drawings, sketches, style, language, etc.
iv) Practical applications, relationships with basic theory, and concepts taught in the appropriate course.
v) Variety and relevance of learning experience.

Procedure for the Evaluation of Internship-I

a) Students should submit the reports immediately on completion of the Internship to the respective mentors
b) The Examination of the internship will be carried out by the mentor
c) The Internship-I shall be slated for 100 marks CIE only and will not have SEE.
d) Internship-I marks are based on CIE marks (25 marks for the first presentation, 25 marks for the second presentation, and 50 marks for the report and final presentation).
e) A Viva-Voce examination conducted during the I/II/III Semesters (Presentation followed by question-answer session) and the prescribed credit shall be included in the IV semester grade card.

3.5.3 Assessment Rubrics for evaluation of Internship-I (Intra and Inter-Institutional Activities)

Table – B2 Internship-I Assessment Rubrics
Scheduled during the first year (Prescribed Period 02 weeks and Prescribed credits: 02)

Sl No	Sub Activity Head	Performance/ Appraisal	Assessment Rubrics (Allotted marks decide the letter	Proposed Document as Evidence	Evaluated by
1	Inter/ Intra Institutional Workshop/ Training.	Excellent	80 to 100	(i) Student's Diary and (ii) Internship Report along	Institute
		Good	60 to 79		
		Satisfactory	40 to 59		
		Unsatisfactory and fail	< 39		
2	Working for	Excellent	80 to 100		

	consultancy/ Research project.	Good	60 to 79	with the certificate issued from the relevant authorized Authority	Faculty (mentor) together with External Expert, if any.
		Satisfactory	40 to 59		
		Unsatisfactory and fail	< 39		
3	Festival (Technical / Business / Others) Events.	Excellent	80 to 100		
		Good	60 to 79		
		Satisfactory	40 to 59		
		Unsatisfactory and fail	< 39		
4	Contribution in Incubation/ Innovation/ Entrepreneurship Cell.	Excellent	80 to 100		
		Good	60 to 79		
		Satisfactory	40 to 59		
		Unsatisfactory and fail	< 39		
5	Learning at Departmental Lab/Tinkering Lab/Institutional workshop.	Excellent	80 to 100		
		Good	60 to 79		
		Satisfactory	40 to 59		
		Unsatisfactory and fail	< 39		
6	Other than the above five activities	Excellent	80 to 100		
		Good	60 to 79		
		Satisfactory	40 to 59		
		Unsatisfactory and fail	< 39		
Note: The total CIE marks shall be the sum of marks allotted to completed activities by the student.					

3.6 Internship-II: (Societal internship and Research/Industry Internship) (08 weeks) [Scheduled during the intervening period of IV & V semester and VI & VII semester]

During the intervening period of the IV & V semesters and VI & VII semesters, students shall be ready for industrial experience. Therefore, they shall choose to undergo an Internship involving Innovation / Entrepreneurship/short-term (about 2 weeks) societal-related activities. Students may choose to work on innovation or entrepreneurial activities, or both resulting in start-up or undergo internship with industry/NGO/ Government organizations/ Micro/ Small/ Medium enterprises to make themselves ready for the industry.

3.6.1 Innovation

Innovation refers to a new or improved product or process or a combination thereof that differs marginally or significantly from the unit's previous product. An innovation center is a place where students are encouraged to implement the innovative ideas formed through imagination, brainstorming sessions, design thinking, and associated activities to bring them to reality. It is a place, where creative minds are shaped.

3.6.2 Entrepreneurship

Entrepreneurship refers to setting up a new business or business and taking on financial risks in the hope of profit. It involves investment to undertake production along with arranging inputs like land, labour, material, and capital, introducing new techniques and products, identifying new sources for the enterprise, etc.

3.6.3 Incubation Center

An organized unit designed for innovation as well as to accelerate the growth and success of new entrepreneurial companies through mentorship and an array of business support resources and services that could include physical space, capital, coaching, common services, and networking connections.

3.6.4 Startup

An entity that develops a business model based on either product innovation or service innovation and makes it scalable, replicable, and self-reliant.

An entity shall be considered a Startup

i) Up to ten years from the date of incorporation/ registration, if it is incorporated as a private limited company (as defined in the Companies Act, 2013) or registered as a partnership firm (registered under section 59 of the Partnership Act, 1932) or a limited liability partnership (under the Limited Liability Partnership Act, 2008) in India.

ii) Turnover of the entity for any of the financial years since incorporation/ registration has not exceeded one hundred crore rupees.

iii) The entity is working towards innovation, development, or improvement of products or processes, or services, or if it is a scalable business model with a high potential for employment generation or wealth creation.

iv) Provided that an entity formed by splitting up or reconstruction of an existing business shall not be considered a Startup.

3.6.5 Societal (Social) related activities

Short-term internships (about 2 weeks) in villages, slums, or urban areas can be under social internship. The internship will be more fruitful if students work in teams. The teams can select one or more fields to do their best in the field of agriculture, watershed management, wastelands development, non-conventional energy, low-cost housing, sanitation, nutrition and personal hygiene, schemes for skill development, income generation, blood bank, government schemes such as

i) (Swachch Bharat: Swachh Bharat Mission, Swachh Bharat Abhiyan, or Clean India Mission is a country-wide campaign to eliminate open defecation and improve solid waste management.

ii) Accessible India: Accessible India Campaign or Sugamya Bharat Abhiyan is a program to serve the differently able community of the country.

iii) Digital India: A campaign to ensure the Government's services are made available to citizens electronically by improved online infrastructure and by increasing Internet connectivity or making the country digitally empowered in the field of technology.

iv) Beti Bachao and Beti Padhao: A campaign of the Government of India that aims to generate awareness and improve the efficiency of welfare services intended for girls in India.

v) Environment and Energy Conservation and Education, legal aid, consumer protection, and allied field including Indian Red Cross Society, National Cadet Corps, Bharat Scouts, and Guides.

Societal activities are one of the NBA graduate attributes that are part of PO6 and PO7, which are reproduced below.

vi) PO-6: The engineer and society: Apply reasoning informed by the contextual knowledge to assess societal, health, safety, legal, and cultural issues and the consequent responsibilities relevant to the professional engineering practice.

vii) PO-7: Environment and Sustainability: Understand the impact of the professional engineering solution in societal and environmental contexts and demonstrate the knowledge of and need for sustainable development. The long-term goal under Societal (social work) related activities, particularly in a rural area, results in a rural internship. In urban areas, the student may adopt slum/ economically weaker section areas for short duration social internship to uplift the living conditions.

Given the above, internship coordinators should encourage students to take up a societal internship as far as possible.

3.6.6 Places for Innovation/Entrepreneurial Activities

Students shall carry out Innovation or Entrepreneurial activities or both at the Incubation Center and Entrepreneurship Cell of the parent institution or elsewhere such as ATAL Incubation Centers [A flagship of Atal Innovation Mission (AIM), NITI Aayog for promoting the culture of innovation and entrepreneurship in India], institutes of national importance, public sector units, IT companies, government organizations, and non-governmental organizations, industries including MSME, etc.

- **Institutes should deter students to opt for internships at places established for commercial benefits.**

3.6.7 Industrial Internships

The gap between the theoretical knowledge obtained in the classrooms and the practical skills required in the actual workplace scenarios is fast growing. This has put forth varied challenges to graduating students when it comes to job placements. As institutes cannot have a relevant facility to expose students to a real-time industrial environment, an industrial internship is an appropriate solution.

The main objective of the industry internship is to ensure that the intern is exposed to a real job world environment and gains practical experience. Often, it may be a practical exposure to the theory that has been learned during the academic period. The industry internship helps students understand analytical concepts and tools, hone their skills in real-life situations, and build confidence in applying the skills learned.

3.6.7.1 Industry Internship Benefits

i) Have ample opportunities to attend seminars, symposiums, workshops, etc. This in turn provides an opportunity to establish rapports with professionals and pioneers in their respective fields for further growth.
ii) Have wide scope to publish paper/s in journals.
iii) Good recommendation letter/s that increase the prospectus for further internships, higher studies, and placements.
iv) Helps to acquire team spirit, motivated acts, techniques to resolve conflicts, etc.
v) Helps to develop a lot of leadership skills.
vi) Increases the prospect of placement in the same concern, provided the intern has exhibited a clear understanding of basics and completed the internship.
vii) Fosters to substantiate the issues with facts and figures.

For AICTE Internship opportunities refer to https://internship.aicte-india.org/

3.6.8 Assessment Rubrics for Innovation / entrepreneurship/ Societal Internship Activities

Once the internship begins, the students are required to maintain a diary/journal and submit a report regularly to the guide. These reports should summarize the activities in which the student was involved during the previous week's period. At the end of the internship, each student is required to submit a hard copy of the consolidated diary/journal and report for evaluation. The report should indicate the learning and achievements of the internship.

Table – B3 Innovation/entrepreneurship/ Societal Internship Activities and Assessment Rubrics Scheduled during the intervening period of IV & V semester and VI & VII Sem (Prescribed Period 08 weeks: Credits 08)				
Sub Activity Head	**Performance/ Appraisal**	**Assessment Rubrics**	**Proposed Document as Evidence**	**Evaluated by**
(1) Development of new product/ Business Plan/ registration of start-up/societal internship	Excellent	80 to 100	(i) Student's Diary and (ii) Internship Report or the activity report along with Certificate or Declaration from relevant Authorized Authority. Wherever only Certificate is issued, Assessment shall be at the institute as per (i) and (ii) to decide the letter grade.	(i)Institute Faculty (mentor) together with External Expert if any.
	Good	60 to 79		
	Satisfactory	40 to 59		
	Unsatisfactory and fail	< 39		
(2) Internship with Industry/ Govt. / NGO/ PSU/ Any Micro/ Small/Medium Enterprise.	Excellent	80 to 100		
	Good	60 to 79		
	Satisfactory	40 to 59		
	Unsatisfactory and fail	< 39		
Note: **(i)** The total CIE marks shall be the sum of marks allotted to successfully completed activities by the student.				

3.7 Research Internships / Extended Industry Internships

3.7.1 Research Internship /Extended Industry Internship of sufficient duration encourages students early on in their careers. Its main goal is to allow improving their analytical and technical skills in an international environment. An internship can be in an industry or at an appropriate workplace.

3.7.2 Research internships and industrial internships have different purposes and come with a set of benefits. A prior experience in any field is always preferred over a fresh start. Therefore, one of them can be selected depending on the interest the students have. Internships pose unexpected challenges and make students think appropriately, tackle difficulties with ease, and act in a scholarly way to get past the hurdles and practical constraints. An internship is always beneficial however good or bad it is.

3.7.3 Internships not only enhance one's learning but also identifies him/her as someone who commits to approaching a project and completing it with or without guidance. Internship learning is an impetus for professional development.

3.7.4 While a research internship is a stepping stone to higher studies, an industry internship is a pathway to a placement. Those who are self-motivated and interested in searching for new things that are original and unique can choose a research internship. Those who are interested in real industry- experience and aspire to get a job soon after graduation can choose an industry internship.

3.7.5 Research Internships (Also known as dissertation internships) are focused research projects that push students' intellectual abilities beyond those driven by the classroom. Often, a research internship typically helps solve problems that are usually part of major research projects. It involves a short theoretical or experimental research project supervised by a researcher.

3.7.6 The research internships, under the advice of a faculty supervisor, can be one's own selected project or a project on which a Researcher is researching, or a new project/real-world project offered by an organization. The research area may be about single or multidisciplinary fields such as science, technology, engineering, mathematics, management, and business studies. Research internships can be carried out either individually or in teams (not exceeding 3 or 4 students).

3.7.7 Research internship opportunities, before graduation, maybe in a laboratory of college, a research institute, or a company's R & D department. Apart from fixed working hours of the day of an organization, the researcher can devote sufficient time to other research-related activities for early and successful completion of the Research Internship.

3.7.8 Necessary Skills for Research Internship and Industrial Internship

For the internships to progress without hurdles and for successful completion, the Researchers should maintain a harmonious relationship with the guide/s, administrators, co-workers, and others, and strictly adhere to the rules and regulations of the workplace. The other skills required or acquirable during the Internship are,

1. Good Communication skills.
2. Attention to detail.
3. Planning and scheduling.
4. Documentation.
5. Critical thinking.
6. Data collection.
7. Data analysis.
8. Ability to maintain quality, safety, and/or infection control standards.
9. Appreciating and practicing ethical issues.

3.7.9 Responsibilities of an Intern

Interns,

1. If working with a researcher, shall assist the researcher in an ongoing research project or work collaboratively in designing a new project of mutual interest.
2. Shall engage in literature survey and get an insight of the research work at the initial stages.
3. Shall compile data, sort, file, implement ideas with minimal guidance and assist write papers.
4. Shall become familiar with several tools [meters (Electrical and Electronics, mechanical, computer, etc.)] used in data collection, software, graphic software, Statistical Package for the Social Sciences (SPSS) software [IBM's statistical software platform], etc.
5. Shall attain skills with Microsoft Word Office, Excel, PowerPoint, Outlook, etc.
6. Shall give a mid-term oral presentation to a committee for review and feedback.
7. Shall attend discussions, meetings, symposiums, classroom lectures, etc., to learn new

scientific techniques, design experiments, analyze results, and formulate different hypotheses.

8. Shall learn to write reports and be able to correspond independently.
9. Shall manage time effectively.
10. Shall keep a track of the progress of the project.
11. Shall develop integrative thinking.

3.7.10 Research internship Outcomes

1. Generating technical paper/s and publishing in refereed journal/s.
2. Possibility of acquiring intellectual ownership and patent.
3. Build a prototype for an idea on which the research was carried out.
4. File patent/s.
5. Add academic knowledge to the field.
6. Enhanced ability in arranging meetings, presentations, seminars, training, etc.
7. Improved conscientiousness and ethics.

3.7.11 Research internships Benefits

1. Are a great way to pursue an academic career in teaching and research, as a Research Scientist at a Research Organization, Company, Industry sector, etc.
2. Establish professional networks for a future career.
3. Pave the way to join a research team and work alongside leading experts in the field.
4. Introduced to new ideas through interaction with like-minded students and others.
5. Develop research skills and knowledge in a specific area of interest.
6. Provide opportunities for growth, achievement, and personal development.
   Offer an opportunity to publish a research paper that will boost the resume while applying for Post Graduate Studies

4. Evaluation Procedure of UC3001-1 Research Internship /Extended Industry Project/Internship/Project work (16 weeks)

4.1 The students pursuing the course UC3001-1 shall submit the diary recordings of day-to-day activities to the concerned guide, reporting progress achieved in the course and seeking guidance to proceed with the internship. The interns should provide all the details to the guide so that he/she can discuss with the employer to make the internship successful.

4.2 The intern should constantly update the guide about the progress of the internship. The guide should know the intern's internship tasks, duties, responsibilities, and potential projects. The evaluation of interns and their internship progress should be honest and constructive.

4.3 The hardcopy or softcopy of the diary maintained by the interns must be signed at regular intervals by the guide.

4.4 Regarding the intern's feedback, the guides should propose changes in internship activities so that they are helpful to the internship.

4.5 Illustrations, drawings, photos, forms, samples, classified materials, etc., are to be included in the report only after obtaining the consent of the concerned authorities and should indicate the source of all such material. The final report should also be submitted to the place where the internship was carried out. The report should avoid a tone that is predominantly cynical or unduly critical of the employer or of those with whom the student intern has worked. The content of the report must be based on interns' own work.

4.6 Continuous Internal Evaluation (CIE)

The guides should evaluate the interns using the following as well as any other appropriate methods;

a) Punctuality of intern.
b) Conduct and character.
c) Tactfulness and politeness with colleagues and the public.
d) Attitude regarding professionalism.
e) Inquisitiveness and eagerness to learn.
f) Research attitude.
g) Problem-solving techniques.
h) Innovation mindset.
i) Time management and meeting deadlines.
j) Receptiveness to feedback and critiques.
k) Ability to work in a team as a member.
l) Ability to work without supervision.
m) Supervisory skills and leadership skills.
n) Judgment and decision-making skills.
o) Writing skills, oral communication skills, technical communication skills, computer skills, analysis skills, and business writing skills.
p) Appropriateness of technical skills.
q) Familiarization with writing technical papers, standards, codes, etc.
r) Reading Behavioural attitude.
s) Outcomes.
t) Successes and failures experienced

4.7 Recommendation letter

The guide must state whether the intern,

a) Exceeded the expectations of the internship.
b) Met the expectations of the internship.
c) Did not meet the expectations of the internship.
d) Did work to a satisfactory level.
e) Did an unsatisfactory internship.

In the end, the guide should issue a recommendation letter.

4.8 Assessment of CIE marks

4.8.1 **Single discipline:** The CIE marks shall be awarded by a committee consisting of the Head of the concerned Department and two faculty members of the Department, one of whom shall be the Guide. The CIE marks awarded for the internship, shall be based on the evaluation of the diary, presentation skill, and viva-voce in the ratio of 50:25:25.

4.8.2 **Interdisciplinary:** The CIE marks awarded for the internship, shall be group-wise at the institution level with the participation of all guides of the internship. Participation of external guide/s, if any, is desirable.

4.8.3 The CIE marks awarded for the internship, shall be based on the evaluation of the diary, presentation skill, and viva-voce in the ratio of 50:25:25.

4.9 Assessment of SEE marks

4.9.1 Single discipline: Contribution to the internship and the performance of each group member shall be assessed individually in the semester-end examination (SEE) conducted at the department. Marks shall be awarded based on the evaluation of the report, presentation skill, and viva-voce in the ratio of 50:25:25.

4.9.2 Interdisciplinary: Contribution to the internship and the performance of each group member shall be assessed individually in the semester-end examination (SEE) conducted separately at the departments to which the student/s belongs. Marks shall be awarded based on the evaluation of the report, presentation skill, and viva-voce in the ratio of 50:25:25.

4.10 Evaluation of research Internship/Extended Industry Internship/Project Work:

Split-up of marks for evaluation of Project work for 100 CIE marks and 100 SEE marks

Split up	Rubrics		Marks
Report (50 Marks)	Content Development	Abstract/ Synopsis Write-up	10
		Selection of Topic/ Relevance of the subject to the concerned discipline	05
		Problem Identification	05
		Objectives and Methodology	05
	Problem-Oriented Exposition	Literature Survey (Papers/Sites/Sources Surveyed)	10
		Documentation/ Systematic Approach	10
		Results (with inferences, Conclusions, etc.)	05
Project Presentation Skill (25 Marks)		Quality of preparation of presentation	05
		Communication Skills	05
		Technical knowledge and awareness	05
		Individual involvement	10
Viva- Voce (25 Marks)		The clarity in answering questions relating to fundamentals and concepts	10
		The clarity in answering the questions related to the project	05
		The understanding ability of the questions asked	05
		The confidence in answering the questions asked.	05
		Total Marks	100

NITTE (Deemed to be University) | NMAM INSTITUTE OF TECHNOLOGY

Established under Section 3 of UGC Act 1956
Accredited with 'A+' Grade by NAAC

Off-Campus Centre, Nitte - 574 110, Karnataka, India

B.Tech. Syllabus

Effective from

Academic Year

2022 – 2023

Curriculum for Acquiring Professional Skills (CAPS)

With Scheme of Teaching & Examination

Course Numbering Scheme

Branch Code		Course Level	Course Code			Separator	Version
Letter	**Letter**	**Number**	**Number**	**Number**	**Number**	**-**	**Number**

Branch Code	RI is 2 Letter code for the Department of Robotics &AI
Course Level	Course Level is a 1-digit number that can have a value between 1-4 and indicates the prerequisite of a course. Level-1 courses are basic courses with no courses as pre-requisites. Level-2 course(s) have Level-1 course(s) as prerequisites. Level-3 course(s) have Level-2 course(s) as prerequisites. Level-4 course(s) have Level-3 course(s) as prerequisites.
Course Code	Course Code is a 3 Digit number that can have a value between 001-999 and indicates the number assigned to a course based on the following guidelines. 001-199 is assigned to Professional Core Courses 001-099 for Integrated Professional Core Courses [4 Credit] 101-199 for Professional Core Theory Courses [3 Credit] 201-499 for Professional Elective Courses 201-299 Electives under Group I 301-399 Electives under Group II 401-499 for future use 501-550 for Open Elective Courses 551 – 599 for Vocational Education Courses 601-650 for Professional Core Lab Courses [1 Credit] 651-699 for Ability Enhancement Courses 701-799 for Courses offered to Honors Program
Separator	"_" is used as a separator between the Course code and the version
Version	Version is a 1-digit number that can have a value between 1-9 and indicates minor revisions of the same course.

B. Tech. (RI): Scheme of Teaching and Examinations 2022-26

Outcome Based Education (OBE) and Choice Based Credit System (CBCS)

(Effective from the academic year 2022 - 23)

GROUP - I

I SEMESTER (AI&DS, AI&ML, CC, CS, IS, RI)

Sl No.	Course and Course code		Course Title	Teaching Department	Teaching hours/Week			Examination				Credits
					Theory Lecture	Tutorial	Practical/ Drawing	Duration in hours	CIE	SEE	Total Marks	
					L	T	P					
1	BSC	MA1001-1	Matrix Algebra & Calculus	MA	3	0	0	3	50	50	100	3
2	BSC	PH1001-1	Engineering Physics	PH	3	0	2	3	50	50	100	4
3	ESC	CV1001-1	Elements of Civil Engineering	CV	3	0	0	3	50	50	100	3
4	ESC	EC1001-1	Basic Electronics	EC	3	0	0	3	50	50	100	3
5	ESC	ME1001-1	Engineering Skill Development Practice	ME	0	0	2	2	50	50	100	1
6	ESC	ME1002-1	Computer Aided Engineering Graphics	ME	0	2	2	3	50	50	100	2
7	HSMC	HU1001-1	Technical English	HU	1	0	2	3	50	50	100	2
8	HSMC	HU1002-1	Constitution of India and Professional Ethics	HU	1	0	0	1	50	50	100	1
9	MNC	UM1001-1	Skill Development Lab Group- A	Any Dept.	0	0	4	0	0	0	0	0
TOTAL					TOTAL	**14**	**2**	**12**	**21**	**400**	**800**	**19**

Matrix Algebra & Calculus

(common to BT\CV\EC\EE\ME\RI)

Course Code:	**MA1001-1**	**Course Type**	**BSC**
Teaching Hours/Week (L: T: P: S)	**3:0:0:0**	**Credits**	**03**
Total Teaching Hours	**39**	**CIE + SEE Marks**	**50+50**

Teaching Department: Mathematics

Course Objectives:

1.	This course will enable the students to master the basic tools of differential calculus, infinite series, elementary linear algebra, partial differentiation, multiple integration and become skilled for solving problems in science and engineering.

UNIT-I

MATRICES	**07 Hours**

Elementary transformation of a matrix, Echelon form and rank of a matrix. Consistency and solution of system of linear equations; Gauss elimination method and approximate solution by Gauss Seidel method. Eigen values and eigen vectors of square matrices, Rayleigh's power method to find the largest eigen values and eigen vectors of square matrices.

SEQUENCES AND SERIES	**07 Hours**

Convergence and divergence of infinite series. Tests for convergence of positive term series- comparison test, D-Alembert's ratio test and Cauchy's root test. Power series- Taylor's theorem for a function of single variable with remainder (without proof), expansion of functions into Taylor's and Maclaurin's series.

UNIT-II

DIFFERENTIAL CALCULUS	**07 Hours**

Polar curves, angle between the radius vector and the tangent, angle of intersection of two curves. derivatives of arcs, radius of curvature - cartesian, parametric and polar forms. Rolle's Theorem (without proof), mean value theorems and applications to simple problems.

PARTIAL DIFFERENTIATION	**07 Hours**

Partial derivatives of simple functions, total differentiation - differentiation of composite and implicit functions, Jacobians. Taylor's theorem for functions of two variables, maxima and minima for functions of two variables, Lagrange's method of undetermined multipliers (with one subsidiary condition).

UNIT-III

MULTIPLE INTEGRALS	**11 Hours**

Double integrals and triple integrals, evaluation by change of order of integration, change of variables and applications to area and volume. Beta and Gamma functions and their properties.

Course Outcomes: At the end of the course student will be able to

1.	Solve the system of linear equations and find eigen values and eigen vectors of the given matrix.
2.	Develop the power series of the given function and understand the concept of convergence and divergence of series.
3.	Apply the concept of radius of curvature and mean value theorems.

4.	Learn the concept of partial differentiation of a function with two or more independent variables, apply them to solve engineering problems and examine the given function for its extrema.
5.	Apply the notion of multiple integrals to find areas and volumes.

Course Outcomes Mapping with Program Outcomes & PSO

Program Outcomes→	1	2	3	4	5	6	7	8	9	10	11	12	**PSO↓**		
↓ Course Outcomes													1	2	3
MA1001-1.1	3	2													
MA1001-1.2	2	2													
MA1001-1.3	3	1													
MA1001-1.4	3	2													
MA1001-1.5	3	2													

1: Low 2: Medium 3: High

TEXTBOOKS:

1.	Erwin Kreyszig, "Advanced Engineering Mathematics", John Wiley and Sons, 10th Edition (Reprint), 2016.
2.	B.S. Grewal, "Higher Engineering Mathematics", Khanna Publications, 43rd Edition, 2015.

REFERENCE BOOKS:

1.	G.B. Thomas and R.L.Finney, "Calculus and Analytic geometry", Pearson, 2002.
2.	T. Veerarajan, "Engineering Mathematics", McGraw-Hill, New Delhi, 2008.
3.	B. V. Ramana, "Higher Engineering Mathematics", Tata Mc Graw –Hill, New Delhi,2010.
4.	N.P. Bali and M.Goyal, "A text book of Engineering Mathematics", Laxmi Publications, 2010.

E Books / MOOCs/ NPTEL

1.	*http://nptel.ac.in/courses/111107108/*
2.	*https://nptel.ac.in/courses/122101003*

ENGINEERING PHYSICS

Course Code:	**PH1001-1**	**Course Type:**	**IPCC**
Teaching Hours/Week (L: T: P: S):	**3:0:2:0**	**Credits:**	**04**
Total Teaching Hours:	**39+0+26**	**CIE + SEE Marks:**	**50+50**

Teaching Department: Physics

Course Objectives:

1.	To introduce the concepts of wave mechanics to study the properties of sub-atomic particles.
2.	To study the concepts of crystalline solids and X-rays.
3.	To explain the concepts of semiconductors and semiconductor devices
4.	To explain the properties of superconductors and their applications.
5.	To explain the principle, working and applications of lasers & optical fibers.

UNIT-I

Wave mechanics — **08 Hours**

Introduction to wave mechanics. Matter waves – de Broglie's relation, characteristics of matter waves. Wave function, properties and physical significance of a wave function, probability density and normalization of wave function, Schrödinger wave equation (time dependent & independent). Application of Schrödinger wave equation –particle in a potential well of infinite depth, Eigen functions, probability densities and energy Eigen values for a particle in an infinite potential well. Numerical examples.

Crystallography & X-rays — **07 Hours**

Crystallography: Introduction to crystallography - space lattice, unit cell, primitive cell, lattice parameters. Crystal systems and Bravais lattice. Direction and planes in a crystal, Miller indices – method of finding the Miller indices. Interplanar spacing – derivation. Co-ordination number, number of atoms per unit cell and atomic packing factor - simple cubic, body centered cubic, and face centered cubic lattices.

X rays: X-rays – generation and properties. Continuous and characteristic X-rays. Bragg's law and Bragg's spectrometer, Applications. Numerical examples.

UNIT-II

Semiconductors — **11 Hours**

Semiconductors: Band structure - classification of solids. Semiconductors - intrinsic and extrinsic semiconductors, carrier generation. Direct and indirect band gap semiconductors. Fermi - Dirac Statistics, Fermi factor, Fermi energy level in intrinsic and extrinsic semiconductors and effect of temperature on Fermi level, intrinsic effect - maximum device temperature. Conductivity of intrinsic and extrinsic semiconductors - derivation. Effect of temperature on conductivity of intrinsic and extrinsic semiconductor. Hall effect - derivation of Hall coefficient, carrier concentration and mobility. Applications of Hall effect. Numerical examples.

Semiconductor devices: light emitting diode, photodiode, and solar cell.

Superconductors	**04 Hours**
Introduction to superconductors, characteristic properties. Type-I and Type-II superconductors. BCS theory (qualitative). Applications of superconductors. Numerical examples.	
UNIT-III	
Lasers	**05 Hours**
Lasers: Introduction to lasers. Absorption and emission of radiation, Einstein's coefficients. Condition for laser action, population inversion and metastable states. Requisites of a laser system – active medium, pumping mechanism and optical resonant cavity. Three level and four level lasers. Principle, construction and working of Nd:YAG laser, He-Ne laser and semiconductor laser. Applications.	
Optical fibers	**04 Hours**
Optical fibers: Introduction to optical fibers. Propagation mechanism in optical fibers - angle of acceptance, acceptance cone and numerical aperture – derivation. Fractional index change and V-number. Types of optical fibers and modes of propagation. Attenuation. Applications. Numerical examples.	

Suggested List of Experiments (Any 10 Experiments)	
1.	Energy band gap of a semiconductor by four-probe technique.
2.	Hall effect – Determination of the carrier concentration in a semiconductor
3.	Transistor characteristics – Common emitter mode.
4.	Semiconductor laser - Determination of wavelength by diffraction.
5.	Zener diode characteristics – study of current-voltage characteristics
6.	Solar cell – study of its characteristics.
7.	Photo electric effect – Determination of the work function of the material of the emitter of a photocell.
8.	Charging and discharging of a capacitor – Determination of capacitance value, half time and time constant.
9.	Velocity of ultrasonic waves using ultrasonic interferometer
10.	Series and parallel resonance circuits.
11.	LED characteristics.

Course Outcomes: At the end of the course student will be able to

1.	Comprehend various properties of sub-atomic particles on the basis of wave mechanics.
2.	Understand the concepts of crystalline solids, and X-rays.
3.	Understand the concepts of semiconductors and working of semiconductor devices.
4.	Understand the characteristics of superconductors and its applications.
5.	Understand the principle, working and applications of lasers & optical fibers.

Course Outcomes Mapping with Program Outcomes & PSO														
Program Outcomes→	1	2	3	4	5	6	7	8	9	10	11	12	PSO↓		
↓ Course Outcomes															
PH1001-1.1	H	H													
PH1001-1.2	H	H													
PH1001-1.3	H	H													
PH1001-1.4	H	H													
PH1001-1.5	H	H													

1: Low 2: Medium 3: High

TEXTBOOKS:

1. **G.K.Shivakumar**, Engineering Physics, Prism Engineering Education Series, Prism books Pvt Ltd., Bangalore, 2010-11 edition (Reprint 2013-14).
2. **S. P. Basavaraju**, Engineering Physics, Subhas Stores, Bangalore, latest editions.
3. **Arthur Beiser et.al.,** Concepts of Modern Physics, Tata McGraaw Hill Education Private Limited, Special Indian Edition, 2009.

REFERENCE BOOKS:

1. **V. Rajendran**, Engineering Physics, Tata McGraw Hill Pub., 2011.
2. **M. R. Srinivasan**, Physics for Engineers, New Age International Publishers, Bangalore, 2nd Edition, 2009.
3. **Kenneth Krane,** Modern Physics, Wiley International, 3rd Edition, 2012.
4. **S. O. Pillai**, Solid State Physics, New Age International, 7thEdition, 2015
5 **A.Ghatak**, Optics, Tata McGraw Hill Pub.,5th edition, 2012
6 **A. J. Dekker**, Electrical Engineering Materials, Prentice Hall India Pub.,New Delhi, Reprint 2011.
7 **B. G. Streetmann,** Solid State Electronic devices, 6th edition, Prentice Hall India Learning Private Limited.

E Books / MOOCs/ NPTEL

1. http://nptel.ac.in/courses/122101002/23
2. http://nptel.ac.in/courses/113106039/1
3. http://nptel.ac.in/courses/115106061/

Elements Of Civil Engineering and Engineering Mechanics

Course Code:	**CV1001-1**	**Course Type**	**ESC**
Teaching Hours/Week (L: T: P: S)	**3:0:0:0**	**Credits**	**03**
Total Teaching Hours	**39**	**CIE + SEE Marks**	**50+50**

Teaching Department: Civil Engineering

Course Objectives:

1.	**Understand** the importance of Civil Engineering and **develop** the analytical skills to solve coplanar concurrent force system
2.	**Solve** non – concurrent force system and **analyze** cylinders and strings using equilibrium conditions.
3.	**Identify** different types of supports, loadings and **analyze** determinate beams
4.	**Understand** static friction and **analyze** block friction and ladder friction
5.	**Understand** centroid and moment of inertia of typical sections

UNIT-I

06 Hours

Scope and importance of different fields of Civil Engineering-Surveying, Building Materials, Construction Technology, Geotechnical Engineering, Structural Engineering, Hydraulics, Water Resources and Irrigation Engineering, Transportation Engineering, Environmental Engineering

Introduction to Engineering Mechanics: Basic idealizations -; Definition of force, Characteristics of a force, Force systems and classification; Principle of transmissibility. Resolution of forces, Composition of forces - Definition of Resultant; Resultant of coplanar concurrent force system.

09 Hours

Moment of a force, couple, characteristics of couple, Equivalent force - couple system; Varignon's theorem, Resultant of coplanar - non-concurrent force system.
Equilibrium of forces - *Definition of Equilibrant; Conditions of static equilibrium for different force systems. Particle equilibrium in 2-D & 3-D, Concept of free body diagram, Equilibrium of coplanar concurrent force system.

UNIT-II

07 Hours

Support Reactions –Types of beams, types of loads and supports, statically determinate beams, numerical problems on support reactions for statically determinate beams with point load (normal and inclined), uniformly distributed load, uniformly varying loads and moments

07 Hours

Friction – Theory of friction, types of friction, Coulumb's laws of friction, limiting friction, angle of friction, block friction and ladder friction

UNIT-III

Center of Gravity — **05 Hours**

Centroid of plane figures, locating the centroid of rectangular, triangular and sector of a circular areas using method of integration, Centroid of simple composite area (consisting of three components).

	05 Hours

Moment of inertia of an area, polar moment of inertia, Radius of gyration, Perpendicular axis theorem and Parallel axis theorem; Moment of Inertia of rectangular, triangular, semicircular, quarter of a circular area and sector of a circular areas from the method of integration; Moment of inertia of composite areas (consisting of three components).

Course Outcomes: At the end of the course student will be able to

1.	**List** and **explain** the scope of Civil Engineering and **solve** resultant of coplanar concurrent force system.
2.	**Determine** the resultant of coplanar non-concurrent force system by **applying** Varignon's Theorem and **solve** for unknown forces in the cylinders and strings using equilibrium conditions.
3.	**Explain** the types of beams, supports, loadings and **find** the support reactions for determinate beams.
4.	**Find** the static frictional force in blocks and ladder
5.	**Determine** the centroid and moment of inertia of composite area about the reference axes.

Course Outcomes Mapping with Program Outcomes & PSO

Program Outcomes→	1	2	3	4	5	6	7	8	9	10	11	12	**PSO↓**		
↓ Course Outcomes													1	2	3
CV1001-1.1	**3**	**2**											**1**	**1**	
CV1001-1.2	**3**	**2**											**1**	**1**	
CV1001-1.3	**3**	**2**											**1**	**1**	
CV1001-1.4	**3**	**2**											**1**	**1**	
CV1001-1.5	**3**	**2**											**1**	**1**	

1: Low 2: Medium 3: High

TEXTBOOKS:

1. Ferdinand L. Singer "*Engineering Mechanics*" Harper and Row Publishers, New York, 3rd edition,2015.
2. Bhavikatti,S.S, "*Engineering Mechanics*", Vikas Publishing House Pvt. Ltd., New Delhi. 17th edition,2018

REFERENCE BOOKS:

1. Ferdinand P. Beer and E. Russel Johnson, "*Mechanics for Engineers: Statics and dynamics*" McGraw-Hill Book Company, New York.4th edition,1987.
2. Timoshenko,Young,J.V Rao and S.Patil inS.I Units "*Engineering Mechanics*" McGraw-Hill Book Company, New Delhi.5th edition,2013
3. Merium J.L, Kraige L.G, *Engineering Mechanics* Vol.I & II Wiley Publishers.1993
4. McLEAN and Nelson,"*Engineering Mechanics*"(Schaum's outline Series), McGraw-Hill Book Company, New Delhi, 5th edition, 1997

E Books / MOOCs/ NPTEL

1. https://nptel.ac.in/courses/112/106/112106286/
2. http://nptel.vtu.ac.in/econtent/courses/BS/CIV1323/index.php
3. https://lecturenotes.in/notes/15363-note-for-element-of-civil-engineering-and-mechanics-ecem-by-vtu-rangers

BASIC ELECTRONICS

Course Code:	**EC1001-1**	**Course Type:**	**ESC**
Teaching Hours/Week (L: T: P: S):	**3:0:0:0**	**Credits:**	**03**
Total Teaching Hours:	**39+0+0+0**	**CIE + SEE Marks:**	**50+50**

Teaching Department: Electronics & Communication Engineering

Course Objectives:

1.	To familiarize the student with Semiconductor devices like Diodes, Transistors and their applications
2.	To analyze the working of simple electronic circuits involving Op-amps, 555 Timer and Linear Regulator ICs.
3.	To understand the fundamentals of Modern communication system.
4.	To introduce the fundamentals of Embedded Systems
5.	To familiarize the student with Semiconductor devices like Diodes, Transistors and their applications

UNIT-I

Diodes and their Applications	**06 Hours**

Semiconductor Diode, Diode Equivalent circuits, Load Line analysis, Half Wave Rectifier, Full wave Bridge Rectifier, capacitor and choke filter circuit (only qualitative approach). Zener Diode and its use in Voltage Regulation

Transistors and their Applications	**09 Hours**

Bipolar Junction Transistor: Construction and operation, Common Emitter and Common Base Characteristics, DC load line analysis, RC coupled amplifier (frequency response excluded), BJT as a switch, BJT circuit to switch ON/OFF an LED

Field Effect Transistor: Construction and Characteristics of JFET, Transfer Characteristics, Depletion and Enhancement mode MOSFETs, CMOS Inverter.

UNIT-II

Op-Amp & Linear IC Applications	**11 Hours**

Introduction, Op-Amp Specifications, Differential & Common-Mode operation, Op-Amp applications: Inverting/Non-Inverting Amplifier, Summing, Integrator, Differentiator, Comparator. 555 Timer IC in Astable mode. 78XX series IC Voltage Regulators.

Feedback and Oscillator Circuits	**05 Hours**

Feedback– Principle and advantages of negative feedback, Voltage series feedback amplifier. Concept of positive feedback, Op-Amp Oscillators – RC phase shift, Hartley and Colpitts's Oscillator

UNIT-III

Fundamentals of Communication and Embedded Systems	**08 Hours**

Modern communication system scheme (Block scheme), Information source, Input Transducers, Transmitter, Channels, Receivers, Noise, Fundamentals of Cellular communication.

Embedded system definition, Embedded System v/s General Computing Systems, Classification of Embedded systems, Elements of Embedded systems, Core of Embedded systems, Microprocessor v/s Microcontroller, RISC v/s CISC, Hardware v/s Von Neumann Architecture, Sensors and Actuators with examples

Course Outcomes: At the end of the course student will be able to

1.	Explain the operation of Rectifiers; Design a rectifier circuit, given the specification for output Voltage, PIV, and ripple factor; Design a Zener voltage regulator for the given specification of output voltage and Power;
2.	Explain the construction and operation of Bipolar transistor in CE or CB Mode; Explain the use of BJT in Amplification as well as switching operations; Explain the construction and operation of JFET or MOSFET; Explain the operation of a CMOS Inverter;
3.	List the ideal and practical parameters for an Op-Amp; Define Op-amp Specifications; Explain the use of Op-Amp in Amplification, Summing, Integration, Differentiation and comparison; Design an Astable Multivibrator, using 555 Timer IC, for the given frequency and duty cycle;
4.	List the advantages and disadvantage of Negative Feedback; Explain the impact of negative feedback on Amplifier gain, Input and Output Impedance for a Series Voltage Negative feedback; Explain the operation of Op-Amp based RC Phase-shift, Hartley, and Colpitts Oscillator
5.	Explain the scheme of a Modern Communication System; List the differences between a general computing system and Embedded System; Describe the differences between Harvard and Von-Neuman, RISC and CISC system architectures

Course Outcomes Mapping with Program Outcomes & PSO

Program Outcomes→ **↓ Course Outcomes**	1	2	3	4	5	6	7	8	9	10	11	12
EC1001-1.1	3											
EC1001-1.2	3											
EC1001-1.3	3											
EC1001-1.4	3											
EC1001-1.5	3											

1: Low 2: Medium 3: High

TEXTBOOKS:

1.	Robert L. Boylestad, Louis Nashelsky, "Electronic Devices and Circuit Theory", 11th Edition, PHI, 2016
2.	Simon Haykin, "Introduction to Analog and Digital Communications", Wiley Publishers, 2nd Edition, 2019
3.	Theodore Rappaport, "Wireless Communications: Principles and Practice", Pearson, 2nd Edition, 2016
4.	Shibu K V, "Introduction to Embedded Systems", TATA Mc Graw Hill Edu., 2nd Edition, 2016

E Books / MOOCs/ NPTEL

1.	https://nptel.ac.in/courses/117107095
2.	https://nptel.ac.in/courses/117103063
3.	https://www.coursera.org/learn/electronics?#syllabus
4.	https://www.coursera.org/learn/diode-pn-junction-metal-semiconductor-contact?specialization=semiconductor-devices#syllabus

Engineering Skill Development Practices

Course Code:	**ME1001-1**	**Course Type**	**ESC**
Teaching Hours/Week (L: T: P: S)	**0:0:2:0**	**Credits**	**01**
Total Teaching Hours	**26**	**CIE + SEE Marks**	**50+50**

Teaching Department: Mechanical Engineering

Course Objectives:

Students belonging to all branches of Engineering are made to learn certain fundamental topics related to mechanical engineering so that they will have a minimum understanding of mechanical systems, equipment and process.

1.	Prepare fitting models by using required tools and fitting operations according to the given dimensions using different hand tools.
2.	Prepare sheet metal models using the required tools and soldering process. Prepare carpentry joints using important carpentry tools.
3.	Calculate velocity ratio in a V belt drive. Assemble and disassemble simple machine parts such as machine vice and linear actuator.

UNIT-I

Fitting Shop	**09 Hours**

Study and use of engineering steel rule, height gauge, caliper, micrometer, files, chisels, hacksaw, hammers, drill bit, taps etc.

Models: Preparation of fitting models by making use of filing, sawing and chipping.

UNIT-II

Carpentry, Sheetmetal Work and Soldering	**09 Hours**

Study the use of carpentry sheet metal work and soldering tools. Study the development of surfaces of simple solids like prism, cylinder and cone.

Models: Preparation of a carpentry and two sheet metal models (square/ rectangular prism and cylinder.

UNIT-III

Active learning	**08 Hours**

1. Calculation of speed/ velocity ration of a V belt of a drilling machine
2. Assembly/ Disassembly of a machine part such as machine vice and tailstock of a lathe.
3. Fabrication/ Assembly of Automatic Linear actuator (Fabrication of holes using Power tools such as magnetic drill/ power tool kit)

Course Outcomes: At the end of the course student will be able to

1.	Prepare fitting models by using required tools and fitting operations according to the given dimensions.
2.	Draw the development and prepare sheet metal models of prisms, cylinder and frustum of a cone using the required tools and soldering process. Prepare carpentry joints using carpentry tools. Calculate the percentage error between the theoretical and actual velocity ratios in a V belt drive. Assemble and disassemble simple machine parts such as machine vice and linear actuator performing necessary machining operations.

Course Outcomes Mapping with Program Outcomes & PSO

Program Outcomes→	1	2	3	4	5	6	7	8	9	10	11	12	PSO↓		
↓ Course Outcomes													1	2	3
ME1001-1.1	3	1	-	-	-	-	-	2	3	2	-	-	-	-	-
ME1001-1.2	3	1	-	-	-	-	-	2	3	2	-	-	-	-	-

1: Low 2: Medium 3: High

TEXTBOOKS:

1. K.R.Gopalkrishna, **"A text Book of Elements of Mechanical Engineering"** Subhash Publishers, Bangalore. 2010
2. 2. Mikell P. Groover, **"Automation, Production Systems & CIM"**, 3rd Edition, PHI, 2012
3. V.K. Manglik, "Elements of Mechanical Engineering", PHI Publications,

REFERENCE BOOKS:

1. S. Trymbaka Murthy, "A Text Book of Elements of Mechanical Engineering", 4th Edition 2006, Universities Press (India) Pvt. Ltd, Hyder abad.
2. K.P. Roy, S.K. Hajra Choudhury, Nirjhar Roy, "Elements of Mechanical Engineering", Media Promoters & Publishers Pvt Ltd, Mumbai,7 th Edition,2012.
3. Pravin Kumar, "Basic Mechanical Engineering", 2013 Edition,

E Books / MOOCs/ NPTEL

1. https://nidm.gov.in/iec.asp (Study material of National Institute of Disaster

Computer Aided Engineering Graphics

Course Code:	**ME1002-1**	**Course Type**	**ESC**
Teaching Hours/Week (L: T: P: S)	**1:0:2:0**	**Credits**	**02**
Total Teaching Hours	**60**	**CIE + SEE Marks**	**50+50**

Teaching Department: Mechanical Engineering

Course Objectives:

1.	To impart and inculcate understanding of the theory of projection and concepts like dimensioning, conventions and projection of points and lines in different quadrants of projection system.
2.	To know and understand the projection of different plane surfaces.
3.	To impart the knowledge on understanding and drawing of different solid objects in different positions.
4.	To develop the lateral surfaces of solid objects and its use in sheet metal development

UNIT-I

Orthographic Projection	**10 Hours**

Orthographic Projection: Planes of Projection, First angle projection, reference line. Conventions employed for drawing, Projection of points located in first, second, third and fourth quadrants, Projection of Lines (First angle projection only), True and apparent lengths, true and apparent inclinations.

UNIT-II

Projection of Plane surfaces	**12 Hours**

Projection of plane surface: Triangle, Square, Rectangle, Pentagon, Hexagon and Circle in different positions.

UNIT-III

Projection of Solids	**16 Hours**

Projection of right regular solids: Prisms, Pyramids, Cones and Cylinders in different positions.

UNIT-IV

Development of Lateral surfaces of solids	**12 Hours**

Development of lateral surfaces of: Right regular Prisms, Pyramids, Cylinders and cones and their frustums.

Isometric projection and Isometric view	**10 Hours**

Isometric scale, Difference between Isometric projection and isometric view: To draw Isometric views of simple solids and machine components using their orthographic projections.

Course Outcomes: At the end of the course student will be able to

1.	Identify a coordinate system in which a point element exists. Draw the orthographic projections of a point and a line.
2.	Draw the orthographic projections of a plane surface (Triangular, square, rectangular, pentagonal, hexagonal and circular) for a given position using conventional drafting method and Solid Edge software.
3.	Draw the orthographic projections of a solid object (Pyramid, Prism, Cubic, Conical, cylindrical) for a given position using conventional drafting method and Solid Edge

	software.
4.	Draw the development of lateral surfaces of standard solid objects. Draw isometric projection of solid objects individually or in combination using conventional drafting and Solid Edge software.

Course Outcomes Mapping with Program Outcomes & PSO

Program Outcomes→	1	2	3	4	5	6	7	8	9	10	11	12	PSO↓		
↓ Course Outcomes													1	2	3
ME1002-1.1	3	1	0	0	0	0	0	0	1	1	0	2	2	1	2
ME1002-1.2	3	1	0	0	3	0	0	0	1	1	0	2	2	1	2
ME1002-1.3	3	1	0	0	3	0	0	0	1	1	0	2	2	1	2
ME1002-1.4	3	1	0	0	3	0	0	0	1	1	0	2	2	1	2

1: Low 2: Medium 3: High

TEXTBOOKS:

1. Engineering Drawing by N. D. Bhat & V. M. Panchal, Pramod R. Ingle, 53 Ed. 2014, Charotar Publishing House, Gujarat.
2. Engineering Drawing by K R Gopalakrishna, Subhas publishers, Bangalore , 32nd edition, 2012.

REFERENCE BOOKS:

1. A Text book of Engineering Graphics And Drafting by P. S. GILL, 11th Ed.2009, S. K. Kataria & sons, ISBN- 8185749612, 9788185749617, New Delhi.
2. A Text book of Engineering Drawing by K. L. Narayanan & Kannaiah P, Radiant Publishing House, 9th Edition, 2012.
3. A Primer on computer aided Engineering Drawing, Published by VTU, Belgaum, 8th edition, 2011.
4. Engineering Drawing and Computer Graphics, Shah, Pearson, 2010.
5. Textbook on Engineering Drawing, Narayana, Scitech Publishers, 1 December 2011
6. Engineering Graphics, Agarwal & Agarwal, TMH, Second edition, 2013
7. Publications of Bureau of Indian Standards
   a) IS 10711 – 2001: Technical products documentation – Size and lay out of drawing sheets.
   b) IS 9609 (Parts 0 & 1) – 2001: Technical products documentation – Lettering.
   c) IS 10714 (Part 20) – 2001 & SP 46 – 2003: Lines for technical drawings.
   d) IS 11669 – 1986 & SP 46 – 2003: Dimensioning of Technical Drawings.
   e) IS 15021 (Parts 1 to 4) – 2001: Technical drawings – Projection Methods.

SCHEME OF EXAMINATION

1. Question paper consists of 4 units with two questions in each unit.
2. Students are expected to answer Four full questions choosing at least ONE question from each unit.

Technical English

Course Code:	**HU1001-1**	**Course Type**	**HSMC**
Teaching Hours/Week (L: T: P: S)	**1:0:2:0**	**Credits**	**01**
Total Teaching Hours	**39**	**CIE + SEE Marks**	**50+50**

Teaching Department: Humanities

Course Objectives:

1.	Identify the nuances of Phonetics, Intonation and enhance pronunciation skills
2.	Understand Technical Communication along with the barriers and application of effective Interpersonal Communication Skills
3.	Enhance basic English grammar and essentials of language skills
4.	Improve sentence structure with the help of cohesive devices
5.	Develop spoken and writing skills

UNIT-I

16 Hours

Phonetics & Pronunciation

Introduction to Phonetics; Word Stress, Rhythm and Intonation; Weak Forms and Strong Forms, Role of IPA in past tense and plural forms of words, Awareness of Different Accents

Communication Skills

Introduction to Communication, Greeting and Introducing, Making Requests, asking for and Giving Permission, Offering Help

Understanding Telephone Communication, Handling Calls, Asking for and Giving Information, Telephone Etiquette

UNIT-II

Language Skills	**15 Hours**

Basic English Grammar, Ability to identify, Analyse, Interpret and Describe the critical ideas, values, and themes through literary works

UNIT-III

Writing Skills	**08 Hours**

Paragraph writing, Refutations, Linkers, Types of Letters

Course Outcomes: At the end of the course student will be able to

1.	Identify the nuances of phonetics, intonation and pronunciation to appreciate and incorporate Received Pronunciation
2.	Interpret and assess nuances of oral communication skills and the non-verbal communication for professional usage
3.	Identify, interpret and describe the critical ideas, values, and themes to appreciate literary pieces for its language and social interpretations
4.	Implement English vocabulary at command and language proficiency in personal and professional life
5.	Develop effective writing skills for incorporating them in different forms of writing

Course Outcomes Mapping with Program Outcomes & PSO

Program Outcomes→	1	2	3	4	5	6	7	8	9	10	11	12	PSO↓		
↓ Course Outcomes													1	2	3
HU1001-1.1	1	1						2		2		3			
HU1001-1.2	2					2				3		3			
HU1001-1.3		2					3	2		3		3			
HU1001-1.4		2				2			2	2		2			
HU1001-1.5		2				2		2	1	2		2			

1: Low 2: Medium 3: High

TEXTBOOKS:

1. Subhashini, A Textbook of English Language & Communication Skills, R Victor et al.

REFERENCE BOOKS:

1. English Pronunciation Dictionary, Daniel Jones A Remedial English Grammar for Foreign Students, Woods
2. Communication Skills, Sanjay Kumar, Oxford University Press.
3. Exercises in Spoken English Part I - CIEFL, Hyderabad, Oxford University Press.
4. Exercises in Spoken English Part II - CIEFL, Hyderabad, Oxford University Press.
5. Exercises in Spoken English Part III - CIEFL, Hyderabad, Oxford University Press.
6. On Writing Well, William Zinsser
7. Practical English Usage, Swan, Oxford University Press.
8. Study Writing, Liz-Hamp Lyons, Cambridge University Press.

Constitution of India & Professional Ethics

Course Code:	**HU1002-1**	**Course Type**	**HSMC**
Teaching Hours/Week (L: T: P: S)	**1:0:0:0**	**Credits**	**01**
Total Teaching Hours	**13**	**CIE + SEE Marks**	**50+50**

Teaching Department: Humanities

Course Objectives:

1.	Inculcate Social and Political consciousness of the Indian Polity.
2.	Understand their Obligations, Responsibilities, Privileges and Rights, Duties and the Role that they have to play in deciding the Administrative Machinery of the country.
3.	Develop National and Patriotic Spirit.
4.	Understand the nature and character of relations between union and state governments.
5.	Divulge the students about the statutory institutions and policies.

UNIT-I

Evolution of the Indian Constitution	**06 Hours**

1909 Act, 1919 Act, 1935 Govt of India Act, Constituent Assembly: Composition and Functions, Basic structure of Indian Constitution, Fundamental features of the Indian Constitution, Salient Features of Indian Constitution

UNIT-II

Structure of Government	**05 Hours**

Union Government: Legislature; Executive-President, Prime Minister, Council of Ministers; Judiciary, Judicial Review and activism

State Government: Executive: Governor, Chief Minister, Council of Ministers

Local Government: Panchayat Raj Institutions, Urban Governance

UNIT-III

Statutory Institutions	**02 Hours**

Elections - Election Commission of India, National Human Rights Commission, National Commission for Women.

Course Outcomes: At the end of the course student will be able to

1.	Analyze the legalities and related issues of drafting, adoption, and enforcement of the Indian Constitution as a fundamental law of the nation and the provisions and privileges of Indian Citizenship
2.	Understand and judiciously use the fundamental rights, fundamental duties and privileges envisaged in the constitution propagating social harmony and equality and respecting the rights and liberties of other people.
3.	Contribute in protecting and preserving the sovereignty and integrity of India and have a compassion to all living creatures, uphold sense of brotherhood ness among all citizens of the nation and promote peace and harmony
4.	Respect the Constitutional Institutions and all noble ideals cherished during Indian struggle for freedom
5.	Develop a Spirit of belongingness to the country.

Course Outcomes Mapping with Program Outcomes & PSO

Program Outcomes→	1	2	3	4	5	6	7	8	9	10	11	12	PSO↓		
↓ Course Outcomes													1	2	3
HU1002-1.1								3			1	1			
HU1002-1.2								2			1	1			
HU1002-1.3			2				1	2			1	1			
HU1002-1.4								1							
HU1002-1.5			1					3			1	1			

1: Low 2: Medium 3: High

REFERENCE BOOKS:

1. Introduction to the Constitution of India; Dr. Durga Das Basu; Twentieth Edition, Reprint 2011; LexisNexis Butterworths Wadhwa, Nagpur, Haryana, India.
2. Introduction to Constitution of India; M.V. Pylee; Fourth Revised Edition, 2005; Vikas Publishing House Pvt. Ltd., New Delhi.
3. Introduction to Constitution of India; Brij Kishore Sharma; Second Edition, 2004; Prentice Hall of India Pvt. Ltd., New Delhi.
4. An Introduction to Constitution of India and Professional Ethics; Prof. B R Venkatesh and Merunandan K B; Merugu Publications, Bangalore; Second Edition, 2007.

E Books / MOOCs/ NPTEL

1. http://nptel.ac.in/courses/109104032/
2. https://pothi.com/pothi/book/ebook-ministry-law-and-justice-constitution-india
3. *iasplanner.blogspot.com/2010/11/free-ebook-download-constitution-of.html*
4. www.iasabhiyan.com
5. Samvidhaan, Documentary by Prasaar Bharathi

NITTE (Deemed to be University) | NMAM INSTITUTE OF TECHNOLOGY

B. Tech. (RI): Scheme of Teaching and Examinations 2022-26

Outcome Based Education (OBE) and Choice Based Credit System (CBCS)

(Effective from the academic year 2022 - 23)

GROUP - I

II SEMESTER (AI&DS, AI&ML, CC, CS, IS, RI)

SI No.	Course and Course code		Course Title	Teaching Department	Teaching hours/Week			Examination				Credits
					Theory Lecture	Tutorial	Practical/ Drawing	Duration in hours	CIE	SEE	Total Marks	
					L	T	P					
1	BSC	MA1003-1	Differential Equations and Laplace Transforms	MA	3	0	0	3	50	50	100	3
2	BSC	CY1001-1	Engineering Chemistry	CH	3	0	2	3	50	50	100	4
3	ESC	CS1001-1	Problem-Solving through Programming	CS	3	0	2	3	50	50	100	4
4	ESC	EE1001-1	Basic Electrical Engineering	EE	3	0	2	3	50	50	100	4
5	ESC	ME1003-1	Elements of Mechanical Engineering	ME	3	0	0	3	50	50	100	3
6	AEC	BT1001-1	Biology for Engineers	BT	1	0	0	1	50	50	100	1
7	AEC	CS1002-1	IT Skills	CS	1	0	2	3	50	50	100	2
8	MNC	CV1002-1	Environmental Science	CV	1	0	0	1	50	50	100	0
9	MNC	UM1002-1	Skill Development Lab Group B	Any Dept.	0	0	4	0	0	0	0	0
TOTAL					TOTAL	**18**	**0**	**12**	**20**	**400**	**800**	**21**

Mandatory Internship-I*								
1.	INT	UC1001-1	Internship – I	Mandatory Intra Institutional Internship of duration (80 - 90 Hours) to be completed during I & II Semesters. *The grades will be included in the IV semester grade card (Refer 11.5.2 for details)	100	--	100	2

Differential Equations and Laplace Transforms
(Common to BT\CV\EC\EE\ME\RI)

Course Code:	**MA1003-1**	**Course Type**	**BSC**
Teaching Hours/Week (L: T: P: S)	**3:0:0:0**	**Credits**	**03**
Total Teaching Hours	**39**	**CIE + SEE Marks**	**50+50**

Teaching Department: Mathematics

Course Objectives:

1.	This course will enable the students to master the basic tools of Laplace transforms, differential equations, partial differential equations and become skilled for solving problems in science and engineering.

UNIT-I

15 Hours

FIRST ORDER ORDINARY DIFFERENTIAL EQUATIONS

Exact, linear and Bernoulli's differential equations, orthogonal trajectories of cartesian and polar curves. Applications to simple engineering problems. Non linear differential equations (first order and higher degree) equations solvable for p, equations solvable for y and equations solvable for x, general and singular solutions of Clairaut's equations.

ORDINARY DIFFERENTIAL EQUATIONS OF HIGHER ORDER

Second and higher order linear differential equation with constant coefficients, solution by inverse differential operator, method of variation of parameters, linear differential equation with variable coefficients- Cauchy's linear differential equation. Applications to engineering problems.

UNIT-II

LAPLACE TRANSFORMS — **15 Hours**

Definitions, transforms of elementary functions, transforms of derivatives and integrals-properties. Periodic functions, unit step functions and unit impulse functions.
Inverse Transforms and properties, convolution theorem, initial & final value theorems. Applications to engineering problems.

UNIT-III

PARTIAL DIFFERENTIAL EQUATIONS — **09 Hours**

First and higher order partial differential equations. Formation of partial differential equations by elimination of arbitrary constants/arbitrary functions. Derivation of one dimensional heat and wave equations, Solution of PDE's by direct integration method, by the method of separation of variables, by Lagrange's Method. Solution of partial differential equations of derivatives involving only one independent variable.

Course Outcomes: At the end of the course student will be able to

1.	Solve first order ordinary differential equations.
2.	Solve linear ordinary differential equations of higher order.
3.	Understand the concept of Laplace Transform and apply it to solve engineering problems.
4.	Make use of Laplace transform method to solve linear ordinary differential

	equations with constant coefficients
5.	Understand the derivation of one dimensional heat and wave equations and solve partial differential equations.

Course Outcomes Mapping with Program Outcomes & PSO

Program Outcomes→	1	2	3	4	5	6	7	8	9	10	11	12	**PSO↓**		
↓ Course Outcomes													1	2	3
MA1003-1.1	3	2													
MA1003-1.2	3	2													
MA1003-1.3	2	2													
MA1003-1.4	2	2													
MA1003-1.5	3	2													

1: Low 2: Medium 3: High

TEXTBOOKS:

1.	B.S. Grewal, "Higher Engineering Mathematics", Khanna Publications, 43rd Edition, 2015.
2.	Erwin Kreyszig, "Advanced Engineering Mathematics", John Wiley and Sons, 10th Edition (Reprint), 2016.

REFERENCE BOOKS:

1.	T. Veerarajan, "Engineering Mathematics", McGraw-Hill, New Delhi, 2008.
2.	B. V. Ramana, "Higher Engineering Mathematics", Tata Mc Graw –Hill, New Delhi,2010.
3.	N.P. Bali and M.Goyal, "A text book of Engineering Mathematics", Laxmi Publications, 2010.
4.	W.E. Boyce and R.C. DiPrima, "Elementary Differential Equations and Boundary Value Problems", Wiley India, 2009.
5.	E.A. Coddington, "An Introduction to Ordinary Differential Equations", Prentice Hall India, 1995.
6.	G.F. Simmons and S.G. Krantz, "Differential Equations", McGraw Hill, 2007.

E Books / MOOCs/ NPTEL

1.	*http://nptel.ac.in/courses/**111106100***
2.	*http://nptel.ac.in/courses/**111106139***
3.	*http://nptel.ac.in/courses/**111107111***

Engineering Chemistry

Course Code:	**CY1001-1**	**Course Type:**	**IPCC**
Teaching Hours/Week (L:T:P: S):	**3:0:2:0**	**Credits:**	**04**
Total Teaching Hours:	**39+0+26**	**CIE + SEE Marks:**	**50+50**

Teaching Department: Chemistry

Course Objectives:

1.	a) Know the basics of electrochemistry and its usage in the working of fuel cells and modern-day batteries. b) Gain knowledge of the harmful effects of corrosion on metal and techniques used in preventing it, including metal finishing.
2.	a) Get acquainted with the different types of industrially important polymers along with their characteristic properties. b) Know the requirements of boiler feed water.
3.	a) Get the knowledge on the different chemical fuels and related parameters. b) Know the basics of liquid crystals. c) Understand the different routes of nonmaterial synthesis.
4.	To provide students with practical knowledge of quantitative analysis of materials by classical methods.
5.	Familiarize with the practical knowledge of chemistry enabling their skill development by instrumental methods of analysis.

UNIT-I

ELECTROCHEMICAL CELLS & BATTERY TECHNOLOGY	**08 Hours**

Introduction, Derivation of Nernst equation for single electrode potential. EMF of the cell, Numerical problems. Construction and working of calomel electrode, Measurement of single electrode potential. Ion-selective electrode- definition, construction, and working of the glass electrode. Determination of pH using a glass electrode. 4 Hours

Introduction to battery, battery characteristics, Classification of batteries–primary, secondary, and reserve batteries. Construction, working, and applications of Lithium-ion battery, and Flow batteries- Construction, working and applications of Vanadium flow battery. Fuel cells- Introduction, construction, working, and uses of Methanol-Oxygen fuel cells. 4 Hours

CORROSION SCIENCE & METAL FINISHING	**07 Hours**

Corrosion - definition, Electro-chemical theory of corrosion, Factors affecting the rate of corrosion. Differential metal corrosion- galvanic series, Differential aeration corrosion - Waterline and pitting corrosion. Stress corrosion. Corrosion Control: Protective coatings; Inorganic coating - Anodizing and Phosphating. Metal coating - Galvanization and Tinning, cathodic protection. 4Hours

Introduction to metal finishing, Polarization, decomposition potential, and over-voltage.

Electroplating, effect of plating variables on the nature of electrodeposit, Electroplating of Chromium, Electroless plating - advantages, Electroless plating of copper on PCB. 3Hours	
UNIT-II	
POLYMERS	**07 Hours**
Definition, Classification, free radical mechanism of polymerization of vinyl chloride. Emulsion polymerization. Glass transition temperature. Structure and property relationship. Synthesis, properties, and applications of PMMA, Polycarbonate Elastomers – Definition, Synthesis, and applications of Butyl rubber and Silicone rubbers. Adhesives- Synthesis and applications of Epoxy resins. Polymer Composites: Introduction, synthesis, properties, and applications of carbon fiber. Conducting polymers-definition, applications. Mechanism of conduction in polyacetylene.	
WATER CHEMISTRY	**06 Hours**
Impurities in water, Water analysis - Determination of Hardness, determination of Dissolved Oxygen by Winkler's method, Boiler feed water, and boiler problems – scales and sludges, boiler corrosion. External treatment - hot lime soda process, Ion-exchange method. Internal treatment -phosphate conditioning, colloidal conditioning, Calgon conditioning. Desalination of seawater - Electro dialysis and reverse osmosis. Sewage treatment: Primary, secondary, and tertiary treatment.	
NANOMATERIALS	**02 Hours**
Introduction, classification of nanomaterials. Synthesis of nanomaterials by microwave, combustion, chemical vapour deposition, and sol-gel methods. Applications of nanomaterials.	
UNIT-III	
CHEMICAL FUELS	**06 Hours**
Introduction, definition, classification of fuels. Calorific value-definition, Gross, and Net calorific values. Determination of calorific value of a solid/liquid fuel using a Bomb calorimeter. Numerical problems. Petroleum cracking-fluidized bed catalytic cracking. Reformation of petrol. Knocking and its harmful effects. Prevention of knocking, power alcohol and biodiesel.	
LIQUID CRYSTALS	**03 Hours**
Introduction, classification- Thermotropic, and Lyotropic with examples. Types of mesophases - nematic, chiral nematic, smectic, and columnar. The chemical constitution of liquid crystals. Electro-optic effect of liquid crystals. Applications of liquid crystals in display systems.	

Suggested List of Experiments	
1.	Determination of Total Hardness of a sample of water using disodium salt of EDTA.
2.	Determination of percentage of copper in brass using standard sodium thiosulphate solution.

3.	Determination of nitrogen ammonia in each sample of fertilizer using a standard hydrochloric acid solution.
4.	Determination of manganese dioxide in Pyrolusite using standard potassium permanganate solution.
5.	Determination of Iron in the given sample of Hematite ore solution using potassium dichromate crystals by external indicator method.
6.	Determination of Chemical Oxygen Demand (COD) of the given industrial wastewater sample.
7.	Potentiometric estimation of FAS using standard $K_2Cr_2O_7$solution.
8.	Colorimetric determination of iron.
9.	Conductometric estimation of an Acid mixture using standard NaOH solution.
10.	Determination of pKa of a weak acid using pH meter.
11.	Determination of the viscosity coefficient of a given liquid using Ostwald's viscometer.
12.	Flame photometric estimation of sodium in the given sample of water.

Course Outcomes: At the end of the course student will be able to

1.	a) Understand the basic components of electrochemical cells and thereby relate their principles to modern batteries and fuel cells. b) Identify the different types of corrosion; techniques generally used for its prevention, and understand the metal surface modification techniques like electroplating and electroless plating.
2.	a) Analyze the different types of polymers, their synthetic routes, and applications. b) Understand the prime problems faced in boiler feed water, subsequent remedial measures undertaken and analyze the quality of water. c) Identify the synthetic approaches undertaken for designing nanomaterials.
3.	Identify the methodologies used to analyze as well as improvise on chemical fuels. Understand the applications of liquid crystals in display systems.
4.	Understand the different types of volumetric titrations for the estimation of composition in materials for accurate results.
5.	Handling different types of instruments for analysis of materials using small quantities involved for quick and accurate results.

Course Outcomes Mapping with Program Outcomes & PSO

Program Outcomes→	1	2	3	4	5	6	7	8	9	10	11	12	PSO↓		
↓ Course Outcomes															
CY1001-1.1	H	L													
CY1001-1.2	H	M													
CY1001-1.3	H	H													
CY1001-1.4	M	L													
CY1001-1.5	M	L													

1: Low 2: Medium 3: High	
TEXTBOOKS:	
1.	Engineering Chemistry by P.C. Jain & Monica Jain., DhanpatRai Publications, New Delhi.2015
2.	Engineering chemistry by R V Gadag & A Nityananda Shetty., IK International Publishing House Private Ltd. New Delhi.2016.
3.	Physical Chemistry, by P. W. Atkins, Oxford Publications (Eighthedition-2006)
REFERENCE BOOKS:	
1.	Chemistry for Engineering Students by B.S. Jai Prakash, R.Venugopal, Sivakumaraiah & Pushpa Iyengar., Subhash Publications, Bangalore.2016.
2.	Principles of Physical Chemistry by B.R.Puri, L.R.Sharma& M.S. Pathania., S.Chand & Co. Pvt. Ltd. NewDelhi.1998.
3.	Liquid crystals and plastic crystals, Vol-I, edited by G.W.Gray and P.A.Winsor, Ellis Horwood Series in Physical Chemistry, New York. 2010, (p.No.106-142).
4.	Corrosion Engineering by M.G. Fontana, Mc Graw HillPublications.2006.
5.	Vogel's textbook of quantitative inorganic analysis, revised by J.Bassett, R.C. Denny, G.H. Jeffery, 4thEd.
6.	Laboratory manual in Engineering Chemistry Sudharani, Dhanpatrai Publishing Company, New Delhi.
E Books / MOOCs/ NPTEL	
1.	http://bcs.whfreeman.com/vollhardtschore5e/default.asp.
2.	https://www.ttu.ee/public/m/Mehaanikateaduskond/Instituudid/Materjalitehnika_instituut/MTX9100/ Lecture11_Synthesis.pdf.
3.	http://nptel.ac.in/courses/113108051/module1/lecture1.pdf

PROBLEM SOLVING THROUGH PROGRAMMING

Course Code:	**CS1001-1**	**Course Type:**	**BSC**
Teaching Hours/Week (L: T: P: S):	**3:0:2:0**	**Credits:**	**04**
Total Teaching Hours:	**39+0+26**	**CIE + SEE Marks:**	**50+50**

Teaching Department: Computer Science & Engineering

Course Objectives:

1.	Make students learn basics of Computer System, Principles of Problem solving, and the basics of C programming language including the basic structure, data types and keywords used to design & develop programming skills.
2.	Outline the usage of Input Output statements, Operators and Evaluating expressions in C.
3.	Apply the concepts of decision making and looping in problem solving to demonstrate its usage using simple programs.
4.	Apply the concepts of Arrays, User-defined functions and code reusability in problem solving along with parameter passing and returning with the help of user defined functions.
5.	Demonstrate the usage of Strings, Structures, Pointers and File handling that are essential for understanding the concepts with simple examples.

UNIT-I

15 Hours

INTRODUCTION TO COMPUTER SYSTEM:
Introduction to Computer generations and types, CPU, Primary Memory, Secondary Memory, Ports and Connections.
Problem solving, Program Development steps, Introduction to Algorithms and Flowcharts.

INTRODUCTION TO C PROGRAMMING LANGUAGE:
Evolution & Characteristics of C Language, Structure of a C Program, C Compilation Model.
Characters set, C tokens, Keywords and identifiers, Constants, Data Types and Variables.
OPERATORS AND EXPRESSIONS:
Arithmetic operators, Relational operators, Logical operators, Assignment operators, Increment and Decrement operators, conditional operator, Bitwise operators, Special Operators.
Arithmetic expressions, Operator precedence and associativity, Type conversions in expressions, Evaluation of expressions.

MANAGING INPUT AND OUTPUT OPERATIONS:
Formatted Input and Output functions, Unformatted Input and Output functions.

UNIT-II

15 Hours

DECISION MAKING AND BRANCHING:
Decision making with if statement, Simple *if* Statement, the *if…else* statement, *Nesting of if…else* statements, The *else…if* ladder, The *switch* statement, The *goto* statement, break and continue statements.

DECISION MAKING AND LOOPING:
The *while* statement, the *do…while* statement, the *for* statement, Jumps in Loops.

ARRAYS:
Arrays (1-D, 2-D) Initialization and Declaration.

USER-DEFINED FUNCTIONS:
Need for the User-defined Functions, Element of User-defined Functions, Argument Passing – call by value, call by reference, Category of Functions.

Examples: Linear Search, Binary Search, Bubble sort, Selection Sort, Trace and Transpose, Matrix Multiplication.

UNIT-III	
	09 Hours

STRINGS:
Declaring and Initializing strings, String manipulation functions.

STRUCTURES:
Defining a Structure, Declaration and Accessing the Structured Variable.

POINTERS AND FILE HANDLING:
Introduction, Declaration, accessing of variables using Pointers, Basic file operations: Open, Close, Read, Write.

Suggested List of Experiments

Part A

1.	Write a C program to find the roots of a quadratic equation ax2+bx+c=0.
2.	Write a C program to find the sum of all the digits and occurrence of a digit in the number.
3.	Write a C program to find the GCD and LCM of given two numbers using Euclid's method.
4.	Write a C program to print the prime numbers in a given range.
5.	Write a C program to find if a given string is a palindrome or not.
6.	Write a C program to input N real numbers in 1-D array. Compute mean, variance and Standard Deviation. [Mean= sum/N, Variance = Σ(Xi-mean) 2 /N, STDDeviation= √variance.]
7.	Write a C program to read N integers into an array A and find the sum of elements using pointers.
8.	Write a C program to copy contents of one file to another file.
	Part B
9.	Write a C program to perform a binary search for a given key integer in a single dimensional array of numbers in ascending order and report success or failure in the form of a suitable message.
10.	Write a C program to input N integer numbers into a single dimension array, sort

	them in to ascending order using selection sort technique, and then to print both the given array and the sorted array with suitable headings.
11.	Write a C program to transpose a matrix of order M x N and find the trace of the resultant matrix.
12.	Write a C program using functions to read two matrices A (M x N) and B (P x Q) and to compute the product of A and B if the matrices are compatible for multiplication.
13.	Write a C program using functions readmat ( ), rowsum ( ), colsum ( ), totsum ( ) and printmat( ) to read the values into a two dimensional array A, find the sum of all the elements of a row, sum of all the elements of a column, find the total sum of all the elements of the two dimensional array A and print the results.
14.	Write a C program to perform a linear search for a given key integer in a single dimensional array of numbers and report success or failure in the form of a suitable message using functions.
15.	Write a C program to enter the information like name, register number, marks in 6subjects of N students into an array of structures, and find the average & display grade based on average for each student Average — Grade 80-100 — Distinction 60-79 — First Class 40-59 — Second Class <40 — Fail
16.	Write a C program, to implement a bubble sort technique using a function to sort given N integers in ascending/ descending order as per user's preference.

Course Outcomes: At the end of the course student will be able to

1.	**Describe** the basics of computer system, basics of C and the process of problem-solving aspects using algorithmic solution for a given problem.
2.	**Apply** the knowledge of expression solving to evaluate simple expressions and input/output statements to **develop** a C program.
3.	**Develop** the C program using control statements such as branching and looping constructs for a given problem.
4.	**Apply** the knowledge of code re-usability, parameter passing and returning values to **develop** a maintainable C program using these concepts including arrays and functions.
5.	**Identify and describe** the use of strings, structures, pointers and file handing mechanisms in a C program.

Course Outcomes Mapping with Program Outcomes & PSO

Program Outcomes→	1	2	3	4	5	6	7	8	9	10	11	12	PSO↓		
↓ Course Outcomes													1	2	3
CS1001-1.1	3													2	
CS1001-1.2	2	3												3	
CS1001-1.3	2	3												3	
CS1001-1.4	2	2	3											3	

CS1001-1.5	2	3												3	

1: Low 2: Medium 3: High

TEXTBOOKS:	
1.	E. Balaguruswamy, Programming in ANSI C,Tata McGraw Hill, 3rd Edition,2004.
2.	Jacqueline A. Jones & Keith Harrow, C Programming with Problem Solving, Pearson, Pap/Dskt edition, 1996
REFERENCE BOOKS:	
1.	Kernighan & Ritchie, The C Programming (ANSI C), Prentice Hall; 2ndEdition, 1998.
2.	Rajiv Khanna, Computer Concepts and C Programming, New Age International Pvt Ltd Publishers, 1st Edition, 2006.
3.	Yashwant Kanetkar, Let Us C, 5th Edition, BPB Publications, New Delhi, 2004.
E Books / MOOCs/ NPTEL	
1.	http://www.lysator.liu.se/c/bwk-tutor.html#introduction
2.	http://www.acm.uiuc.edu/webmonkeys/book/c_guide/
3.	C programming Tutorial by Mark Burgers http://markburgess.org/CTutorial/C-Tut-02.pdf
4.	http://nptel.ac.in/courses/106105085/4
5	https://www.lynda.com/C-training-tutorials/1249-0.html

Basic Electrical Engineering

Course Code:	**EE1001-1**	**Course Type:**	**ESC**
Teaching Hours/Week (L: T: P:S):	**3:0:2:0**	**Credits:**	**04**
Total Teaching Hours:	**39+0+26**	**CIE + SEE Marks:**	**50+50**

Teaching Department: Electrical & Electronics Engineering

Course Objectives:

1.	To familiarize the student with the DC circuit analyses.
2.	To analyze single and three-phase AC circuits.
3.	To understand the working principle of electrical machines.
4.	To introduce the concept of electrical wiring protective devices and safety measures

UNIT-I

Circuit Fundamentals	**07 Hours**
Basic nodal and mesh analysis excited by independent DC voltage sources, Power and Energy. Generation of sinusoidal voltage, frequency of generated voltage, definition and numerical values of average value, root mean square value, form factor and peak factor of sinusoidally varying voltage and current, phasor representation of alternating quantities.	
A.C. Circuits	**09 Hours**
Analysis of R, L, C, R-L, R-C and R-L-C series and parallel circuits. Phasor Diagrams. Real power, reactive power, apparent power and power factor. Three-phase balanced circuits, voltage and current relations in star and delta connections. Measurement of three phase power using two wattmeters	

UNIT-II

Single-Phase Transformers	**06 Hours**
Faradays Laws, self and mutually induced emfs. Necessity of transformer, Principle of operation. Types of Transformers, Emf equation, losses, efficiency, problems on emf equation and efficiency, Autotransformer, Applications.	
DC Machines	**04 Hours**
Constructional details, Principle of operation of generator and motor, Expression for back emf, Types of dc motors, Characteristic of dc motors (shunt and series motors only) and Applications.	
Three Phase Synchronous Machines	**04 Hours**
Basic parts, Principle of operation, Synchronous speed, Frequency of generated voltage, Emf equation. Concept of winding factor (excluding the derivation of distribution and pitch factors). Principle of operation of Synchronous Motor. Applications	

UNIT-III

Induction Motors	**05 Hours**
Concept of rotating magnetic field, Construction and working of a three-phase Induction Motor, Slip and its significance, Torque slip characteristics (qualitative). Necessity of a starter, Principle of operation Single Phase Induction Motor. Applications	
Domestic Wiring	**04 Hours**
Brief discussion on Service mains, Meter board, Distribution board, conduit wiring. Two-way	

and Three-way control. Elementary discussion on Circuit protective devices: Fuse and Miniature Circuit Breaker (MCB's). Electric shock, precautions against shock. Earthing: Pipe and Plate earthing.	
Suggested List of Experiments	
1.	Verification of KVL and KCL for DC circuits.
2.	Measurement of current, power and power factor of incandescent lamp, fluorescent lamp, CFL and LED lamp.
3.	Sinusoidal steady state response of R-L, and R-C circuits- impedance calculation and verification.
4.	Load test on a single-phase Transformer.
5.	Voltage and Current relationships of three phase star/delta circuits.
6.	Measurement of three-phase power using two wattmeter method.
7.	Speed load characteristic of a 3-phase Induction Motor.
8.	Two-way and Three-way Control of lamp and formation of truth table
Demonstration Experiments	
1.	Demonstration of fuse, MCB by creating a fault.
2.	Demonstration of cut out sections of electrical machines (DC machines, Induction machines and Synchronous machines).

Course Outcomes: At the end of the course student will be able to

1.	Analyze the DC Circuits using mesh & node methods and describe AC fundamentals.
2.	Analyze voltage & current phasor relationships in single phase & three phase AC circuits and compute complex power.
3.	Summarize the fundamentals of electromagnetism and apply principle of single-phase transformer to compute transformer efficiency.
4.	Describe the construction, operating principle of DC & synchronous machines and analyze their performance characteristics.
5.	Describe the working principle, starting process, performance characteristics & applications of Induction motor and domestic wiring & protective schemes.

Course Outcomes Mapping with Program Outcomes & PSO

Program Outcomes→	1	2	3	4	5	6	7	8	9	10	11	12	PSO↓	
↓ Course Outcomes													1	2
EE1001-1.1	2	3												
EE1001-1.2	2	3												
EE1001-1.3	2	3												
EE1001-1.4	2	3											1	
EE1001-1.5	2	3											1	

1: Low 2: Medium 3: High

TEXTBOOKS:

1.	Electrical Technology, Hughes, Edward, Pearson Education Publications, 10^{th} Edition, 2010.

2.	Basic Electrical Engineering, D. P. Kothari and I. J. Nagrath, Tata McGraw Hill, 3rd Edition 2009.
3.	Lecture Notes on Basic Electrical Engineering, Department of E&E, NMAMIT, Nitte
REFERENCE BOOKS:	
1.	Electrical Engineering Fundamentals, Vincent Del Toro, 2nd Edition, Pearson, 2015
2.	Electrical Technology, H. Cotton, CBS; 7th Edition, 2005.
3.	Basic Electrical Engineering by A. Mittle and V. N. Mittle, Tata McGraw Hill, 2005
4.	Basic Electrical Engineering, Dr. Debashisha Jena, Wiley India Private Limited, 2012
E Books / MOOCs/ NPTEL	
1.	http://nptel.ac.in/courses/108105053/
2.	Basic Electrical Technology Lectures by Dr. L Umanand Department of Power Electronics Group, CEDT IISC Bangalore available at http://www.nptelvideos.in/2012/11/basic-electrical-technology.html

Elements of Mechanical Engineering

Course Code:	ME1003-1	Course Type	PCC
Teaching Hours/Week (L: T: P: S)	3:0:0:0	Credits	03
Total Teaching Hours	39	CIE + SEE Marks	50+50

Teaching Department: Mechanical Engineering

Course Objectives:

Students belonging to all branches of Engineering are made to learn certain fundamental topics related to mechanical engineering so that they will have a minimum understanding of mechanical systems, equipment and processes.

1.	Understand the principles of energy sources, formation of steam and boilers.
2.	Know the working principles of pumps, compressors, and turbines.
3.	Understand basic principles of I. C. Engines, Refrigeration and Airconditioning.
4.	Understand the basic principles of power transmission and metal joining processes.
5.	Understand the different machining operations, automation, and robotics.

UNIT-I

09 Hours

Sources of energy: Introduction to Fossil fuels, Classification of different sources of energy. (Conventional & Non-conventional) with examples.

Properties of Steam: Formation of steam, States of Steam and Steam properties, Numerical Problems.

Boilers: Definition and Functions of boilers, Classification of boilers, Details of Cochran boiler, Babcock & Wilcox boiler. Boiler mountings and accessories – Meaning and Functions.

06 Hours

Pumps and compressors: Introduction, Working principles of Centrifugal Pump and Single Stage Reciprocating Compressor.

Turbines: Working principles of Impulse and Reaction steam turbines (De Laval and Parson's turbines), Water turbines (Pelton wheel, Kaplan, and Francis turbines), Gas turbines (Open and Closed cycles).

UNIT-II

09 Hours

Internal Combustion Engines: I. C. Engines parts, Working of 2-Stroke and 4-stroke Petrol and diesel engines. Numerical Problems on Indicated Power, Brake power, mechanical and thermal efficiencies.

Refrigeration and Air conditioning: Properties of refrigerants, Refrigeration – Meaning, Uses and Definitions (COP, Tons of Refrigeration, Refrigerating Effect). Construction and working Principle of Vapor Compression, Vapor Absorption refrigeration system, and Air-conditioners (Window A.C.)

06 Hours

Power Transmission: Belt drives - Applications, Open and Crossed belt drives, Length of belt and Velocity ratio, Ratio of belt tensions - Formulae and Numerical problems (No derivations). Gear drives - Introduction of Spur, Helical, Bevel gears, Worm & Worm wheel, and Rack & Pinion. Simple and compound spur gear trains, Gear ratios, Formulae and Numerical problems (No derivations)

Welding and Soldering: Basic principles of Arc welding, Gas welding, Soldering, and

Brazing.

UNIT-III

09 Hours

Machine Tools: Introduction, Types of machine tools and Applications.
Lathe operations - Turning, facing, Taper Turning using swiveling compound rest and Thread cutting.
Drilling operations - Drilling and Tapping
Milling operations - Plane milling (Up and Down milling), End milling.
Grinding operations - Surface grinding, cylindrical grinding and Centerless grinding.
Mechatronics and Automation: Meaning, Need for automation, Types - Fixed, Programmable & Flexible automation. Elements of automated systems, Open and Closed loop control systems.
Robotics: Introduction, Robot Anatomy, Classification based on Robot Configuration, Applications of Robots.

Course Outcomes: At the end of the course student will be able to

1.	Explain the principles of energy sources, formation of steam and boilers.
2.	Discuss the working principles of pumps, compressors, and turbines.
3.	Explain basic principles of I. C. Engines, Refrigeration and Airconditioning.
4.	Discuss the basic principles of power transmission and metal joining processes.
5.	Explain the different machining operations, automation, and robotics.

Course Outcomes Mapping with Program Outcomes & PSO

Program Outcomes→	1	2	3	4	5	6	7	8	9	10	11	12	**PSO↓**		
↓ Course Outcomes													1	2	3
ME1001-1.1	3	1	-	-	-	1	-	1	-	1	-	-	-	-	-
ME1001-1.2	3	1	-	-	-	-	-	-	-	1	-	-	-	-	-
ME1001-1.3	3	2	-	-	-	-	-	-	-	1	-	-	-	-	-
ME1001-1.4	3	2	-	-	-	-	-	-	1	1	-	-	-	-	-
ME1001-1.5	3	2	-	-	-	-	-	1	1	1	-	-	-	-	-

1: Low 2: Medium 3: High

TEXTBOOKS:

1. K.R.Gopalkrishna, **“A text Book of Elements of Mechanical Engineering”** Subhash Publishers, Bangalore. 2010
2. Mikell P. Groover, **“Automation, Production Systems & CIM”**, 3rd Edition, PHI, 2012
3. V.K. Manglik, **“Elements of Mechanical Engineering”**, PHI Publications, 2013.

REFERENCE BOOKS:

1. S. Trymbaka Murthy, **“A Text Book of Elements of Mechanical Engineering”**, 4th Edition 2006, Universities Press (India) Pvt. Ltd, Hyderabad.
2. K.P. Roy, S.K. Hajra Choudhury, Nirjhar Roy, **“Elements of Mechanical Engineering”**, Media Promoters & Publishers Pvt Ltd, Mumbai,7thEdition,2012.
3. Pravin Kumar, **“Basic Mechanical Engineering”**, 2013 Edition, Pearson.

E Books / MOOCs/ NPTEL

1. https://nidm.gov.in/iec.asp (Study material of National Institute of Disaster management)

BIOLOGY FOR ENGINEERS

Course Code:	**BT1001-1**	**Course Type**	**AEC**
Teaching Hours/Week (L: T: P: S)	**1:0:0:0**	**Credits**	**01**
Total Teaching Hours	**13**	**CIE + SEE Marks**	**50+50**

Teaching Department: Biotechnology Engineering

Course Objectives:

1.	To learn the types of cells, biomolecules and life processes
2.	To know the applications inspired by nature in various streams
3.	To be updated application of biology in real life scenarios.

UNIT-I

INTRODUCTION FOR BIOLOGY FOR ENGINEERS — **05 Hours**

Why Biology for Engineers? Cell Types & Properties: Prokaryotes - Bacteria, Viruses and Fungi, Eukaryotes - Plant and Animal Cells, Biomolecules, Life Processes at Cellular Level.

UNIT-II

APPLICATIONS INSPIRED BY NATURE — **05 Hours**

Composites in Construction, Termite Mound architecture, Counter current heat exchangers, Design of aeroplane, helicopter and submarine, Information Theory and Biology, SONAR, Medical Devices.

UNIT-III

REAL LIFE SCENARIOS — **03 Hours**

Recent scenarios in Environment, Agriculture and Medical Technology.

Course Outcomes: At the end of the course student will be able to

1.	Ascertain the importance of Biology to be applied in various engineering streams
2.	Interpret the basics of cell and life processes
3.	Draw inspiration nature in design of machinery and construction
4.	Analyse the significance of mimicry of nature in design of electrical, electronic and medical devices
5.	Judge knowledge on recent advances in application of biology to Environment, Agriculture and Medical Technology

Course Outcomes Mapping with Program Outcomes & PSO

Program Outcomes→	1	2	3	4	5	6	7	8	9	10	11	12	**PSO↓**		
↓ Course Outcomes													1	2	3
BT1001-1.1	3								1			1			
BT1001-1.2	3								1			1			
BT1001-1.3	3	3					2		1			1			
BT1001-1.4	3	3					2		1			1			
BT1001-1.5	3	3					2		1			1			

1: Low 2: Medium 3: High

TEXTBOOKS:

1.	Suraishkumar , G.K. *Biology for Engineers*, Oxford University Press India, 2019.
2.	Chakraborty, T, Akthar, N *Biology for Engineers*, PHI learning Print Book ISBN : 9789391818142 eBook ISBN : 9789391818197
REFERENCE BOOKS:	
1.	Rao C.V., *Biology for Engineers*, 2021
2.	Raven, P. H. and Johnson, G. B. *Biology*. 4th Ed. WCB publishers, 2010.
3.	Ethier, R. S. and Simmons, C. A. *Introductory biomechanics*- From cells to organisms. Cambridge University Press, 2012

IT SKILLS

Course Code:	**IS1001-1**	**Course Type**	**AEC**
Teaching Hours/Week (L: T: P: S)	**1:0:2:0**	**Credits**	**02**
Total Teaching Hours	**39**	**CIE + SEE Marks**	**50+50**

Teaching Department: Information Science Engineering

Course Objectives:

1.	Demonstrate the basics of Android Programming.
2.	Design and develop web pages that include static and dynamic content.
3.	Describe the basic concepts of Cloud.
4.	Discuss the basic concepts of IoT.
5.	Recognize the best practices of Cyber Safety and security.

UNIT-I

Introduction to Application development — **05 Hours**

Simple android application development (No knowledge of programming language is required).

Note:

1. The purpose of application development is to ignite and promote programming skills.
2. Application development should be done using any App builder platforms such as
3. MITApp Inventor: https://appinventor.mit.edu/
4. Thunkable: https://thunkable.com/
5. ibuildapp: https://ibuildapp.com/
6. The student should be introduced to the android application development environment for further research and learning https://developer.android.com/

Activity: Create a simple Android application (Unique for each student) and publish on the learning management system.

Design and develop web pages — **03 Hours**

Basic web technologies

- Browser
- Web –Server
- Client-ServerModel
- URL
- SEO techniques
- Domain names and domain name system.

Creating Web-pages with HTML5 - Static web pages

- Introduction, Editors
- Tags, Attributes, Elements, Headings
- Links, Images, List, Tables, Forms
- Formatting, Layout, Iframes.

Formatting web pages with stylesheets (CSS3)

- Introduction to CSS

- Inline CSS, Internal CSS, Classes, and IDs
- div, Color, Floating, Positioning
- Margins, Padding, Borders
- Fonts, Aligning Text, Styling Links

Creating a web page dynamic using JavaScript

- Dynamic web page and Introduction to JS
- Basic syntax
- Functions
- Events

Creating dashboards in websites

Activity: Personal website design and launch with a free platform or Create a Blogging website.

UNIT-II	
Introduction To Cloud, IoT Concepts and Cyber Security	**05 Hours**

Fundamentals of cloud
Cloud service models

- IaaS (Infrastructure-as-a-Service)
- PaaS (Platform-as-a-Service)
- SaaS (Software-as-a-Service)

Cloud deployment types

- Public
- Private
- Hybrid

Community Cloud Cloud services:

- Google Drive - file storage and synchronisation service developed by Google;
- Google docs, sheets and slides - bring your documents to life with smart editing and styling tools to help you easily format text and paragraphs;
- GoogleCo-lab (Usage ofJupyter Notebook): Colab notebooks allow you to combine executable code and rich text in a single document, along with images, HTML,LaTeX, and more.

Working of IoT and IoT components (Only brief introduction and demonstration through videos) Explain concept of Internet of Things with examples

- Smart home
- Smart city
- Smart Farming

Activity: Create your cloud service account and demonstrate using cloud services. Identify cloud service providers with respect to service models and deployment types. Identify areas where the Internet of Things could bring positive changes.

Introduction to Cyber security and cyber safety

- Brief awareness on cyber safety measures
- Identification of basic security issues in mobile phones and personal computers
- Installation of Antivirus software
- Firewall concepts
- Browser settings
- Importance of privacy and Password policy (Best practices).

Programs	**26 Hours**

1. Design and create simple game using MIT-scratch/Code.org
2. Design and create simple android application
3. Design and create web page for displaying your article (Title, header, paragraph, formatting tags)
4. Design and create a webpage for your wishlist (What you want to do). Also list challenges and opportunities along with images to present your dreams (List ordered and unordered, Image, table)
5. Design and create webpage using HTML and CSS about an awesome animal (Use necessary CSS tags)
6. Design and create web page for a travelbook /recipe book with more than 3 pages, table to list places /recipes (iframe, hyperlink)
7. Design and create web page with JavaScript to design a simple calculator to perform the following operations: sum, product, difference and quotient
8. Design and create a personal webpage with dashboard
9. Design and create web page about advantages of business process automation with respect to your branch of engineering
10. Create user account and demonstrate use of Google drive, Google docs, GoogleColab (Usage of Jupyter Notebook)
11. Demonstrate Internet of Things using examples a. Smart home b. Smart city c. Smart farming
12. Demonstration and hands on browser settings, privacy settings and password policy
13. Demonstration of common security threats (using videos) a. Phishing b. DoS attack c. Man in the middle attack d. Spamming e. Virus

Course Outcomes: At the end of the course student will be able to

1.	Understand the basics of Android Programming.
2.	Develop web pages that include static and dynamic content.
3.	Analyze the basic concepts of Cloud.
4.	Comprehend the basic concepts of IoT.
5.	Illustrate the best practices of Cyber Safety and security

Course Outcomes Mapping with Program Outcomes & PSO

Program Outcomes→	1	2	3	4	5	6	7	8	9	10	11	12	PSO↓		
↓ Course Outcomes													1	2	3
IS1001-1.1	3	-	-	-	-	-	-	-	-	-	-	-	-	3	
IS1001-1.2	3	1	-	-	-	-	-	-	-	-	-	-	-	3	
IS1001-1.3	3	2	-	-	-	-	-	-	-	-	-	-	-	3	
IS1001-1.4	2	-	-	-	-	-	-	-	-	-	-	-	-	3	
IS1001-1.5	3	-	-	-	-	-	-	-	-	-	-	-	-	3	

1: Low 2: Medium 3: High

TEXTBOOKS:

1.	Digital Fluency, Suman M, Chinmaya Dash, R Sreenivas Rao, Himalaya Publishing House Pvt. Ltd., 2021.
2.	2. Digital Fluency, Melwyn Amrithraj, Prem Sagar, Pradeep, Himalaya Publishing House Pvt. Ltd., 2021.
3.	3. Digital Fluency, R G Saha, Dr. Kantesha S, Niha Asif, Himalaya Publishing House Pvt. Ltd., 2021.

E Books / MOOCs/ NPTEL

1.	Randy Connolly, Ricardo Hoar, "Fundamentals of Web Development", 1st Edition, Pearson Education India. (ISBN:978 9332575 271)
2.	https://www.sas.com/en_in/insights/analytics/machine-learning.html
3.	https://www.aig.com/IoT
4.	14 Types of Phishing Attacks That IT Administrators Should Watch For (syscloud.com)
5.	Common Phishing Attacks and How to Protect Against Them (tripwire.com)
6.	Important Applications of Cloud Computing (jigsawacademy.com)
7.	Phishing Attack Prevention: How to Identify & Avoid Phishing Scams in 2021 | Digital GuardianIT Security FAQ (udel.edu)

ENVIRONMENTAL SCIENCE

Course Code:	**CV1002-1**	**Course Type**	**MNC**
Teaching Hours/Week (L: T: P: S)	**1:0:0:0**	**Credits**	**00**
Total Teaching Hours	**13**	**CIE + SEE Marks**	**50+50**

Teaching Department: Civil Engineering

Course Objectives:

1.	To raise consciousness about environmental conditions and to imbibe environmentally appropriate behaviour.
2.	To equip the engineering undergraduates to identify the significance of environmental practice in their daily life and in the engineering practices.
3.	To make them conscious of understanding the environment where we live and act up on.

UNIT-I

Title	**03 Hours**

Environment- Definition, significance of environmental studies- current scenario, local, regional, national and global problems
Components of environment: atmosphere, hydrosphere, lithosphere and biosphere. Layers of atmosphere and its role.
Parts of Earth- lithosphere and its role; hydrological cycle

Eco system- Definition, ecology and environment, ecosystem components: biotic and abiotic components; ecological balance; elements of ecosystem: biotic, abiotic; producers, consumers and decomposers.
Habitat, range of life, Biome, balanced eco- system, food chain, food web and ecological pyramids

Human activities- The Anthropogenic System- human activities like growing food, building shelter and other activities for economy and social security. Soil erosion, water logging - definition. Organic farming- definition

Natural resources	**03 Hours**

Resources - Natural resources, water, minerals, Fossil fuels and energy

Water resources - Global water resources: distribution, uses of water for irrigation, domestic and industrial purposes in India.

Quality aspects - Water quality parameters, drinking water standards for turbidity, pH value, total hardness, iron, fluoride, lead, arsenic, nitrate

Mineral resources- Metallic minerals, non-metallic minerals Fossil fuels - Coal and petroleum

Forest Wealth - Components of the forest, key benefits of forests. Deforestation- environmental effects of deforestation and remedies Sustainable development- definition, objectives

Material cycles Carbon, nitrogen and sulphur cycles.

UNIT-II

Environmental pollution: Definition, harmful effects related to public health	**03 Hours**

Water pollution: Definition, types and sources – agriculture (pesticides and fertilizers), industry, domestic and mining, harmful effects, water borne and water

	induced diseases- definition, common diseases and their causatives, Fluoride problem in drinking water	
Land pollution:	Definition, sources_ agriculture, housing, industry, mining, transportation. Types of municipal Solid waste Disposal (Sanitary landfills, composting, incineration (in brief) and effects	
Air Pollution:	Definition, types and sources: industry, mining, agriculture, transportation and effects	
Noise pollution:	Definition, sources, mining, industries, rail-roads, aviation, effects and control measures	
Energy		**02 Hours**
Different types of energy- Nonrenewable energy; fossil fuels- coal, oil and natural gas- brief description only. Nuclear energy- nuclear power plants, Renewable energy: solar energy- Photovoltaic systems for street and domestic lighting, solar water heating-brief description only Wind energy- definition, merits and demerits, Hydro power- definition, merits and demerits. Biomass energy- definition, sources of bioenergy, biogas, biofuels, India's position in renewable energy Hydrogen as an alternative future source of energy- brief scope, fuel cells.		
UNIT-III		
Current environmental issues of importance		**02 Hours**
Population growth- Definition, growth rate, effects, remedies Urbanization - Definition, environmental impacts and remedies Global warming and climate change- Concept of greenhouse effect, sources of greenhouse gases, effects and remedial measures of greenhouse gases Acid rain: Definition, causes and effects, control measures. Ozone Depletion:Definition, causes, effects and control measures. Environmental Impact Assessment- EIA definition, objectives and benefits of EIA.		
TEXTBOOKS:		
1.	Benny Joseph (2005), "Environmental Studies", Tata McGraw Hill Publ. Co., New Delhi	
2.	Rajagopalan, R. (2005), "Environmental Studies: From Crisis to Cure", Oxford University Press, London	
REFERENCE BOOKS:		
1.	Balasubramanya, N and Chatwal, Gurdeep R. (2007), *"Environmental Studies"*, Himalaya Publishing House, Mumbai	
2.	Barucha, E. (2004), *"Environmental Studies"*, University Grants Commission, New Delhi	
3.	Bhatia, S. C. (2005), *"Environmental Chemistry"*, CBS Publishers, New Delhi	
4.	De, A.K. and De, A. K. (2006), *"Environmental Studies"*	
	Keller, Edward A., (1985), *"Environmental Geology"*, CBS Publishers and Distributors, Delhi.	

HOLISTIC COMPONENTS

HUMANITIES

Holistic education is not only about teaching the basic subjects, but it is more about redefining the way a student should be taught. The purpose of holistic language teaching is the development of the learners' ability to handle both their language oral skills as well as maximizing their life skills. The department contributes to educational life and work spaces that are creative and meaningful. Multidisciplinary and holistic learning is an ancient method used in Indian education system as well as the other parts of the world. This is the reason that such type of education system was advocated by scholars like Kautilya, Banabhatta, Plato, and Aristotle among many others. Holistic approach is essentially a student centered strategy rather than a teacher centered one.

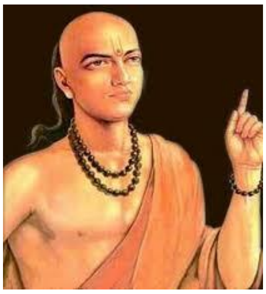
Holistic education through courses allied to Humanities is created within the inclusive connections of social and human experience. A curriculum built around such stages is considered holistic if they involve the practices that integrates language acquisition and fills multiple cognitive demands in interlocking activities that spiral learning. Through the applied learning style of a person--mind, body and spirit students will learn more effectively the nuances of language, responsibilities towards social fabrics and ethics.

The approach strives to make a learner construct his own understanding of the text he/she interacts with and converses with others according his understanding. Intensive experiential and group sessions, a co-created learning ambience and hands-on engagement through real-life cases, field trips and internships to make learning exciting, rigorous and transformative. As a part of the holistic approach and its philosophy, a student is educated beyond core academics providing him/her virtuous and holistic education. This helps the students to discover their individuality and comprehend the significance of life purposefully, creatively, and morally in a complex world. Krishnamurti writes If the unity of life and the oneness of its purpose could be clearly taught to the young, how much brighter would be our hopes for the future! (Krishnamurti, J. 1974).

MATHEMATICS

INDIAN MATHEMATICIANS

It is essential to know about the ancient, medieval and modern time Indian mathematicians and their contribution to Science and Mathematics. Ancient Indian mathematicians have contributed immensely to the field of mathematics. The invention of zero is attributed to Indians and this contribution outweighs all other made by any other nation since it is the basis of the decimal number system, without which no advancement in mathematics would have been possible. The number system used today was invented by Indians and it is still called Indo-Arabic numerals because Indians invented them and the Arab merchants took them to the western world.
Here we are introducing some of the important Indian mathematicians from ancient times.



Aryabhata: (500 A. D.) - Studied at the University of Nalanda, which was considered as a great centre of learning. Aryabhata was a great Indian mathematician. He gave the value of "π" as 3.1416, claiming for the 1st time, that it was approximation. Aryabhata also dealt with other aspects of mathematics and Astronomical calculations, namely Geometry, Mensuration, Square root, Cube root, Progression and Celestial sphere. He presented a method to solve an intermediate equation of certain type that are important in astronomy and computer science.

Bhaskara : (1100 A. D.) - was a great Mathematician and Astrologer. He was the first Mathematician to declare confidently that any term divided by ZERO is infinity and the sum of any term and infinity is infinity. His concept of "Tatkalikagati", which means instantaneous motion, used by astronomers to determine the motion of the planet accurately brought credit to him. He explained the solutions of quadratic and cubic equations. He stated the Rolle's theorems in analysis, the mean value theorem.

Srinivas Ramanujan was an Indian Mathematician who made significant contributions to mathematical analysis, Number theory and continued fractions. He made many important contributions in the field of mathematics with his wonderful and unique knowledge. That's why his birthday is celebrated as Mathematics Day.

PHYSICS

The ancient world had considered Physical Sciences, Chemical Sciences, Earth Sciences, Biological Sciences, Mathematical Sciences etc. as study of nature, which were all studied under the banner of Philosophy. Even today, the philosophers are studying Metaphysics which connects physical attributes to mind. Physics is a branch of science which deals with the study of matter and energy. The Physical Science was a matter of interest for all the civilizations including Vedic era of India dating back to over 3000 years. The physical science in ancient India was majorly restricted to Astronomy and Astrology. It was **Kanada**(600 B.C.) who presented holistic approach of physics, by blending science, philosophy and religion through 'Vaisesika Sutra'. Their essence is the atomic theory of matter. He gave the name 'Paramanu' (Atom), to be the indivisible entity of matter. The idea of chemical change was also put forward by Kanada. Bharadwaja is credited with teaching missile technology. Aryabhata(500 A.D.) was a great astronomer. He was the first to state that the earth is round and it rotates on its own axis, creating day and night. He declared that the moon is dark and shines only because of sunlight. Aryabhatta contributed greatly to the field of science particularly astronomy. Varaha mihira (500 A.D.) studied astrology and astronomy and declared that the earth was spherical. He also proposed that the moon and planets are lustrous not because of their own light but due to sunlight. Bhaskra (1100 A. D.) was a great scientist his concept of "Tatkalikagati", which means instantaneous motion, used by astronomers to determine the motion of the planet accurately brought credit to him. Brahmagupta(598 A.D.) calculated the instantaneous motion of a planet, gave correct equations for parallax, and some information related to the computation of eclipses and is widely regarded as one of the most accomplished of the ancient Indian astronomers.

"If you wish to make an apple pie from scratch, you must first invent the universe."So said astronomer Carl Sagan in an episode of his landmark television series, Cosmos. Embedded in Sagan's memorable quip is a certain holistic understanding of the universe — a notion that the existence of any one thing is intimately tied to the existence of everything else. There are no apple pies without apples; there are no apples without the proper climate for growing apple trees; there is no proper climate for growing apple trees without a planet on which the apple trees can grow — and so on, all the way back to the Big Bang.Pythagoras and his followers held mathematics in an almost holy regard, and they saw numbers as a basic form of matter. According to their view, all things had numbers, and the objects of the universe — including human societies — were arranged in harmonious mathematical relationships with one another.

All sciences were originated from philosophy. Physics was called natural philosophy until the 19th century, but once it was proven to be correct it was no longer philosophy and became a science. Physics is the science of the natural world, more specifically dealing with the matter, energy, space-time, and fundamental forces that govern the physical world. In physics we study a wide range of physical phenomena from subatomic particles to large galaxies of the material universe, and use empirical data and mathematics to find results and conclusions. Physics is also deeply concerned with arriving at knowledge about the ultimate nature of reality. Since we cannot know whether we have discovered everything which would affect our theories of the universe, all such theories are perpetually subject to modification or change. Mathematics is a language and a tool that we use in physics to explain the universe. Quantum physics is a mathematical description that rules the tiny world of atoms and subatomic particles in our universe. Without quantum physics, much of the information technology that we rely on, from microcircuits to lasers, would not exist. Today many scientists argue that metaphysics plays an important role in quantum mechanics at a deeper level; the nature of reality is all mathematical. This could be an example of how metaphysical assumptions can get in the way of our understanding the paradoxical nature of quantum mechanics. But even when quantum mechanics appears a mystical science of metaphysics, it is not metaphysics but productive science.

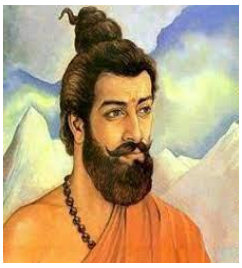
Thus, the Physics though has many branches and uses many other branches of science and philosophy, in the past and the present, its aim is to understand the whole universe which is nothing but matter and energy which is seen or unseen.

CHEMISTRY

ANCIENT SEERS OF INDIA – CHEMISTRY

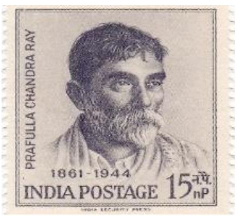
In ancient India, chemistry was called **Rasayan Shastra, Rasa-Vidya, Rasatantra and Rasakriya** all of which roughly mean '***Science of Liquids***'. There also existed chemical laboratories which were called **Rasakriya-nagaram**/**Rasakriya-shala**, which literally mean '***School where liquids are activated***'. Rigveda (earlier than 1500 BCE) mentions many fermented drinks and methods of fermentation, apart from various metals. Soma juice from the stems of the soma plant was considered a divine drink. The Vedic Indians were acquainted with the art of dyeing with certain natural vegetable colouring matters. A type of pottery, now known as 'Painted Grey Ware', is also associated with the Vedic period.

Ancient chemistry in India grew out of the early efforts to develop an elixir; to turn base metals into gold and on metallurgy. Chemical techniques in India can be traced back all the way to the Indus valley or Harappan civilisation (3rd millennium BCE). Pre-Harappan Indians were acquainted with the art of making baked or burnt clay pottery as well as painting the same with two or more colours (by addition of iron oxide, manganese oxide, etc.). Kautilya's Arthashaastra (3rd or 4th century BCE) has a lot of information on prevailing chemical practices. Apart from mines and minerals, it discusses the details of precious stones (pearl, ruby, beryl, etc.); preparation of fermented juices (sugarcane, jaggery, honey, jambu, jackfruit, mango, etc.) and oil extraction.



It is said that **Maharshi Kanada** was the first to propound that the *Parmanu* (atom) was an indestructible particle of matter and that Universe is made up of *Kana*. When matter is divided and sudivided, we reach a stage beyond which no division is possible, the undivisible element of matter is *Parmanu*. Kanada explained that this indivisible, indestructible y cannot be sensed through any human organ.

Nagarjuna (931 A.D.) from Somnath in Gujarat was a chemist/alchemist, who concentrated his efforts in transforming the base metals into gold. His reputation was such that people believed Nagarjuna to be in communion with gods and goddesses who had blessed him with the power of changing base metals into gold and extracting the 'elixir of life'.



Prafulla Chandra Ray (1861-1944), an Indian chemist, is often referred to as the Father of Chemistry in India. He received his BS in 1882 and his PhD in 1887 from University of Edinburgh. In 1896, he announced a major discovery of a new compound, mercurous nitrite.

Today's Science and Technology has been greatly inspired by the contributions of these wise seers. Indians have continued to show their global impact in the Field of Science.

In the 21st century, biochemist **Har Gobind Khorana** won the Nobel Prize (1968) for demonstrating how the nucleotides in nucleic acids control the synthesis of proteins.

Thus, the seers of ancient India have contributed significantly in the development of Modern Chemistry.

Biology for Engineers

Science deals with matter. It is based on starting from scratch with what a human can observe, test, and rationalize. Ancient sages have worked hard to be seen as the only reliable providers of knowledge to the world. In 1875, the Vymaanika Shaastra, a 4th Century BC text written by Sage Bharadwaj was discovered in a temple in India. It contains 3000 shlokas in 8 chapters which was physically delivered by the ancient Hindu Sage Bharadwaj. The book greatly deals with the operation of ancient vimanas and included information on steering, precautions for long flights, protection of the airships from storms and lightning and how to switch the drive of solar energy or some other form of energy. One of the chapter will reveal the secrets of constructing aeroplanes that cannot be broken or cut, that is indestructible, that is fire resistant. It also deals with the secret of making planes motionless and invisible. It also describes how to defeat the enemy planes etc. as per the Sage Bharadwaj the vimanas were classifies as per the Yugas. During the period of Krita Yuga, Dharma was establishes firmly. The pushpak Vimana which was used by Ravan was an Aerial vehicle. He used this vehicle to kidnap Sita from jungle and took him to his Kingdom Srilanka. Ramayana was during the Treta Yug in which the Vimanas were highly discovered. During this period “Laghima” gave them the power to lighten their vehicle do they can travel freely in the air.

COMPUTER, INFORMATION SCIENCE & ENGINEERING

The Indians (**Aryabhata**, 476 BC - 550 BC) contributed **Zero (0)** to the number system**.** So that numeric system and computing world found an ease in solving numerical problems using computer programs.

Acharya **Pingala** was an ancient Indian mathematician who lived around 300 BCE. He wrote the Chandaḥśāstra, where he analysed **Sanskrit poetry mathematically**. It also contained the first known explanations of **digit zero**, **binary numbers, Fibonacci numbers and Pascal's triangle**.

Baudhayana (8th century BCE) composed the Baudhayana Sulba Sutra, which contains examples of Pythagorean triples, such as: (3,4,5), (5,12,13), (8,15,17), (7,24,25) and (12,35,37) as well as a statement of the Pythagorean theorem for the sides of a square: "The rope which is stretched across the diagonal of a square produces an area double the size of the original square."

In Indian astronomy, the study of **trigonometric functions** flourished in the Gupta period, especially due to **Aryabhata (sixth century CE),** who discovered the **sine function**.

Quadratic equation of the form $ax^2 + bx + c = 0, a \neq 0$ and is given by $x = (-b \pm \sqrt{(b^2 - 4ac)}) / 2a$. was discovered by **Sridharacharya** in the 11th century.

The largest numbers the Greeks and Romans used were 106. In 5000 BC **Indians used numbers as big as 10^{53}** (10 to the power 53) with specific names. The largest used number today is **Tera 10^{12}**.

Kaṭapayadi numerical notation is an ancient Indian system to depict letters to numbers for easy remembrance of numbers as **words or verses**.

For example: क(Ka)=1 ख(Ka)=2 ग(Ga)=3 घ(Ga)=4 ज्ञ(Gnya)=5 च(Cha)=6 छ(Cha)=7 ज(Ja)=8 झ(Ja)=9 अ(Nya)=0. The modern **Hasing technique in computing system** which is resembling was then being used in the **Indian Katapayadi system**. For example, the hashing number based on Katapayadi system would be as follows for '**Gurudev'**

Gu=Ga(is the consonant)=3, Ru=Ra(is the consonant)=2, De=Da(is the consonant)=8 Va=Va(is the consonant)=4, So Gurudeva = 4823.

In the recent decades, following are the few of the major contributors to the computing world:

1. In 1996 the USB port invented by the **Ajay Bhatt,** an Indian at Intel Oregon which involved low level **programs delt with embedded C Language** to perform flexible IO transfer and opened up an area to use plug-and-play devices efficiently.
2. The Pentium chip invented by **Vinod Dham,** that **made C compiler to speed up the program execution** and do well with **GUI applications (both System and User Level) that are wiritten in C language.**
3. **Amit Singhal** is an Indian who rewrote (search engine in 2001) the **google algorithm** (C language coding embedded with Assembly Language service routins in Windows and Unix/Linux). Then on the Google processes over 40,000 search queries every second on average which translates to over **3.5 billion searches per day** and **1.2 trillion searches per year** worldwide.

Few of the contribution as Auther of CP and Educators of C language:

1. **Yashavant Kanetkar** is an Indian computer science author, known for his varieties of C Programming books.
2. **E. Balagurusamy : An Computer scientist** known for **Programming in ANSI C.**

ELECTRONICS AND COMMUNICATION ENGINEERING

The idea of a holistic approach to engineering design and education has been envisioned to meet the perceived and emerging needs for innovation in the 21st century. Many engineering educators, practicing engineers and engineering students have already recognized the gaps and areas of potential improvements in the knowledge acquisition process implemented in current engineering degree programs when compared to current societal and technological issues and developments.

Society and humanity have progressed drastically over the past few generations. Engineers as a network of professional problem solvers have been heavily involved in these global communities and the engineering profession is evolving from one that focuses on targeted, isolated issues, to one that embraces challenges that incorporate physical, economic, environmental, and humanitarian aspects.

Currently, engineering students are required to take classes on ethics, liberal studies and technology and society courses, however engineering students are not prefaced with the importance of rounding out their education with these topics, and while social issues are discussed, they are not related to engineering specifically. That being said, explicitly linking the technical aspects of engineering to society is paramount in training effective problem solvers for the 21st century. With some exposure to multi-disciplinary, inter-disciplinary and trans-disciplinary approaches to engineering and design, students will be better prepared for their future careers in industry or research fields.

The functional requirements for the perceived solution were determined by the expected outcomes and what students should take away after experiencing the new educational product. Some of them are:

• students will be inspired and driven to seek opportunities in engineering for environmental, social, medical, and human development/poverty issues.

• students will be able to identify the issues that are emerging from new technology, how to mitigate the negative aspects and reduce the amount of impact, while leveraging the positive outcomes.

• students will have respect and knowledge of the importance of ethics and policy matters in the field of engineering and be able to determine between unethical and an ethical situation in a proactive manner.

The courses should overcome the challenges of the current engineering educational system. Approaching the degree from a holistic perspective. The integrated system that fosters collaboration among faculty and students. A new organizational and pedagogical model, which emphasizes knowledge integration and interweaves thematic content threads throughout the curriculum should be proposed.

- Foundations thread (math and science) Key mathematical concepts lay the foundation for understanding the anchoring concepts in courses throughout the ECE curriculum. The foundations thread unpacks mathematics and physics concepts to help students learn fundamentals in ECE topics like circuits, signals and systems, and electromagnetics. The foundations thread champion spearheads the collaboration between the math and ECE departments to introduce and promote the value and utility of mathematics in ECE courses, as well as the importance of mathematical thinking.
- Creativity thread (research, design, and optimization tools) The creativity thread is intended to integrate research and design throughout the undergraduate experience. By showing the impact of research, students will see the practical applications and potential breakthroughs of fundamental ECE concepts. Likewise, exposing students to design at every level of the undergraduate experience allows them to experience the excitement of engineering by applying their foundational knowledge to a tangible product.
- Professional formation thread (communications, cultural adaptability, ethics, leadership, and teamwork) Partnering with faculty and industry leaders to ensure students develop professional skills meaningfully and effectively to enhance student-industry interactions.

ELECTRICAL AND ELECTRONICS ENGINEERING

Agastya Samshita available at Prince's Library of Ujjain in India, dates back to the first millennium BC, contains a detailed description construction of an electric battery/cell along with way to utilize the battery to 'split' water into its constituent gasses. The method of generating electricity using modern battery cell resembles Agastya's method. The materials used by Sage Agastya for generating electricity were an earthen pot, copper plate, copper sulphate, wet saw dust, zinc amalgam. As quoted in Agastya Samhita the open circuit voltage and short circuit current of the prepared cell are 1.138 volts and 23 mA respectively. He articulates 100 earthen pots on water, has the power to change the form of water to oxygen and hydrogen. If hydrogen is contained in an air tight cloth, it can be used in aerodynamics, i.e. it will fly in air. In an iron vessel and in a strong acidic medium, gold or silver nitrate covers copper with a layer of gold or silver. The copper that is covered by gold is called Shatakumbha or artificial gold.

Rao Saheb Krishnaji Vajhe, an engineer from Pune while reading books related to science found the pages of Agastya Samhita with Damodar Tryambak Joshi of Ujjain. Dr. M. C. Sahastrabuddhe, the Head of the Sanskrit Department in Nagpur, when reading Agastya Samhita found the similarity of it with of Daniel Cell. He requested P.P. Hole, the Professor of Engineering at Nagpur to investigate on the same.

On the basis of the descriptions in Agastya Samhita Mr. Hole and his friend started preparing the apparatus for the experiment. While preparing the set up they could not understand the meaning of shikhigreeva and while checking the Sanskrit dictionary, they understood that it meant the neck of a peacock. They went to Maharaja Park and asked the chief when a peacock would die. The chief was very angry and asked them to give in an application. After few days during a conversation with an Ayurveda expert he confirmed that shikhigreeva is copper sulphate, which solved their problem. Thus, a cell was formed and it had an open circuit voltage of 1.38 volts and short circuit current of 23 milli amperes. The results of the experimentation were communicated to Dr. M.C. Sahastryabuddhe. It was exhibited fourth general meeting at the Swadeshi Vigyan Sanshodhan Sanstha, Nagpur on August 7, 1990 to the scholars. It was concluded that the description was of an electric cell

On the basis on Agastya Samhita and other scriptures, Rao Saheb Vajhe, who spent his life in rummaging the Indian scientific scriptures, gave different names to electricity. The six ancient terminologies for electricity are:

- Tadit—produced by friction from leather or silk,
- Saudamini—produced by friction from gems or glass,
- Vidyut— from clouds or steam,
- Shatakoti alias Shatakumbhi—produced from a battery of hundreds of cells,
- Hradini—obtained from storage cells,
- Ashani—the one emanating from a magnetic rod.

MECHANICAL ENGINEERING

Mechanical engineering is one of the oldest disciplines of engineering, which requires the knowledge of mathematics, materials, physics and other engineering technologies. It is concerned with materials, processes and machines and requires the concepts of forces, moments, energy, entropy, work etc. The developments that are visible in all spheres of life have connection to mechanical engineering. Engineering has made a significant contribution in the development of civilizations and contribution of mechanical engineering in areas like construction of large scale structures including for irrigation, architecture, military etc. is significant. Difficult problems of the society have been solved using simple concepts of mechanical engineering, say for eg. use of lever principle to move heavy objects. In fact, mechanical engineering made a significant contribution to the first cycle of industrial revolution, i.e., industrial revolution 1.0 during the 18th century. James Watt is often called the 'Father of Mechanical Engineering', as his invention of steam engine led to significant developments during the industrial revolution and beyond. The earliest computers were mechanical devices with electronics.

Significant contributions have been made during the Vedic ages and the first ever mechanical device that was invented was wheel and potter. Surmyam Suiramiva identified metals like Fe, Cu, Ag, Au etc., during the Vedic times. People knew about materials and material processing during those times and identified terminologies for the same in Sanskrit and produced gold and silver coins.

Seers like Tritala, Jalayan, Karaa, Vayurathaa and Vidyutrathaa discovered about aerodynamics during Rig Veda period, much before Wright Brothers discovered about aero planes. Computational Fluid Dynamics (CFD) analysis, which we are talking about today for different analysis, was there in the Vimana Shastra slokas.

Mechanical and manufacturing technology of ancient India ensured processing of natural products and their transformation into goods of trade, commerce and export.

Many scientists have made significant contributions to this domain. Leonardo da Vinci (16th century) studied and designed many mechanical systems that were related to transportation and warfare. In 17th century, Isaac Newton contributed the Laws of Motion used in several applications. Rudolf Diesel (18th century) was a German inventor, who created the first successful diesel engine and today diesel engines play a very important role in the transport and power sector in the world. Carl Frederich Benz (18th century) was a German automotive engineer, who developed the first practical automobile.

Mechanical engineering has evolved over the years and today the advent of computer and IT tools has facilitated better mechanical engineering in terms of design, analysis, and manufacturing. A mechanical engineer needs to work in multiple domains and needs to possess multiple skills like design, redesign, analyze, test, manufacture etc. It has been one of the founding disciplines of engineering and has contributed and will keep contributing to the growth and developments in this physical world.

CIVIL ENGINEERING

Indian civilization was the oldest civilization in the world and has a strong tradition of science and technology. It was the land of sages, seers, scholars, and scientists. Hinduism is a knowledge-based civilization, the Vedic texts should not be ignored dismissed as mythologies or as the work of imagination or just containing some moral stories. The Veda means knowledge and they contain relevant knowledge otherwise these texts would not have survived the millennia years of the historic storm. Let us know some of the great work done in ancient times.

Ancient India not only practised scientific methods of design and construction but also documented them for future generations. Here are some tips given by ancient sages on selection of site and construction

(1) Vishwakarma Vastu Shastra- Vishwakarma explains the first point of construction in the ancient book Vastu Shastra – 'पूर्व भूमिं परिक्ष्येत पश्चात् वास्तु प्रकल्पयेत्', This means that before construction one should test the land. Vishwakarma further says that construction should not be done on the land which is very mountainous or on land with large cracks. Vastu shastra literally "science of architecture" are texts on the traditional Indian system of architecture. These texts describe principles of design, layout, measurements, ground preparation, space arrangement, and spatial geometry. The designs aim to integrate architecture with nature, the relative functions of various parts of the structure, and ancient beliefs utilising geometric patterns (yantra), symmetry, and directional alignments.

(2) Kashyap Shilpa (Craft) – In this ancient book, Kashyap Rishi has said that the foundation should be dug until water is seen because this way you would ensure that you have reached the rock level and the foundation would be strong.

(3) Bhrigu Samhita – In this scripture saint Bhrigu says that before buying land, one should test it for form, colour, juice, smell and touch. Rishi Bhrigu also explains its methods in his book.

Ancient cities of India found on the basis of archaeological discoveries:

- Rama was the world's first king to build a bridge across the sea. But he did not do it on his own. He sought the help of a great engineer called Nala according to Valmiki Ramayana. Any wise man will seek local knowledge when he ventures into new places. Nala knew the shallow areas across the sea in and around Tamilnadu. American space agency NASA also confirmed that there was a bridge through the satellite pictures. Any wise engineer will use such naturally elevated areas instead of deep waters to build a bridge.
- Bageeratha changed the course of the mighty river Ganges. The vast forest areas of modern Bihar, Uttar Pradesh, and West Bengal were made into fertile lands by his marvelous engineering feat. In those days very few people lived in those jungles. Puranas say that Bageeratha did penance for several thousand years to do this that too 'standing in one foot'. This is a phrase Indians use very often. Even the great Tamil poet Tiruvalluvar uses the simile of Stork that stands in one foot to catch a fish. This is the hidden language to say that he tried for a very long time with focused attention.
- Vedic Saint Agasthya discovered the land route to South India via Vindhyas. The Puranas say that he "subdued the arrogance of the hills", this is hidden language. Till Agastya's this great discovery kings and travellers used only sea routes. Since they knew the secret of monsoon winds they can travel to West Bengal or Maharashtra from Sri Lanka in a few months' time.
- Uparichara Vasu, an ancient king made mountain passes for the benefit of land travellers. He was a Vasu king ruling over the Chedi kingdom. Mahabharata says that he kicked the Kolahal Mountain which was blocking the flow of the Shaktimati River. This is a hidden language to say that he diverted the river for irrigation by cutting the hills.
- In short Bageerathan, Agastya, and Uparichara Vasu are the earliest engineers who built dams across the rivers. But unlike modern engineers, they did not use cement or mortar but they used the hills themselves. To avoid the force they made checks and balances. They use a hidden language saying that Shiva bore the force when Ganga came down from heaven.
- Parasuraman retrieved a lot of lands and gave it to Indians. A Pandya king called Nilam Tharu Vil Nediyon built sea walls to prevent the sea from invading the land.
- Balraman always travelled with an axe to clear the forests and make them cultivable. He was a great agriculturist. When Krishna spent most of his time in politics, his brother Balarama did constructive work.

- The Mohanjodaro, created 3000 years ago, is considered as a wonderful piece of civil engineering. Found in archaeological excavations even the ruins prove that this town was well settled and its buildings and roads – all were made using symmetry and geometrical measurements. The roads found in this city were straight and were made from east to west and north to south and surprisingly they were at an angle of 90 degrees from each other. Buildings were also constructed in proportion. The intersection of the corners, the heights of the walls was equal. The city had public buildings, gardens, a restaurant, a large public bath as well as residential buildings. There was a provision for bathroom, living room etc in the residential buildings. The public buildings were 11.82m long, 7.01m wide and 2.44m high, and there were two streams of water. The building material and bricks of the walls were coated with a substance on which there was no effect of water. Archaeological research shows that people living here were well-versed in the construction techniques.
- Indus Valley Cities such as Harappa, Mohanjadaro, Lothal, Dholavira, Kalibangan need no new interpretations. The well-laid cities with uniform brick structures, Great Bath, most hygienic drainage systems, grain storage barns, and wells are all already well known to the world.
- Dwarka, also known as Lord Krishna's city, also narrates a similar story. Dr S R Rao discovered Dwarka in the archaeological excavation and found that the ancient city (Dwarka Nagar) was well built and settled. There was a wall around the city. The stones used for the construction of buildings did not erode despite the fact that the city was very close to the sea. Two-storey buildings, roads and water system are also found in the city. Copper, bronze and some alloys with zinc mixed up to 34 percent have also been found during the excavation. The size of columns, windows, etc reveals that they were designed with a complete mathematical precision.
- South Indian Tamil saint Appar always travelled with a pickaxe to clear the bushes from the temple towers. He simply followed Balarama. Great Chola king Karikalan built a dam across river Cauvery in Kal Anai. The Grand Anicut was an engineering wonder of ancient Tamils. It was built around the 1st century AD. Big temples of India, the number of which runs into thousands, stand as monumental proof for the engineering skills of Indians. Mamallapuram and other Pallavacave temples are well-known milestones in Indian architecture.
- The Group of Monuments at Hampi are also recognized as a UNESCO World Heritage Site. The Vittala temple—the stone chariot – is the most iconic symbol of Hampi. The Virupaksha Temple at Hampi was built in the seventh century by the Chalukya rulers.


Virupaksha and Vithala Temple in Hampi

NITTE (Deemed to be University) | NMAM INSTITUTE OF TECHNOLOGY

Scheme & Syllabus for

B. Tech. (Robotics & Artificial Intelligence)

DEPARTMENT OF ROBOTICS & ARTIFICIAL INTELLIGENCE

2022-23

B. Tech. in Robotics & Artificial Intelligence

Vision:
Empowering people, Partnering in Community Development by achieving expertise requiring the knowledge of state of the art technology in the field of Robotics and Artificial Intelligence.
Mission:
To impart specialized education in the field of Robotics & Artificial Intelligence that contributes to the socio-economic development of the region and to generate technical manpower with high degree of credibility, integrity and ethical standards by providing vibrant learning environment.

Program Educational Objectives (PEOs):

PEO 1: Demonstrate technical competence in Robotics and Artificial Intelligence and their applications

PEO 2: Design hardware solutions for robotics application and software solutions for implementation of Artificial Intelligence in Robotics

PEO 3: Pursue higher studies to carry out research and development in the area of Robotics and Artificial Intelligence

PEO 4: Engage in lifelong learning, communicate effectively and exhibit leadership skills and demonstrate sensitivity towards professional ethics.

Program Outcomes (POs):

Engineering Graduates will be able to:
PO1: Engineering knowledge: Apply the knowledge of mathematics, science, engineering fundamentals, and an engineering specialization to the solution of complex engineering problems.

PO2: Problem analysis: Identify, formulate, review research literature, and analyze complex engineering problems reaching substantiated conclusions using first principles of mathematics, natural sciences, and engineering sciences.

PO3: Design/development of solutions: Design solutions for complex engineering problems and design system components or processes that meet the specified needs with appropriate consideration for the public health and safety, and the cultural, societal, and environmental considerations.

PO4: Conduct investigations of complex problems: Use research-based knowledge and research methods including design of experiments, analysis and interpretation of data, and synthesis of the information to provide valid conclusions.

PO5: Modern tool usage: Create, select, and apply appropriate techniques, resources, and modern engineering and IT tools including prediction and modeling to complex engineering activities with an understanding of the limitations.

PO6: The engineer and society: Apply reasoning informed by the contextual knowledge to assess societal, health, safety, legal and cultural issues and the consequent responsibilities relevant to the professional engineering practice.

PO7: Environment and sustainability: Understand the impact of the professional engineering solutions in societal and environmental contexts, and demonstrate the knowledge of, and need for sustainable development.

PO8: Ethics: Apply ethical principles and commit to professional ethics and responsibilities and norms of the engineering practice.

PO9: Individual and team work: Function effectively as an individual, and as a member or leader in diverse teams, and in multidisciplinary settings.

PO10: Communication: Communicate effectively on complex engineering activities with the engineering community and with society at large, such as, being able to comprehend and write effective reports and design documentation, make effective presentations, and give and receive clear instructions.

PO11: Project management and finance: Demonstrate knowledge and understanding of the engineering and management principles and apply these to one's own work, as a member and leader in a team, to manage projects and in multidisciplinary environments.

PO12: Life-long learning: Recognize the need for, and have the preparation and ability to engage in independent and life-long learning in the broadest context of technological change.

Program Specific Outcomes (PSOs):

PSO 1: Design the robotic structure for different applications and implementation of control circuits to achieve the desired automation through analytical, logical and problem-solving skills.

PSO 2: Develop software systems for the application of artificial intelligence in robotics.

PSO 3: Apply the knowledge of robotics and Artificial intelligence in the areas of industrial robotics, service robots, exoskeletons, surgical robots, delivery vehicles, autonomous vehicles, and crewless micro aerial vehicles.

Course Numbering Scheme

<table>
<tr><th colspan="2">Branch Code</th><th>Course Level</th><th colspan="3">Course Code</th><th>Separator</th><th>Version</th></tr>
<tr><th>Letter</th><th>Letter</th><th>Number</th><th>Number</th><th>Number</th><th>Number</th><th>-</th><th>Number</th></tr>
<tr><td>Branch Code</td><td colspan="7">RI is 2 Letter code for the Department of Robotics &AI</td></tr>
<tr><td>Course Level</td><td colspan="7">Course Level is a 1-digit number that can have a value between 1-4 and indicates the prerequisite of a course.
Level-1 courses are basic courses with no courses as pre-requisites
Level-2 course(s) have Level-1 course(s) as prerequisites
Level-3 course(s) have Level-2 course(s) as prerequisites
Level-4 course(s) have Level-3 course(s) as prerequisites</td></tr>
<tr><td>Course Code</td><td colspan="7">Course Code is a 3 Digit number that can have a value between 001-999 and indicates the number assigned to a course based on the following guidelines

001-199 is assigned to Professional Core Courses
001-099 for Integrated Professional Core Courses [4 Credit]
101-199 for Professional Core Theory Courses [3 Credit]

201-499 for Professional Elective Courses
201-299 Electives under Group I
301-399 Electives under Group II
401-499 for future use

501-550 for Open Elective Courses

551 – 599 for Vocational Education Courses

601-650 for Professional Core Lab Courses [1 Credit]

651-699 for Ability Enhancement Courses

701-799 for Courses offered to Honours Program</td></tr>
<tr><td>Separator</td><td colspan="7">“_” is used as a separator between the Course code and the version</td></tr>
<tr><td>Version</td><td colspan="7">Version is a 1-digit number that can have a value between 1-9 and indicates minor revisions of the same course.</td></tr>
</table>

III SEMESTER														
Sl. No.	Course and Course code		Course Title	Teaching Dept.	Teaching Hours/Week				Examination				Credits
					Theory Lecture	Tutorial	Practical/ Drawing	PBL	Duration in hr	CIE Marks	SEE Marks	Total Marks	
					L	T	P	J					
1.	BSC	MA2001-1	Statistics and Probability Theory	MA	3	0	0	0	03	50	50	100	3
2.	IPCC	RI2006-1	Introduction to Robotics	RI	3	0	2	0	03	50	50	100	4
3.	IPCC	RI2001-1	Analog and Digital Circuits	RI	3	0	2	0	03	50	50	100	4
4.	PCC	RI2106-1	Drive Systems for Robot	RI	2	0	2	✓	03	50	50	100	3
5.	PCC	RI2105-1	Data Structures and Algorithms	RI	3	0	0	0	03	50	50	100	3
6.	PCC	RI2603-1	Data Structures and Algorithms Lab	RI	0	0	2	0	03	50	50	100	1
7.	HSMC	HU1004-1	Universal Human Values	HU	1	0	0	0	01	50	50	100	1
8.	AEC	ME1654-1	Innovations and Design Thinking	ME	1	0	0	0	01	50	50	100	1
9.	MNC	HU1003-1	Kannada (Balake / Samskrithika)	HU	1	0	0	0	-	50	00	50	0
TOTAL					**17**	**0**	**8**	**-**	**20**	**450**	**400**	**850**	**20**

Course prescribed to lateral entry Diploma holders admitted to III semester of Engineering programs													
10	MNC	MA1012 -1	Bridge course - Calculus & Differential Equations	MA	3	0	0	0	-	100	0	100	0

IV SEMESTER														
Sl. No.	Course and Course code		Course Title	Teaching Dept.	Teaching Hours/Week				Examination					Credits
					Theory Lecture	Tutorial	Practical/ Drawing	PBL	Duration in hr	CIE Marks	SEE Marks	Total Marks		
					L	T	P	J						
1.	BSC	MA2005-1	Linear Algebra and its Applications	MA	3	0	0	0	03	50	50	100		3
2.	IPCC	RI2002-1	Design of Robotic Components	RI	3	0	2	0	03	50	50	100		4
3.	IPCC	RI2005-1	Introduction to Object-Oriented Programming	RI	3	0	2	0	03	50	50	100		4
4.	PCC	RI2111-1	Smart Mobile Robots	RI	2	0	2	✓	03	50	50	100		3
5.	PCC	RI2109-1	Microcontroller and its Application	RI	3	0	0	0	03	50	50	100		3
6.	PCC	RI2604-1	Microcontroller Lab	RI	0	0	2	0	03	50	50	100		1
7.	HSMC	HU2001-1	Enhancing Self Competence	HU	2	0	0	0	03	50	50	100		2
8.	VEC	RI2551-1	Department specific Vocational Education Course (Motion Control using PLC)	RI	0	0	2	0	03	50	50	100		1
9.	HEC	HU1005-1	Essence of Indian Culture	HU	1	0	0	0	-	50	00	50		0
10.	UCC	UC1001-1	Internship – I (Activity based Internship)	RI	Mandatory Intra Institutional Activity based Internship of 2 weeks duration (80 - 90 h) to be completed during the vacations of I & II Semesters. Lateral entry students have to complete the Internship - I during the vacation of III semester					100	00	100		2
TOTAL					16	2	10	-	24	550	400	950		23

Course prescribed to lateral entry Diploma holders admitted to III semester of Engineering programs													
11	MNC	MA1014-1	Bridge course - Discrete Mathematics & Numerical Methods	MA	3	0	0	0	-	100	0	100	0

V SEMESTER														
Sl. No.	**Course and Course code**		**Course Title**	**Teaching Dept.**	**Teaching Hours/Week**				**Examination**				**Credits**
					Theory Lecture	**Tutorial**	**Practical/ Drawing**	**PBL**	**Duration in hr**	**CIE Marks**	**SEE Marks**	**Total Marks**	
					L	**T**	**P**	**J**					
1.	IPCC	RI2007-1	Kinematics and Dynamics of Robot	RI	2	2	2	0	3	50	50	100	4
2.	IPCC	RI2008-1	Image Processing and its Application	RI	3	0	2	0	3	50	50	100	4
3.	PCC	RI2101-1	Artificial Intelligence and ML	RI	2	2	0	0	3	50	50	100	3
4.	PCC	RI2601-1	AI and ML Lab	RI	0	0	2	0	3	50	50	100	1
5.	PEC	RI2XXX-1	Professional Elective-I	RI	3	0	0	0	3	50	50	100	3
6.	HSMC	HU1006-1	Introduction to IPR	Any Dept.	1	0	0	0	1	50	50	100	1
7.	AEC	RIx6xx-1	Program Specific Ability Enhancement Course	RI	1	0	2	0	3	50	50	100	2
		ME1659-1	Research Methodology	Any Dept.	2	0	0	0					
8.	AEC	HU1007-1	Social Connect & Responsibility	Any Dept.	1	0	0	0	1	50	50	100	1
9.	AEC	UM1003-1	Employability Skill Development	RI	1	0	0	0	-	50	00	50	1
TOTAL					**14/15**	**6**	**8/6**	**-**	**20**	**450**	**400**	**850**	**20**

VI SEMESTER														
Sl. No.	Course and Course code		Course Title	Teaching Dept.	Teaching Hours/Week				Examination				Credits
					Theory Lecture	Tutorial	Practical/ Drawing	PBL	Duration in hr	CIE Marks	SEE Marks	Total Marks	
					L	T	P	J					
1.	IPCC	RI2003-1	Micro Aerial Robots	RI	2	2	2	0	3	50	50	100	4
2.	PCC	RI2102-1	Control Engineering	RI	3	0	0	0	3	50	50	100	3
3.	PCC	RI2602-1	Control Engineering Lab	RI	0	0	2	0	3	50	50	100	1
4.	PEC	RIxxxx-1	Professional Elective – II [Group-1]	RI	3	0	0	0	3	50	50	100	3
5.	PEC	RIxxxx-1	Professional Elective -III [Group-2]	RI	3	0	0	0	3	50	50	100	3
6.	OEC	XXX5XX-1	Open Elective –I	Any Dept.	3	0	0	0	3	50	50	100	3
7.	HSMC	MG1003-1	Management & Entrepreneurship	Any Dept.	3	0	0	0	3	50	50	100	3
8.	AEC	HU1008-1	Life Skills for Engineers	Any Dept.	1	0	0	0	1	50	50	100	1
TOTAL					**17**	**4**	**4**	**-**	**22**	**400**	**400**	**800**	**21**

VII SEMESTER														
Sl. No.	Course and Course code		Course Title	Teaching Dept.	Teaching Hours/Week				Examination				Credits
					Theory Lecture	Tutorial	Practical/ Drawing	PBL	Duration in hr	CIE Marks	SEE Marks	Total Marks	
					L	T	P	J					
1.	IPCC	RI2004-1	Industry 4.0 and IOT	RI	2	2	2	0	3	50	50	100	4
2.	PCC	RI2605-1	Robot Programming and Simulation Lab	RI	0	0	2	0	3	50	50	100	1
3.	PEC	RIXXXX-1	Professional Elective -IV [Group-1]	RI	3	0	0	0	3	50	50	100	3
4.	PEC	RIXXXX-1	Professional Elective – V [Group-2]	RI	3	0	0	0	3	50	50	100	3
5.	OEC	XXX5XX-1	Open Elective –II	Any Dept.	3	0	0	0	3	50	50	100	3
6.	HSMC	MG1002-1	Financial Management	Any Dept.	3	0	0	0	3	50	50	100	3
7.	HEC	HU1009-1	Indian Knowledge Systems	Any Dept.	1	0	0	0	-	50	00	50	1
8.	UCC	UC2002-1	Major Project Phase I	RI	-	-	4	-	-	100	00	100	2
TOTAL					**15**	**02**	**8**	**-**	**18**	**450**	**300**	**750**	**20**

VIII SEMESTER														
Sl. No.	Course and Course code		Course Title	Teaching Dept.	Teaching Hours/Week				Examination				Credits
					Theory Lecture	Tutorial	Practical/ Drawing	PBL	Duration in hr	CIE Marks	SEE Marks	Total Marks	
					L	T	P	J					
1.	UCC	UC2001-1	Internship- II (Societal internship and Research/Industry Internship)		Mandatory Societal internship for 2 weeks (80 – 90 h) and Research Internship / Industry Internship of 6 weeks (240 – 270 h) or Research Internship / Industry internship for a total of 8 weeks (320 – 360 h)to be completed in one/two stretches during the vacation periods between IV to VII semesters				3	50	50	100	8
2.	UCC	UC3001-1	Major Project Phase II		Student should carry out project in research institute/industry/intra institute Canter of Excellences. Two contact hours /week for interaction between the project guide and students.				3	100	100	200	8
TOTAL					**-**	**-**	**-**	**-**	**6**	**150**	**150**	**300**	**16**

List of Vocational Education Courses (VEC)	
Code	**Elective Course Title**
RI2551-1	Motion control using PLC
RI2552-1	Metrology and Measurement

Program Specific Ability Enhancement Course (AEC)	
Course Code	**Course Title**
RI2651-1	Data Acquisition and Measurements
RI2652-1	Engineering Economics
RI2653-1	PLC Control of Hydraulic and Pneumatic Circuits

Open Electives offered to other branch students by the Department [OEC]	
Course Code	**Course Title**
RI2501-1	Autonomous Mobile Robots
RI2502-1	Medical Robotics
RI2503-1	PLC Control of Hydraulic and Pneumatic Circuits

List of Professional Elective Courses [PEC]			
Group-1		**Group-2**	
Automation Stream			
Code	**Elective Course Title**	**Code**	**Elective Course Title**
RI2201-1	Automation in Manufacturing Systems	RI2301-1	Digital Manufacturing
RI2202-1	CNC Machining	RI2302-1	Intelligent Manufacturing
RI2203-1	Industrial Automation and Control	RI2303-1	Mechatronics
RI2204-1	Medical Robotics	RI2304-1	Robot Gripper Design
RI2205-1	Micro-Electro-Mechanical Systems		
Signal Processing and Programming Stream			
Code	**Elective Course Title**	**Code**	**Elective Course Title**
RI2211-1	Data Visualization	RI2311-1	Augmented Reality and Virtual Reality
RI2212-1	Introduction to MATLAB Programming	RI2312-1	Computer Vision
RI2213-1	Mobile Application Development	RI2313-1	PLC and SCADA
RI2214-1	Virtual Instrumentation	RI2314-1	Signal Processing
Artificial Intelligence Stream			
Code	**Elective Course Title**	**Code**	**Elective Course Title**
RI2221-1	Cloud Computing	RI2321-1	Autonomous Vehicles
RI2222-1	Design and analysis of Algorithms	RI2322-1	Basics of Natural Language processing (NPTEL)
RI2223-1	Machine Learning with Python	RI2323-1	Business Analytics
RI2224-1	Managing Information System		

Courses from Basic Science

STATISTICS & PROBABILITY THEORY

Course Code:	**MA2001-1**	**Course Type:**	**BSC**
Teaching Hours/Week (L: T: P: S):	**3:0:0:0**	**Credits:**	**03**
Total Teaching Hours:	**40+0+0**	**CIE + SEE Marks:**	**50+50**
Prerequisite	**MA1002-1**		

Teaching Department: Mathematics

Course Objectives:

1.	Understand the basic principles of probability, Bayes theorem, understand the definitions of discrete, continuous, and joint random variables, compute the mean, variance and covariance of random variables.
2.	Define the binomial, uniform, Poisson, exponential and normal random variables use these principles in problem solving situations.
3.	Understand the concepts of statistical population and sample, variables and attributes. Learn about moments and their use in studying various characteristics of data and various distributions.

UNIT-I

PROBABILITY THEORY — **16 Hours**

Finite sample space, probability, conditional probability and independence, Bayes' theorem. One dimensional random variable: discrete and continuous random variable, probability functions, cumulative distribution function, expectation and variance.
Two-dimensional random variable: joint pdf, marginal pdf's , covariance (CO1)

Distributions: Binomial, Poisson, Uniform, Normal and exponential distributions.
Moment generating function- properties and simple problems.(CO2)

UNIT-II

SAMPLING DISTRIBUTION AND ESTIMATION — **14 Hours**

Random Sample, Sample mean, sample variance, sampling distribution of mean, Central limit theorem, sampling distributions of proportions and sums. Student's t-distribution, Chi-square distribution. Sample distribution of variance.
Estimation: Point estimation, interval estimation, confidence intervals for means and variance. (CO3)

CURVE FITTING AND REGRESSION

Least square principle, fitting of straight lines, polynomials and exponential curves.
Correlation, Rank correlation, Coefficient of correlation, Linear regression. (CO4)

UNIT-III

STOCHASTIC PROCESS — **10 Hours**

Stochastic processes, stochastic matrices, fixed points, regular stochastic matrices, Markov chains, transition probabilities, Birth-death process, Queuing theory – M/M/1 Model, simple problems.(CO5)

Course Outcomes: At the end of the course student will be able to

1.	Apply the concepts of probability, including discrete and continuous random variables, probability distributions, conditioning, independence, expectations, and variances.
2.	Define and explain the different statistical distributions (e.g., Normal, Binomial, Poisson) and the areas of their application.
3.	Explain the concept of correlation and the difference between positive and negative correlation. Compute the correlation coefficient, r , Explain and apply the least square errors method numerically and algebraically to find the curve of best fit.
4.	Able to apply the central limit theorem to sampling distribution. Translate real-world problems into probability models.
5.	Identify and apply the most appropriate stochastic process technique for a given applied problem. Calculate probabilities of absorption and expected hitting times for discrete time Markov chains with absorbing states.

Course Outcomes Mapping with Program Outcomes & PSO

Program Outcomes→ / **↓ Course Outcomes**	1	2	3	4	5	6	7	8	9	10	11	12	PSO↓ 1	PSO↓ 2
MA2001-1.1	3	2	-	-	-	-	-	-	-	-	-	-	-	-
MA2001-1.2	2	2	-	-	-	-	-	-	-	-	-	-	-	-
MA2001-1.3	3	1	-	-	-	-	-	-	-	-	-	-	-	-
MA2001-1.4	3	2	-	-	-	-	-	-	-	-	-	-	-	-
MA2001-1.5	3	2	-	-	-	-	-	-	-	-	-	-	-	-

1: Low 2: Medium 3: High

TEXTBOOKS:

1. Paul L Meyer, "Introductory Probability and Statistical Applications", Addison-Wesley Publishing Company, 2nd Edition (Reprint), 1970.

2. Hogg and Craig, "Introduction to mathematical Statistics", Pearson Education, New Delhi, 6th Edition.

REFERENCE BOOKS:

1. Schaum Outlines, "Probability and Statistics", Mc Graw Hill, 3rd edition, 2010.

2. T. Veerarajan, "Engineering Mathematics", McGraw-Hill, New Delhi, 2008.

3. B. V. Ramana, "Higher Engineering Mathematics", Tata Mc Graw –Hill, New Delhi,2010.

E Books / MOOCs/ NPTEL

1. https://nptel.ac.in/courses/110107114

2. https://nptel.ac.in/courses/111105090

3. https://nptel.ac.in/courses/111102098

LINEAR ALGEBRA AND ITS APPLICATIONS

Course Code:	**MA2005-1**	**Course Type:**	**BSC**
Teaching Hours/Week (L: T: P: S):	**3:0:0:0**	**Credits:**	**03**
Total Teaching Hours:	**40+0+0**	**CIE + SEE Marks:**	**50+50**
Prerequisites	**MA1002-1, MA1007-1**		

Teaching Department: Mathematics

Course Objectives:

1.	Learn to apply elementary row operations to solve linear systems of equations and find the eigenvalues and eigenvectors of a matrix.
2.	Find the eigenvalues and eigenvectors of a square matrix using the characteristic polynomial and will know how to diagonalize a matrix, when this is possible
3.	Understand real vector spaces and subspaces, linear independence and dependence, and find basis and dimension of a vector space, row space, column space and null space of a matrix.
4.	Define a linear transformation and find the matrix associated with it; determine the kernel and range of a transformation; find inner product of vectors, orthogonal and an orthonormal basis.
5.	Learn basic concepts of real quadratic forms, decomposition of matrices and solve problems on the same.

UNIT-I

Matrices — **15 Hours**

Elementary transformation of a matrix, Echelon form and rank of a matrix. Consistency and solution of system of linear equations - Gauss elimination method, LU Decomposition method and approximate solution by Gauss Seidel method.

Trace, relation between trace and Eigen values of a matrix, Eigen values and Eigen vectors of symmetric matrices, Rayleigh's power method to find the largest eigen value and eigen vector of square matrices. Diagonalization.

UNIT-II

Vector Space — **08 Hours**

Vector spaces, subspaces, linearly dependent and independent vectors, basis and dimension, coordinates, row space, column space and null space.

Linear Transformations — **07 Hours**

Linear transformations, algebra of linear transformations, representation of transformations by matrices, isomorphism, Range and Null space of a linear transformation. Rank – nullity theorem. Inner products, orthogonal sets of projections, Gram-Schmidt's orthogonalization process.

UNIT-III

Matrix Decompositions — **10 Hours**

Quadratic forms, QR-factorization, least-squares problems, singular value decomposition and principal component analysis.

Course Outcomes: At the end of the course student will be able to

1.	Solve the system of linear equations for exact or approximate solutions.
2.	Compute and use eigenvectors and eigenvalues.

3.	Analyze finite dimensional vector spaces and subspaces over a field and their properties, including the basis structure of vector spaces.
4.	Relate matrices and linear transformations, apply the properties of inner product and determine orthogonality on vector spaces and orthogonal bases.
5.	Derive and utilize Quadratic forms, SVD and QR factorization of the matrix for efficiently solving problems in practice.

Course Outcomes Mapping with Program Outcomes & PSO

Program Outcomes→ / **↓ Course Outcomes**	1	2	3	4	5	6	7	8	9	10	11	12	**PSO↓** 1	2
MA2006-1.1	3	1	-	-	-	-	-	-	-	-	-	-	-	-
MA2006-1.2	2	3	-	-	-	-	-	-	-	-	-	-	-	-
MA2006-1.3	2	1	-	-	-	-	-	-	-	-	-	-	-	-
MA2006-1.4	2	2	-	-	-	-	-	-	-	-	-	-	-	-
MA2006-1.5	3	2	-	-	-	-	-	-	-	-	-	-	-	-

1: Low 2: Medium 3: High

TEXTBOOKS:

1.	Kenneth Hoffman And Ray Kunze, “Linear Algebra”, Prentice-Hall, 2nd edition, 1971
2.	David C. Lay, “Linear Algebra and Its Applications”, Pearson Education, Inc., 5th edition, 2016.

REFERENCE BOOKS:

1.	Seymour Lipschutz And Marc Lars Lipson, “Schaum’s outlines - Linear Algebra”, McGraw-Hill, 4th Edition, 2002.
2.	Gilbert Strang, “Introduction to Linear Algebra”, Wellesley-Cambridge Press, 5th Edition, 2016.
3.	Gerald Farin, Dianne Hansford, “Practical Linear Algebra, A Geometry Toolbox”, Chapman and Hall, 4th edition, 2021.
4.	Sheldon Axler, “Linear Algebra Done Right”, Springer Nature, 3rd Edition, 2015.

E Books / MOOCs/ NPTEL

1.	https://nptel.ac.in/courses/111101115
2.	https://archive.nptel.ac.in/courses/111/106/111106135/
3.	https://nptel.ac.in/courses/110104024

CALCULUS & DIFFERENTIAL EQUATIONS (COMMON TO AM\CC\CS\IS\DS\RI)

Course Code:	**MA1012-1**	**Course Type:**	**MNC**
Teaching Hours/Week (L: T: P: S):	**3:0:0:0**	**Credits:**	**00**
Total Teaching Hours:	**40+0+0**	**CIE + SEE Marks:**	**100+00**

Teaching Department: Mathematics

Mandatory Non – credit course (MNC):

This course is prescribed to the lateral entry Diploma holders admitted to III semester of BE/B.Tech., programs, they shall attend the classes during the respective semesters to complete all the formalities of the course and appear for the Continuous Internal Evaluation (CIE). In case, any student fails to register for the said course/fails to secure the minimum 40 % of the prescribed CIE marks, he/she shall be deemed to have secured an F grade. In such a case, the student has to fulfill the requirements during subsequent semester/s to appear for CIE.

MNC Courses shall not be considered for vertical progression as well as for the calculation of SGPA and CGPA, but completion of the courses shall be mandatory for the award of degree

Course Objectives:

This course will enable the students to master the basic tools of differential calculus, partial differentiation, Vector differentiation and Integration and become skilled for solving problems in science and engineering.

UNIT-I

DIFFERENTIAL CALCULUS	**07 Hours**

Polar curves, angle between the radius vector and the tangent, angle of intersection of two curves, derivatives of arcs and radius of curvature -cartesian, parametric and polar forms (No Derivation).

Taylor's theorem for functions of single variable. Mean value theorems.

PARTIAL DIFFERENTIATION	**08 Hours**

Partial derivatives of simple functions, Total differentiation - differentiation of composite and implicit functions. Taylor's theorem for functions of two variables, maxima and minima for functions of two variables.

UNIT-II

VECTOR DIFFERENTIAL CALCULUS	**07 Hours**

Vector algebra(review), scalar and vector valued functions, gradient, directional derivative and hessian of multivariable function, Divergence and curl of a vector valued function.

ORDINARY AND PARTIAL DIFFERENTIAL EQUATIONS	**08 Hours**

Ordinary differential equations(review), linear and nonlinear differential equations. Second and higher order linear differential equations with constant coefficients.

Formation of partial differential equations by eliminating arbitrary constants and arbitrary functions. Solution of P.D.E by the method of separation of variables.

UNIT-III

MULTIPLE INTEGRALS	**10 Hours**

Double integrals and triple integrals, Evaluation by change of order of integration, change of variables and applications to area and volume.

Course Outcomes: At the end of the course student will be able to

1.	Apply the concept of radius of curvature and mean value theorems.
2.	Learn the concept of partial differentiation of a function with two or more independent variables, apply them to solve engineering problems and examine the given function for its extrema.
3.	Solve the vector functions and their derivatives for engineering applications.
4.	Apply the concepts of ordinary and partial differential equations in engineering problems.
5.	Apply the notion of multiple integrals to find areas and volumes.

Course Outcomes Mapping with Program Outcomes & PSO

Program Outcomes→	1	2	3	4	5	6	7	8	9	10	11	12	**PSO↓**	
↓ Course Outcomes													1	2
MA1012-1.1	3	2	-	-	-	-	-	-	-	-	-	-	-	-
MA1012-1.2	2	2	-	-	-	-	-	-	-	-	-	-	-	-
MA1012-1.3	3	1	-	-	-	-	-	-	-	-	-	-	-	-
MA1012-1.4	3	2	-	-	-	-	-	-	-	-	-	-	-	-
MA1012-1.5	3	2	-	-	-	-	-	-	-	-	-	-	-	-

1: Low 2: Medium 3: High

TEXTBOOKS:

1.	B.S. Grewal, “Higher Engineering Mathematics”, Khanna Publications, 43rd Edition, 2015.
2.	Erwin Kreyszig, “Advanced Engineering Mathematics”, John Wiley and Sons, 10th Edition (Reprint), 2016.
3.	Murray R. Spiegal, “Vector Analysis”, Schuam Publishing Co.

REFERENCE BOOKS:

1.	G. B. Thomas and R. L. Finney, “Calculus and Analytic Geometry”, Pearson, 2002.
2.	T. Veerarajan, “Engineering Mathematics”, McGraw-Hill, New Delhi, 2008.
3.	B. V. Ramana, “Higher Engineering Mathematics”, Tata Mc Graw –Hill, New Delhi,2010.

BRIDGE COURSE - DISCRETE MATHEMATICS & NUMERICAL METHODS (COMMON TO AM\CC\CS\IS\DS\RI)

Course Code:	**MA1014-1**	**Course Type:**	**MNC**
Teaching Hours/Week (L: T: P: S):	**3:0:0:0**	**Credits:**	**00**
Total Teaching Hours:	**40+0+0**	**CIE + SEE Marks:**	**100+00**

Teaching Department: Mathematics

Mandatory Non – credit course (MNC):
This course is prescribed to the lateral entry Diploma holders admitted to III semester of BE/B.Tech., programs, they shall attend the classes during the respective semesters to complete all the formalities of the course and appear for the Continuous Internal Evaluation (CIE). In case, any student fails to register for the said course/fails to secure the minimum 40 % of the prescribed CIE marks, he/she shall be deemed to have secured an F grade. In such a case, the student has to fulfill the requirements during subsequent semester/s to appear for CIE.
MNC Courses shall not be considered for vertical progression as well as for the calculation of SGPA and CGPA, but completion of the courses shall be mandatory for the award of degree

Course Objectives:
This course will enable the students to master the basic tools of set theory and relations, propositional and predicative logics, numerical methods, Fourier series and transforms and become skilled for solving problems in science and engineering.

UNIT-I

Set Theory and Logic	**07 Hours**

Sets- operations on sets, product sets and partitions (review)
Relations- representation of relations as matrices and digraphs, equivalence relations.
Functions- permutations functions, functions for computer science.
Fundamentals of logic-
Propositional logic, logical operations(review), rules of inference Predicates calculus.

Graph Theory	**08 Hours**

Graphs: Basic terminologies, some special simple graphs, bipartite graphs, adjacency matrices, incidence matrices, graph isomorphism, connectivity- vertex and edge connectivity, Euler and Hamiltonian graphs and their applications, planar graphs, graph coloring and their applications.

UNIT-II

Numerical Methods	**15 Hours**

Roots of algebraic and transcendental equations- Newton Raphson method, Regula Falsi method.
Numerical solution of ordinary differential equations- Taylor's series method, Modified Euler's method and Runge –Kutta method of fourth order.
Numerical solution of partial differential equations- Classification of partial differential equations, examples, solution of Laplace and Poisson equations by standard five-point formulae, solution of heat and wave equations by explicit method.

UNIT-III

Fourier Series and Transforms	**10 Hours**
Periodic functions, Euler's formulae, Fourier series of odd and even functions, functions with arbitrary period, half range series. Fourier transform, inverse Fourier transform, Convolution theorem, Fourier sine and cosine transforms.	

Course Outcomes: At the end of the course student will be able to

1.	Represent a relation in terms of matrix and digraph, apply permutation functions for encoding and decoding simple text messages and establish by deduction the validity of an argument using inference rules. Identify suitable data structure for representing a graph, apply the concept of connectivity in real life problems
2.	Identify suitable data structure for representing a graph, apply the concept of connectivity in real life problems.
3.	Apply numerical methods to find solutions of algebraic equations and ordinary differential equations.
4.	Apply numerical methods to solve partial differential equations
5.	Apply the analytical technique to express periodic function as a Fourier sine and cosine series and apply the concepts of Fourier- transforms to solve engineering problems.

Course Outcomes Mapping with Program Outcomes & PSO

Program Outcomes→	1	2	3	4	5	6	7	8	9	10	11	12	**PSO↓**	
↓ Course Outcomes													1	2
MA1014-1.1	3	2	-	-	-	-	-	-	-	-	-	-	-	-
MA1014-1.2	3	2	-	-	-	-	-	-	-	-	-	-	-	-
MA1014-1.3	2	2	-	-	-	-	-	-	-	-	-	-	-	-
MA1014-1.4	2	2	-	-	-	-	-	-	-	-	-	-	-	-
MA1014-1.5	3	2	-	-	-	-	-	-	-	-	-	-	-	-

1: Low 2: Medium 3: High

TEXTBOOKS:

1.	B.S. Grewal, "Higher Engineering Mathematics", Khanna Publications, 43rd Edition, 2015.
2.	Erwin Kreyszig, "Advanced Engineering Mathematics", John Wiley and Sons, 10th Edition (Reprint), 2016.

REFERENCE BOOKS:

1.	T. Veerarajan, "Engineering Mathematics", McGraw-Hill, New Delhi, 2008.
2.	B. V. Ramana, "Higher Engineering Mathematics", Tata Mc Graw –Hill, New Delhi,2010.

Integrated Professional Core Courses

Analog and Digital Circuits

Course Code:	**RI2001-1**	**Course Type:**	**IPCC**
Teaching Hours/Week (L: T: P: S):	**3:0:2:0**	**Credits:**	**04**
Total Teaching Hours:	**40+0+26**	**CIE + SEE Marks:**	**50+50**
Prerequisite	**EC1001-1**		

Teaching Department: Robotics & AI Engineering

Course Objectives:

1.	To design linear amplifier using MOSFETs.
2.	To design application circuits using OP-AMPS
3.	Illustrate simplification of Algebraic equations using Karnaugh Maps
4.	Design digital circuits for decoders, encoders, and multiplexers
5.	To design power supply circuits.

UNIT-I

Switches & Amplifiers	**04 Hours**
MOSFET Operation as a switch, operations as a linear amplifier (CS amplifier and source follower)	
Operational Amplifiers	**07 Hours**
Offset voltage and currents, offset compensation, Circuit BW and Slew rate, Difference Amplifier, Instrumentation Amplifier, Bridge circuits, Precision Rectifiers. S&H Circuit, Voltage Level Detectors and Schmitt Trigger, Active Filters.	
Applications using Linear ICs	**04 hours**
Applications using Linear ICs: Data Conversion Basics, Digital to Analog Converters: weighted Resistor, R-2R Digital to Analog Converters, SAR ADC, 555 timer applications.	

UNIT-II

Logic gates & Principles of combination logic:	**06 Hours**
Boolean algebra, De-Morgan's theorem, Simplification of Boolean expressions, Basic and Universal gates, Realization of Boolean expressions using basic and universal gates, Canonical Forms, Introduction to Min/Max term equations, Generation of switching equations from truth tables, Karnaugh map - 3, 4 variables, Incompletely specified functions.	
Analysis and Design of Combinational Logic:	**05 Hours**
Adders and Subtractors, Cascading adders/subtractors, Multiplexers, Demultiplexers, Decoders, Encoders	
Flip-Flops and its Applications:	**04 Hours**
Basic Bistable element, Latches, SR latch, Switch debounce, SR flip-flops, D Flip flop, T flip flop, JK flip flops, Edge triggered flip flop, Characteristic equations.	

UNIT-III

Power amplifier	**05 Hours**
Push pull, H bridge, PWM generation	
Power supply –	**05 Hours**
Regulators- linear regulators, Switching Mode Regulator, Buck Regulator, Boost Regulator, Buck Boost Regulator	

Suggested List of Experiments

1.	MOSFET characteristic (Simulation)
2.	MOSFET amplifier design – CS and source follower (Hardware)
3.	OPAMP – as Comparator, Amplifier (inv and non inv) , LPF, HPF (Hardware)

4.	Astable and monostable (555) (Hardware)
5.	Verification of logic gates (Simulation)
6.	Designing Adders and Subtracters (Simulation)
7.	Design of Multiplexer and Demultiplexer (Simulation)
8.	Design of Encoder and decoder (Simulation)
9.	Push-pull amplifier (Simulation)
10.	H- Bridge amplifier with PWM (Simulation)
11	Buck, Boost, Buck-Boost regulator (Simulation)
	Demonstration Experiments
1.	Handling measuring equipment: Multimeter and DSO
2.	Introduction to the simulation tool

Course Outcomes: At the end of the course student will be able to

1.	Design switching circuits and linear amplifier circuits using MOSFETs
2.	Analyse the working principle of OP-AMPs and its application circuits
3.	To realise the digital circuit using Karnaugh maps
4.	To design the digital circuit such as decoders, encoders, multiplexers, Boolean function generators
5.	Analyse power supply design circuits

Course Outcomes Mapping with Program Outcomes & PSO

Program Outcomes→	1	2	3	4	5	6	7	8	9	10	11	12	PSO↓		
↓ Course Outcomes															
RI2001-1.1	3														
RI2001-1.2	3														
RI2001-1.3	3														
RI2001-1.4	3														
RI2001-1.5	3														

1: Low 2: Medium 3: High

TEXTBOOKS:

1.	Sedra /Smith, "Microelectronic Circuits" 6th Edition, Oxford University Press-New Delhi,2013.
2.	Jacob Millman & Christos C. Halkias, "Integrated Electronics", McGraw Hill Publications, 2nd Edition, 2011.
3.	M.D Singh and K B Khanchandani, Power electronics, 2nd edition,Tata Mc-Grow Hill, 2009, ISBN: 0070583897

REFERENCE BOOKS:

1.	Behzad Razavi, "Fundamentals of Microelectronics", Wiley 2013.
2.	Nashelesky & Boylestead, "Electronic Devices & Circuit Theory", PHI, 11TH Edition.2015.
3.	Jacob Millman & Arvin Grabel, "Microelectronics" 2nd Edition, McGraw Hill Publications,1987
4.	A. D. Helfrick and W.D. Cooper, "Modern electronics and Instrumentation and Measuring Techniques, Pearson, 1st edition, 2015, ISBN: 9789332556065

E Books / MOOCs/ NPTEL

1.	Electronics for analog signal processing-I, Prof. K Radhakrishna Rao, IIT Madras
2.	NPTEL Course on Analog Electronic Circuits by Prof. Pradip Mandal, IIT Kharagpur

Design of Robotic Components

Course Code	RI2002-1	Course Type:	IPCC
Teaching Hours/Week (L: T:P: S)	(3:0:2:0)	Credits:	04
Total Hours of Pedagogy	50	CIE + SEE Marks:	50+50
Prerequisite	ME 1003-1, ME 1002-1		

Teaching Department: Robotics & AI Engineering

Course objectives:

1. Define and explain various terms connected to the design of machine elements-I like static strength, fatigue strength, Impact stresses, theories of failures, rigidity-based design, factor of safety, and stress concentration etc.
2. Explain how engineering design make use of the principles learnt in science courses and identify their practical applications.
3. Design and analyze problem-solving skill in design of machine elements with appropriate assumptions and correct methodology
4. Develop student's ability to understand the Stresses in threaded Fasteners under different loading conditions & Evaluate the forces, stresses, displacements and other related parameters necessary to design different springs.
5. Demonstrate the ability to develop designs for different gears.

Unit-I

Introduction

Meaning of design with special reference to machine design - Definition and understanding of several types of designs. Concept of design.

Mechanical properties of materials, Stress, Strain and Hooke's law, Stress strain diagram for brittle and ductile materials, Factor of safety, True stress and strain, Calculation of stresses in straight, Stepped and tapered sections, Stresses due to temperature change, Shear stress and strain, Lateral strain and Poisson's ratio, Elastic constants and relations between them.

Design for Static Strength: Static Strength, Static loads, Theories of elastic failure – Maximum normal stress theory, Maximum shear stress theory, Distortion energy theory; Failure of brittle materials, Failure of ductile materials, Stress concentration factor.

15 Hours

Unit-II

Threaded Fasteners: Stresses in threaded Fasteners, Effects of initial tension, Effect of compression, Effect of Fatigue loading, shear loading, Design of eccentrically loaded bolted joints.

Belt Drives: Ratio of tensions, Centrifugal stress in a belt, Power transmitted, effect of centrifugal tension on power transmitted, Simple numerical problems.

Rolling contact bearings: Types, static and dynamic load capacities, equivalent bearing load, load-life relationship, bearing life, load factor, selection of bearing from manufacturer's catalogue; ball and roller bearings, design for variable load and speed, bearings with probability of survival other than 90%, bearing materials and their properties.

15 Hours

Unit-III

Shafts and Keys: Pure torsion, assumptions, derivation of torsional equations, polar modulus, torsional rigidity / stiffness of shafts, Derivation of power transmitted by solid and hollow circular shafts, design for strength and rigidity with steady loading, ASME & BIS codes for design of transmission shafting. Keys: Types of keys, Design of keys.

Design of Gears: Classification of Gears, Selection of type of gears, Law of Gearing, Gear terminology, Standard system of gear tooth, force analysis, Interference and undercutting, number of teeth, gear tooth failures, selection of material. Specifications of spur gear, helical gear, bevel gear, worm gears (Design not included).

09 Hours

List of Lab Experiments:

1. Part modeling and Assembly of robotic component using CATIA/Creo Parametric/Solid Edge
2. Stress concentration problems using ANSYS
3. Shear force and bending moment calculation using MD Solids
4. Design of shaft using MATLAB
5. Identification of different types of fasteners
6. Gear identification and applications
7. Gear clock design and fabrication
8. Identification of different types of bearings

26 Hours

Course Outcomes: At the end of the course student will be able to

1.	Determine bending stress, shear stress and design of simple machine components subjected to static loading conditions for different material properties.
2.	Design simple machine elements subjected to fatigue loading using Goodman and Soderberg design equations. Determine the dimensions of the machine elements subjected to impact strength.
3.	Design of shafts subjected to Bending, torsional and fatigue loads, with and without keys based on strength and rigidity criterion.
4.	Determine the parameters of helical springs and threaded fasteners for the given loads
5.	Design a pair of spur and helical gears given the number of teeth or pitch circle diameter, pitch line velocity and center distances and determine the gear parameters critical for the safety of the design; Outline the bevel gear terminologies; Design a pair of worm gears and compute its efficiency.

Course Outcomes Mapping with Program Outcomes & PSO

Program Outcomes→	1	2	3	4	5	6	7	8	9	10	11	12	PSO↓		
↓ Course Outcomes															
RI2002-1.1	3	2	1	-	-	-	-	-	-	-	-	1	3	-	2
RI2002-1.2	3	2	1	-	-	-	-	-	-	-	-	1	3	-	2
RI2002-1.3	3	2	1	-	-	-	-	-	-	-	-	1	3	-	2
RI2002-1.4	3	2	1	-	-	-	-	-	-	-	-	1	3	-	2
RI2002-1.5	3	2	1	-	-	-	-	-	-	-	-	1	3	-	2

1: Low 2: Medium 3: High

TextBooks

1. Mechanical Engineering Design, Joseph E Shigley and Charles R. Mischke, McGraw Hill International edition, 2003
2. Design of Machine Elements, V.B. Bhandari, Tata McGraw Hill Publishing Company Ltd., 2010
3. Machine Design, Robert L., Norton, Pearson Education Asia, 5th Edition, 2013

4. Design of Machine Elements, M.F.Spotts, T.E. Shoup, L.E. Hornberger, S.R. Jayram and C.V. Venkatesh, Pearson Education, 2006
5. Machine Design, Hall, Holowenko, Laughlin, (Schaum's Outlines series). Tata McGraw Hill Publishing Company Ltd., 2007

Web links and Video Lectures (e-Resources):

1. https://nptel.ac.in/courses/112/105/112105124/

Image Processing and its Application

Course Code:	**RI2003-1**	**Course Type:**	**IPCC**
Teaching Hours/Week (L: T: P: S):	**3:0:2:0**	**Credits:**	**04**
Total Teaching Hours:	**50**	**CIE + SEE Marks:**	**50+50**
Prerequisite	**CS1001-1**		

Teaching Department: Robotics and Artificial Intelligence

Course Objectives:

1.	Understand the fundamentals of digital image processing
2.	Understand the image transform used in digital image processing
3.	Understand the image enhancement techniques used in digital image processing
4.	Understand the image restoration techniques and methods used in digital image processing
5.	Understand the Morphological Operations and Segmentation used in digital image processing

UNIT-I

Introduction	**07 Hours**
What Is Digital Image Processing? Examples of Fields that Use Digital Image Processing, Fundamental Steps in Digital Image Processing, Components of an Image Processing System. Digital Image Fundamentals - Elements of Visual Perception, Brightness Adaptation and Discrimination, Light and the Electromagnetic Spectrum, Image Sensing and Acquisition, Image Sampling and Quantization, Some Basic Relationships between Pixels	
Image Enhancement in the Spatial Domain	**08 Hours**
Background, Some Basic Gray Level Transformations, Histogram Processing. Enhancement Using Arithmetic/Logic Operations, Basics of Spatial Filtering, Smoothing Spatial Filters, Sharpening Spatial Filters.	

UNIT-II

Image Enhancement in the Frequency Domain	**06 Hours**
Background, Introduction to the Fourier Transform and the Frequency Domain, Smoothing Frequency-Domain Filters.	
Sharpening Frequency Domain Filters	**05 Hours**
Homomorphic Filtering, Image Segmentation- Detection of Discontinuities, Edge Linking and Boundary Detection, Thresholding, Region-Based Segmentation, Segmentation by Morphological Watersheds.	
Morphological Image Processing	**04 Hours**
Preliminaries, Dilation and Erosion, Opening and Closing, the Hit-or-Miss Transformation Some Basic, Morphological Algorithms.	

UNIT-III

Image Compression	**05 Hours**
Fundamentals Image Compression, Models Elements of Information, Theory Error-Free Compression, Lossy Compression, Image Compression Standards.	
Color Image Processing	**04 Hours**
Color Fundamentals, Color Models, Pseudo color Image Processing, Basics of Full-Color Image Processing.	

Suggested List of Experiments

	Display of gray scale images
	Histogram Equalization
	Design non-linear filtering
	Determination of edge detection using operators
	2-D DFT and DCT
	Filtering in Frequency domain
	Display of colour images
	Conversion between colour spaces
	DWT of images
	Segmentation using watershed transform

Course Outcomes: At the end of the course student will be able to

1.	Identify the concept of Digital Image Processing, Analyze Steps in Digital Image Processing, Apply the Knowledge of Image Sampling and Quantization and illustrate Some Basic Relationships between Pixels using Knowledge of 4-8 and M adjacency. Design and develop the experiments on histogram processing and gray scale images.
2.	Analyze Smoothing Spatial Filters, Sharpening Spatial Filters by applying mathematical knowledge. Explain Frequency domain and illustrate Smoothing Frequency-Domain Filters. Design and develop the experiments on spatial domain filters and frequency domain filters.
3.	Analyze Sharpening frequency-Domain Filters, Design and formulate Image segmentation techniques, prove the properties Region-Based Segmentation. Design and develop the experiments on image segmentation and edge detection
4.	Illustrate and Design Image Compression Standards, Analyze the concept of Morphological Image Processing by applying mathematical knowledge.
5.	Analyze color image processing techniques, illustrate color image sharpening, smoothing, compression, segmentation and Transform. Design and develop the experiments on color image processing.

Course Outcomes Mapping with Program Outcomes & PSO

Program Outcomes→	1	2	3	4	5	6	7	8	9	10	11	12	PSO↓		
↓ Course Outcomes															
RI2003-1.1	3	1	3	2	3	-	-	-	-	-	-	2	1	2	2
RI2003-1.2	3	1	3	2	3	-	-	-	-	-	-	2	1	2	2
RI2003-1.3	3	1	3	2	3	-	-	-	-	-	-	2	1	2	2
RI2003-1.4	3	1	3	2	3	-	-	-	-	-	-	2	1	2	2
RI2003-1.5	3	1	3	2	3	-	-	-	-	-	-	2	1	2	2

1: Low 2: Medium 3: High

TEXTBOOKS:

1.	Rafel C Gonzalez and Richard E Woods., Digital Image Processing, Pearson Education, 2nd Edition, 2003
2.	Anil K Jain., Fundamentals of Digital Image Processing, Prentice Hall of India Pvt. Ltd, 2nd Edition 1997.

REFERENCE BOOKS:

1.	Milan Sonka, Vaclav Hlavac and Roger Boyle., Image Processing, Analysis and Machine Vision, Thomoson Learning, Brooks/Cole, 2nd Edition 2001
2.	B.Chanda, D Dutta Majumder,. Digital Image Processing and Analysis, Prentice- Hall, India, 2nd Edition 2011.
3.	Steven W. Smith,. The Scientist and Engineers Guide to Digital Signal Processing, California Technical Publishing, 2nd Edition 1999.
E Books / MOOCs/ NPTEL	
1.	https://nptel.ac.in/courses/117/105/117105135/
2.	https://www.tutorialspoint.com/dip/index.htm
3.	https://www.coursera.org/learn/digital
4.	Virtual Lab link- https://cse19-iiith.vlabs.ac.in/
5.	https://www.javatpoint.com/digital-image-processing-tutorial
6.	https://www.mathworks.com/discovery/digital-image-processing.html

INDUSTRY 4.0 & IOT

Course Code:	**RI2004-1**	**Course Type:**	**IPCC**
Teaching Hours/Week (L: T: P: S):	**(3:0:2:0)**	**Credits:**	**04**
Total Teaching Hours:	**50**	**CIE + SEE Marks:**	**50+50**
Prerequisite	**CS1001-1, IS1001-1**		

Teaching Department: Robotics & AI Engineering

Course Objectives:

1.	Understand the drivers and enablers of Industry 4.0. Explain internet of Things and its hardware and software components
2.	Develop the students to understand the Interface I/O devices.
3.	Able to outline the various systems used in a manufacturing plant and their role in an Industry 4.0 world
4.	Develop the IOT applications
5.	Understand the opportunities, challenges brought about by Industry 4.0 and how organisations and individuals should prepare to reap the benefits

UNIT-I

Introduction to Industry 4.0, Introduction to IoT	**08 Hours**
Basic principles and technologies of a Smart Factory, Cyber-Physical Systems (CPS). Architectural Overview, Design principles and needed capabilities, IoT Applications, Sensing, Actuation, Basics of Networking, M2M and IoT Technology Fundamentals- Devices and gateways, Data management.	
Hardware Elements of IoT, Software Elements of IoT	**08 Hours**
Computing (Arduino, Raspberry Pi), Communication, Sensing, Actuation, I/O interfaces.	

UNIT-II

Augmented Reality	**08 Hours**
Assistance systems for production, The six main use-cases for Augmented Reality in Manufacturing, Human-Robot Collaboration.	
IoT Application Development	**08 Hours**
Solution framework for IoT applications- Implementation of Device integration, Data acquisition and integration, Device data storage- Unstructured data storage on cloud/local server, Authentication, authorization of devices.	

UNIT-III

Cloud Manufacturing	**08 Hours**
Cloud Manufacturing and the connected factory, Introduction into Cloud Development Environments & a Predictive Maintenance Case, Artificial Intelligence in Production: Machine Learning Application, Safety and Security in networked Production Environments, Cyber-Physical Systems and new Business Models.	

Suggested List of Experiments

	Interfacing communication modules using Arduino
2.	Blinking LED lights with Arduino
3.	Interfacing alphanumerical LCD display using Arduino
4.	Direction control of DC motor using Arduino
5.	Obstacle avoiding robot using Arduino
6.	Operate raspberry pi using headless mode

7.	Communication with devices through pins of the pi, RPi.GPIO library
8.	Direction control of stepper motor using Raspberry pi
9.	Build webserver using raspberry pi
10.	Build NAS using raspberry pi

Course Outcomes: At the end of the course student will be able to

1.	Summarise the basic principles and technologies of a Smart Factory, Cyber-Physical Systems (CPS) and Cyber-Physical Production Systems (CPPS)
2.	Explain internet of Things and its hardware and software components
3.	Develop Interface I/O devices. Analyse the assistance systems for production.
4.	Describe the six main use-cases for Augmented Reality in Manufacturing, Human-Robot Collaboration. Develop Remotely monitor data and control devices
5.	Discuss the Cloud Manufacturing, Cloud Development Environments and Artificial Intelligence in Production

Course Outcomes Mapping with Program Outcomes & PSO

Program Outcomes→	1	2	3	4	5	6	7	8	9	10	11	12	PSO↓		
↓ Course Outcomes													1	2	3
RI2004-1.1	3	-	-	1	2	1	-	-			-	1	-	2	3
RI2004-1.2	3	-	-	1	2	1	-	-			-	1	-	2	3
RI2004-1.3	3	-	-	2	1	3	-	-			-	1	-	2	3
RI2004-1.4	3	-	-	2	1	2	-	-			-	1	-	2	3
RI2004-1.5	3	-	-	2	1	2	-	-			-	1	-	2	3

1: Low 2: Medium 3: High

TEXTBOOKS:

1.	Ghosal, A., Robotics: Fundamental Concepts and Analysis, Oxford University Press, 2008
2.	Internet of Things: A Hands On Approach, Arshdeep Bahga, and Vijay Madisetti, Orient Blackswan, 2014
3.	Introduction to Industrial Internet of Things and Industry 4.0, Sudip Misra, Chandana Roy and Anandarup Mukherjee, CRC Press Taylor & Francis Group, LLC, First Edition, 2021.

REFERENCE BOOKS:

1.	Fu, K., Gonzalez, R. and Lee, C. S. G., Robotics: Control, Sensing, Vision and Intelligence, McGraw- Hill, 2008
2.	Industry 4.0:The Industrial Internet of Things, Alasdair Gilchrist, Apress, 2016
3.	The Fourth Industrial Revolution, Klaus Schwab, Penguin Books Limited, 2017
4.	Handbook of Industry 4.0 and SMART Systems, Diego Galar Pascual, Pasquale Daponte, and Uday Kumar

E Books / MOOCs/ NPTEL

1.	https://nptel.ac.in/courses/106/105/106105195/
2.	https://www.classcentral.com/course/youtube-noc-jan-2019-introduction-to-industry-4-0-and-industrial-internet-of-things-47354

Introduction to Object Oriented Programming			
Course Code	**RI2005-1**	**Course Type:**	**IPCC**
Teaching Hours/Week (L:T:P: S)	**(3:0:2:0)**	**Credits:**	**04**
Total Hours of Pedagogy	**50**	**CIE + SEE Marks:**	**50+50**
Prerequisite	**CS1001-1**		

Course objectives:

1. Learn fundamental features of object-oriented language and Python
2. Create, debug, and run a simple Python Program.
3. Create multi-threaded programs and event handling mechanisms.
4. Introduce event driven Graphical User Interface (GUI) programming using Python
5. Introduce event driven Graphical User Interface (GUI) programming using Python

Unit-I

Python basics: Essentials of a Python program, Integers, Floating-point numbers, Strings, Variables and scope: Variables, Type conversion Selection control statements, Collections: Lists, Tuples, Sets, Ranges, Dictionaries, Converting between collection types, Two-dimensional sequences

Loop control statements: while loop, for loop, Nested loops, Iterables, iterators and generators, Comprehensions, break and continue statements

Errors and exceptions: Errors, handling exceptions, Debugging programs

15 Hours

Unit-II

OOP Concepts: Abstraction, Encapsulation, Inheritance, Polymorphism **Classes:** Instance attributes, Class attributes, Class decorators, inspecting an object, Overriding methods. Composition, Inheritance, Virtual functions

Packaging and testing: Modules, Packages, Documentation, Testing Useful modules in the Standard Library: datetime, math, random, re, csv, sys and argparse

15 Hours

Unit-III

Event-driven programming, Layout options, Custom events

09 Hours

List of Lab Experiments:

Programs

1. Write a python program to print the multiplication table for the given number
2. Write a python program to display prime numbers less than or equal to a number 'n'.
3. Write a python program to find the factorial of the given number?
4. Write a python program to implement List operations (Nested List, Length, Concatenation, Membership, Iteration, Indexing and Slicing)
5. Write a python program to implement List methods (Add, Append, Extend & Delete).
6. Write a python program to implement simple Chatbot with minimum 10 conversations
7. Write a python program to Illustrate Different Set Operations
8. Write a python program to implement a function that counts the number of times a string(s1) occurs in another string(s2)

9. Write a program to illustrate Dictionary operations ([],in, traversal) and methods: keys(), values(), items()
10. Solve 8-Queens Problem with suitable assumptions
11. Write a program that inputs a text file. The program should print all of the unique words in the file in alphabetical order.
12. Write a python program to create a package (college),sub-package (alldept), modules(departments) and create an admin and cabin function to the module?
13. Program to demonstrate Creating Class and Object in Python
14. Program to demonstrate Creating Methods in Python
15. Program to demonstrate Use of Inheritance in Python
16. Program to demonstrate Data Encapsulation in Python
17. Program to demonstrate Using Polymorphism in Python
18. Program to demonstrate event driven programming **11 Hours**

Course Outcomes: At the end of the course student will be able to

1.	Acquire the fundamental knowledge of Programming Language using Python
2.	Obtain the knowledge of Loops and Errors Exception using Python and Object-Oriented Programming Concepts
3.	Acquire the knowledge of Event driven application
4.	Apply the knowledge of Object-Oriented Programming.
5.	Apply the knowledge of Event driven application using Python

Course Outcomes Mapping with Program Outcomes & PSO

Program Outcomes→	1	2	3	4	5	6	7	8	9	10	11	12	PSO↓		
↓ Course Outcomes													1	2	3
RI2005-1.1	3	-	-	1	2	1	-	-			-	1	-	2	3
RI2005-1.2	3	-	-	1	2	1	-	-			-	1	-	2	3
RI2005-1.3	3	-	-	2	1	3	-	-			-	1	-	2	3
RI2005-1.4	3	-	-	2	1	2	-	-			-	1	-	2	3
RI2005-1.5	3	-	-	2	1	2	-	-			-	1	-	2	3

1: Low 2: Medium 3: High

Textbooks:

1. ***"Python 3 Object Oriented Programming",*** **Dusty Phillips,** Packt Publishing, 2015
2. ***"Core Python Programming",*** **R. Nageswara Rao**, Dreamtech Press, Second edition, 2018.

Reference Books

1. ***"Let Us Python: Python Is Future, Embrace It Fast",*** **Yashavant Kanetkar, Aditya Kanetkar,** BPB Publications, 2019
2. ***"Python Programming: A modular approach"***, **Taneja Sheetal, Kumar Naveen,** Pearson India, 2017

E Books / MOOCs/ NPTEL

- Programming for Everybody (Getting Started with Python) https://www.coursera.org/learn/python
- Object-Oriented Python: Inheritance and Encapsulation https://www.coursera.org/learn/object-oriented-python

- Object Oriented Programming with C++ http://vlabs.iitb.ac.in/vlabs-dev/labs/oops/index.php

Introduction to Robotics

Course Code:	**RI2006-1**	**Course Type:**	**IPCC**
Teaching Hours/Week (L: T: P: S):	**(3:0:2:0)**	**Credits:**	**04**
Total Teaching Hours:	**40+0+26**	**CIE + SEE Marks:**	**50+50**
Prerequisite	**EE1001-2, EC1001-1**		

Teaching Department: Robotics & AI Engineering

Course Objectives:

1.	Familiarize with the Anatomy of robot and 3D homogeneous transformations.
2.	To study the different sensors and actuators used in robotics
3.	Study the application of robot technology in wheeled mobile robots, medical robots, unmanned aerial vehicles, service robots, underwater robots
4.	To study the linear and rotary motion control using sensors and actuators
5.	To understand the robot programming and 3D homogeneous transformations applied to robotics

Unit-I

Definitions- Robots, Robotics; Types of Robots- Manipulators, Mobile Robots-wheeled & Legged Robots, Aerial Robots; Anatomy of a robotic manipulator-links, joints, actuators, sensors, controller; open kinematic vs closed kinematic chain; degrees of freedom; Robot considerations for an application- number of axes, work volume, capacity & speed, stroke &reach, Repeatability, Precision and Accuracy, Operating environment, point to point control or continuous path control. **Robotic configurations and end effectors, Human factors in Robotics.**

Robot configurations-PPP, RPP, RRP, RRR; features of SCARA, PUMA Robots; Classification of robots based on motion control methods and drive technologies; 3R wrist.

Classification of End effectors - mechanical grippers, special tools, Magnetic grippers, Vacuum grippers, adhesive grippers, Active and passive grippers, selection, and design considerations of grippers in robot.

3D Homogeneous transformations: 3D homogeneous rotation Matrix, 3D Homogeneous translation Matrix, Composite rotation Matrix, Rotation Matrix about an Arbitrary Axis, Application of 3D homogeneous transformations in robotics, numerical Problems

15 Hours

Unit- II

Sensors for Robots

Sensor classification- Proprioceptive and Exteroceptive sensors, active and passive sensors, characteristics of sensors, touch, force, range, proximity, vision sensors. **Internal sensors**-Linear and rotary position sensors, velocity sensors, acceleration sensors, Force sensors; **External sensors**-contact type, noncontact type; Vision - Elements of vision sensor, image acquisition, image processing; Selection of sensors.

Actuators for Robots: classification-Electric, Hydraulic, Pneumatic actuators; their advantages and disadvantages; Electric actuators- Stepper motors, DC motors, DC servo motors and their drivers, AC motors, Linear actuators, selection of motors; Hydraulic actuators- Components and typical circuit, advantages, and disadvantages; Pneumatic Actuators- Components and typical circuit, advantages and disadvantages.

15 Hours

Unit-III

Application of Robot: Industrial Robots, aerial robots-Fixed wing unmanned aerial vehicle, helicopters, Multi rotor UAV, Flapping wing/Bio inspired UAV, wheeled mobile robots, smarm robots, Legged robots, medical/healthcare robots-Surgical Robot, Exoskeleton robot, Rehabilitation robot, hospital robot, space robots, service robots, Underwater and floating robots, Military Robots.

10 Hours

Suggested List of Experiments

1. Experiments on:
   i. Linear and rotary displacement sensors
   ii. Proximity Sensors
   iii. Range Sensors-Ultrasonic, IR and laser range sensors
   iv. Force and Torque sensors
   v. Vision Sensors
2. Experiments on:
   i. Stepper motor controlled linear slide
   ii. Servo motor controlled linear slide
3. Experiments on sequence control using hydraulic and pneumatic circuits
4. Experiments on Quadcopter micro air vehicle
5. Experiments on 3D Homogeneous transformations using 3D Coordinate frame models
6. Experiments on Robot for demonstrating
   i. Pick and Place operation
   ii. Drawing Artwork
   iii. 3D Printing
   iv. Accept/Reject part based on output from machine vision system
7. Experiments on Differential Wheel Mobile robot
8. Experiments on Meccanum Wheel mobile robot

26 Hours

Course Outcomes: At the end of the course student will be able to

1.	Define, describe, and classify the different types of robots, and identify the different components of a robotic manipulator, such as links, joints, actuators, sensors, and controllers.
2.	Classify, select, and design end effectors for robots, and apply 3D homogeneous transformations to robot motion.
3.	Identify the different types of sensors and their applications, and use them to collect data for robotics applications
4.	Identify the different types of actuators and their applications and use them to control the motion of robots.
5.	Gain a comprehensive understanding of the diverse applications of robots, including industrial robots, aerial robots, wheeled mobile robots, legged robots, medical/healthcare robots, space robots, service robots, underwater and floating robots, and military robots, and their respective functions, advantages, and impact in various domains.

Course Outcomes Mapping with Program Outcomes & PSO

Program Outcomes→ ↓ Course Outcomes	1	2	3	4	5	6	7	8	9	10	11	12	PSO↓ 1	2	3
RI2006-1.1	3	1	-	-	-	-	-	-	-	-	-	-	2	-	1
RI2006-1.2	3	1	-	-	-	-	-	-	-	-	-	-	2	-	-
RI2006-1.3	3	1	-	-	-	-	-	-	-	-	-	-	2	1	-
RI2006-1.4	3	1	-	-	-	-	-	-	-	-	-	-	2	1	-
RI2006-1.5	2	1	-	-	-	-	-	-	-	-	-	-	2	-	2

1: Low 2: Medium 3: High

TEXTBOOKS:

1. ***"Robotics and Control"*** **R. K. Mittal, I. J. Nagrath**, Tata-McGraw-Hill Publications, 2007
2. ***"Robotics: Control, Sensing, Vision, Intelligence"*** **Fu K. S., Gonzelez R. C., Lee C. S. G.**, McGraw Hill Book Co., 2008

REFERENCE BOOKS

1. **"Advances in Rehabilitation Robotics", Z. Zenn BienDimitar Stefanov**, Springer Publications, Year-2004, ISBN: 978-3-540-44396-4.
2. **"Army of None: Autonomous Weapons and the Future of War", Paul Scharre**, Publisher: W. W. Norton & Company; 1st edition, Year- 2018, ISBN-978-0393608984.
3. **"Design of Dynamic Legged Robots", Sangbae Kim, Patrick M. Wensing**, Publisher: Now Foundations and Trends, Year-2017, ISBN: 9781680832570.
4. **"Introduction to Multicopter Design and Control", Quan Quan,** Springer Publications, Year-2017 ISBN: 978-981-10-3382-7.
5. **"Introduction to the Mechanics of Space Robots", Giancarlo Genta**, Springer Publications, Year-2012, ISBN: 978-94-007-3785-3.
6. **"Service Robots and Robotics: Design and Application", Marco Ceccarelli**, Published by Engineering Science Reference, Year-2012, ISBN: 9781466602915.
7. **"Small Unmanned Fixed-Wing Aircraft Design", Andrew J. Keane, András Sóbester, James P. Scanlan,** Wiley Publications Year-2017, ISBN:9781119406303.
8. **"Surgical Robotics: Systems Applications and Visions", Jacob Rosen, Blake Hannaford, Richard M. Satava,** Springer Publication, Year-2011, ISBN:978-1-4419-1126-1.
9. **"Swarm Robotics: A Formal Approach", Heiko Hamann,** Springer Publication, Year-2018, ISBN: 978-3-319-89279-5.
10. **"Underwater Robots Motion and Force Control of Vehicle-Manipulator Systems", Gianluca Antonelli,** Springer Publication, Year-2006, ISBN: 978-3-642-06859-1.
11. **"Wearable Exoskeleton Systems Design, control and applications", Shaoping Bai, Gurvinder S. Virk, Thomas G. Sugar,** Publisher: The Institution of Engineering and Technology, Year-2018, ISBN: 978-1785613029.
12. **"Wheeled Mobile Robotics: From Fundamentals Towards Autonomous Systems", Gregor Klancar , Andrej Zdesar, Saso Blazic, Igor Skrjanc,** Publisher: Butterworth-Heinemann, Year-2017, ISBN: 978-0128042045.

E Books / MOOCs/ NPTEL

1.	Introduction to Robotics https://ocw.mit.edu/courses/mechanical-engineering/2-12-introduction-to-robotics-fall-2005/syllabus/
2.	INTRODUCTION TO ROBOTICS https://nptel.ac.in/courses/107/106/107106090/
3.	Robotics Specialization https://www.coursera.org/specializations/robotics

Kinematics and Dynamics of Robot

Course Code:	**RI2007-1**	**Course Type:**	**IPCC**
Teaching Hours/Week (L: T: P: S):	**(3:0:2:0)**	**Credits:**	**04**
Total Teaching Hours:	**50**	**CIE + SEE Marks:**	**50+50**
Prerequisite	**CV 1001-1**		

Teaching Department: Robotics and Artificial Intelligence

Course Objectives:

1.	To study the direct kinematics solutions for the different robot configurations
2.	To study the Inverse kinematics solutions for the different robot configurations
3.	To study the Jacobian Matrix for the different robot configurations
4.	To identify the singular configurations for different robot configurations
5.	To study the dynamic equation of motion and trajectory planning of a robot

UNIT-I

Direct Kinematics and Inverse kinematics	**15 Hours**

Links joints and their parameters, Kinematic Modeling of the manipulator, Denavit – Hartenberg notation, Kinematic relationship between adjacent links, Manipulator transformation matrix, Problems, Manipulator workspace, Solvability of inverse kinematic model, Existence of solution, Multiple solutions, Solution technique, Closed form solution, Guidelines to obtain closed form solutions, Problems.

UNIT-II

Manipulator Differential Motion and Statics	**15 Hours**

Linear and angular velocity of rigid body, Linear velocity, Angular velocity, Linear velocity due to angular motion, Combined linear and angular motion, Relationship between transformation matrix and angular velocity, Mapping velocity vector, Velocity propagation of a link, Angular velocity of a link, Manipulator Jacobian, Jacobian computation, The prismatic joint Jacobian, The rotary joint Jacobian, Jacobian inverse, Jacobian singularity, Computation of singularities, Wrist singularities, Arm singularities and singular configurations.

UNIT-III

Robot Dynamics	**05 Hours**

Lagrangian mechanics, Two degree of freedom manipulator – dynamic model, Lagrange – Euler formulation, Velocity of a point on the manipulator, The inertia tensor, the kinetic energy, The potential energy, Equation of motion, The LE dynamic model algorithm, Derivation of Dynamic equation of motion for 2DOF robot configuration.

Robot Trajectory Planning and Control	**04 Hours**

Definitions and planning tasks, Terminology, joint space techniques, Use of a p- Degree polynomial as interpolation function, Cubical polynomial trajectories, Linear function with parabolic blends, Cartesian space techniques, A straight –line path, A circular path, Position path, Orientation path, Joint-space versus Cartesian space, trajectory planning, problems.

Suggested List of Experiments

1.	Experiments on direct kinematics using pipe models of 3R, SCARA, RPY robots
2.	Experiments on inverse kinematics using pipe models of 3R, SCARA, RPY robots
3.	Experiments on Linear joint Jacobian
4.	Experiments on Rotary joint Jacobian
5.	Experiments on Estimation of Jacobian for

	(a) 2R robot (b) 3R robot (c) RPY wrist
6.	Experiments on Robot Singularities for (a) 2R robot (b) 3R robot (c) RPY wrist
7.	Experiments on simulation of cubic polynomial trajectory
8.	Experiments on simulation of trapezoidal velocity trajectory
9.	Dynamic simulation of 2R robot

Course Outcomes: At the end of the course student will be able to

1.	Calculate the direct kinematic solution for a given robot configuration
2.	Calculate the inverse kinematic solution for given robot configuration
3.	Calculate the Jacobian matrix for the given robot configuration
4.	Identify the singular configurations for the given robot configuration
5.	Calculate the dynamic equation of motion and to perform the trajectory planning for the given robot configuration

Course Outcomes Mapping with Program Outcomes & PSO

Program Outcomes→	1	2	3	4	5	6	7	8	9	10	11	12	PSO↓		
↓ Course Outcomes													1	2	3
RI2007-1.1	3	2	1	1	1	-	-	-	-	-	-	-	3	2	-
RI2007-1.2	3	2	1	1	1	-	-	-	-	-	-	-	3	2	-
RI2007-1.3	3	2	1	1	1	-	-	-	-	-	-	-	3	2	-
RI2007-1.4	3	2	1	1	1	-	-	-	-	-	-	-	3	2	-
RI2007-1.5	3	3	2	1	1	-	-	-	-	-	-	-	3	2	-

1: Low 2: Medium 3: High

TEXTBOOKS:

1.	Robotics and Control, R K Mithal and I J Nagrath , McGraw Hill
2.	Fu, K., Gonzalez, R. and Lee, C. S. G., Robotics: Control, Sensing, Vision and Intelligence, McGraw- Hill, 2008
3.	Introduction to Robotic Analysis - Niku, S.B., Systems, Applications, Pearson Education, 2008.

REFERENCE BOOKS:

1.	Introduction to Robotics: Mechanics and Control- 2nd Edition - Craig, J. J., Addison-Welsey, 2nd Edition1989.
2.	Fundamentals of Robotics, Analysis and Control- Schilling R. J., PHI, 2006.

E Books / MOOCs/ NPTEL

1.	https://onlinecourses.nptel.ac.in/noc20_me53/preview
2.	https://www.classcentral.com/course/swayam-mechanics-and-control-of-robotic-manipulators-43637
3.	http://vlabs.iitkgp.ac.in/mr/#

Micro Aerial Robots

Course Code:	**RI2008-1**	**Course Type:**	**IPCC**
Teaching Hours/Week (L: T: P: S):	**(3:0:2:0)**	**Credits:**	**04**
Total Teaching Hours:	**50**	**CIE + SEE Marks:**	**50+50**
Prerequisite	**PH 1001-1, ME 1003-1**		

Teaching Department: Robotics and Artificial Intelligence

Course Objectives:

1.	Comprehend the basic aviation history and UAV systems.
2.	Acquire the knowledge of basic aerodynamics and performance.
3.	Understand the stability and control air vehicles
4.	Understand the propulsion, loads and structures.
5.	Develop and test the remote controlled, autonomous aerial vehicles

UNIT-I

The Air Vehicle	**06 Hours**

Introduction aviation history and overview of UAV systems, classes and missions of UAVs, definitions and terminology, UAV fundamentals, examples of UAV systems-very small, small, medium and large UAV

Basic Aerodynamics	**05 Hours**

Basic aerodynamics equations, aircraft polar, the real wing and airplane, induced drag, the boundary layer, flapping wings, total air-vehicle drag

Performance	**04 Hours**

Overview, climbing flight, range and endurance – for propeller-driven aircraft, range- a jet-driven aircraft, guiding flight.

UNIT-II

Stability and Control	**15 Hours**

Overview, stability, longitudinal, lateral, dynamic stability, aerodynamics control, pitch control, lateral control, autopilots, sensor, controller, actuator, airframe control, inner and outer loops, flight-control classification, overall modes of operation, sensors supporting the autopilot.

Propulsion overview, thrust generation, powered lift, sources of power, the two-cycle engine, the rotary engine, the gas turbine, electric motors, and sources of electrical power. Loads and structures loads, dynamic loads, materials, sandwich construction, skin or reinforcing materials, resin materials, core materials, construction techniques.

UNIT-III

Mission Planning and Control	**09 Hours**

Air vehicle and payload control, reconnaissance/surveillance payloads, weapon payloads, other payloads, data-link functions and attributes, data-link margin, data-rate reduction, launch systems, recovery systems, launch and recovery trade-offs.

Suggested List of Experiments

1.	Study on development and integration of Drones.
2.	Study on development and integration of Unmanned Aerial Systems.

3.	Integration and testing Remote Controlled Fixed Wing UAV
4.	Integration and testing Remote Controlled Vertical Take-off and Landing UAV
5.	Integration and testing Autonomous Fixed Wing UAV
6.	Integration and testing Autonomous Vertical Take-off and Landing UAV
7.	Integration and testing of Hybrid UAV
8.	Application of UAV in Remote sensing
9.	Application of UAV in Disaster management
10.	Image processing using Raspberry Pi for agricultural applications

Course Outcomes: At the end of the course student will be able to

1.	Explain the basic of aerodynamics performance and apply the basic concepts of UAV systems and experimentally study the integration of drones.
2.	Explain the stability and control required for UAV and Select the propulsion system, materials for structures. Experimental studies on disaster management.
3.	Develop and test the remote controlled autonomous aerial vehicles. Experimental study on remote controlled and autonomous UAV.
4.	Design air vehicles for different payloads and design standards. Experimental study on autonomous and remote-controlled Vertical Take-off and Landing UAV
5.	Develop and test the rotary wing, fixed wing aerial vehicles. Experimental study on Unmanned aerial vehicles and fixed wing UAV.

Course Outcomes Mapping with Program Outcomes & PSO

Program Outcomes→	1	2	3	4	5	6	7	8	9	10	11	12	PSO↓		
↓ Course Outcomes													1	2	3
RI2008-1.1	2	2	3	2	2	-	-	-	-	-	-	2	2	-	2
RI2008-1.2	2	2	3	2	2	-	-	-	-	-	-	2	2	-	2
RI2008-1.3	2	2	3	2	2	-	-	-	-	-	-	2	2	-	2
RI2008-1.4	2	2	3	2	2	-	-	-	-	-	-	2	2	-	2
RI2008-1.5	2	2	3	2	2	-	-	-	-	-	-	2	2	-	2

1: Low 2: Medium 3: High

TEXTBOOKS:

1.	Paul Gerin Fahlstrom, Thomas James Gleason, Introduction to UAV Systems, Wiley Publication, 4th Edition,2012.
2.	Landen Rosen, Unmanned Aerial Vehicle, Alpha Editions

REFERENCE BOOKS:

1.	Unmanned Aerial Vehicles: DOD's Acquisition, Alpha Editions
2.	Valavanis, Kimon P, Unmanned Aerial Vehicles, Springer, 2011
3.	Valavanis, K., Vachtsevanos, George J, Handbook of Unmanned Aerial Vehicles, Springer, 2015.

E Books / MOOCs/ NPTEL

1.	https://onlinecourses.nptel.ac.in/noc22_me38/preview

Professional Core Courses (Theory)

Artificial Intelligence and Machine Learning

Course Code:	**RI2101-1**	**Course Type:**	**PCC**
Teaching Hours/Week (L: T: P: S):	**(2:2:0:0)**	**Credits:**	**03**
Total Teaching Hours:	**40**	**CIE + SEE Marks:**	**50+50**
Prerequisite	**CS1001-1**		

Teaching Department: Robotics and Artificial Intelligence

Course Objectives:

1.	Understand the basics of Artificial Intelligence. Explain what is involved in learning models from data.
2.	Familiarize with the concepts of informed and uninformed search strategies and Heuristic functions
3.	Demonstrate the application of linear regression and logistic regression for real world problems. Explain the design and implement algorithms for supervised learning
4.	Explain construct basic unsupervised learning algorithms
5.	To explain the concepts of Uncertainty, probability, Bayes rule and interference using full joint distributions

UNIT-I

Introduction to Artificial Intelligence	**06 Hours**
History, need, applications, advantages and limitations. what is artificial intelligence? why we need ml? difference between ai and ml, difference between ml and dl, different ml algorithms	
Foundations for ML	**05 Hours**
Fundamentals and application of machine learning, understanding data, types of machine learning: supervised, unsupervised, reinforcement learning, theory of learning: feasibility of learning, error and noise, training versus testing, theory of generalization, bias and variance, learning curve	
Intelligent Agents	**05 Hours**
Agents and environment, structure of agents, solving problems: problem solving agents, uninformed search strategies, informed search strategies, heuristic functions.	

UNIT-II

Probabilistic reasoning	**10 Hours**
Representing knowledge in uncertain domain, Semantics of Bayesian networks, Relational and first order probability models	
Learning from examples	**04 Hours**
Forms of learning, Learning Decision trees, the theory of learning, Regression and classification with linear models, Nonparametric models.	

UNIT-III

Machine Learning	**05 Hours**
Introduction to Artificial neural network, Network architectures, Learning Clustering: Introduction, K-means, Hierarchical clustering	
Theory of learning: feasibility of learning, error and noise, training versus testing, theory of generalization, bias and variance, learning curve.	**05 Hours**
Support Vector Machines and Kernel methods - Introduction, statistical learning theory, soft vs hard SVMs, optimal hyperplane for linearly separable and non-separable patterns.	

Course Outcomes: At the end of the course student will be able to

1.	Explain about Artificial Intelligence, identify its relationship with Machine learning, Deep Learning and foundation of ML
2.	Describe the working of Linear Regression models and Multiple Linear Regression models
3.	Explain Probability theory and Ensembles methods
4.	Explain decision tree modelling and different clustering methods
5.	Know the fundamental concept of neural network techniques and learning algorithms

Course Outcomes Mapping with Program Outcomes & PSO

Program Outcomes→	1	2	3	4	5	6	7	8	9	10	11	12	PSO↓		
↓ Course Outcomes													1	2	3
RI2101-1.1	3	2	2	1	2	-	-	-	-	-	-	-	2	2	2
RI2101-1.2	3	2	2	1	2	-	-	-	-	-	-	-	2	2	2
RI2101-1.3	2	2	2	1	2	-	-	-	-	-	-	-	2	2	2
RI2101-1.4	2	2	2	1	2	-	-	-	-	-	-	-	2	2	2
RI2101-1.5	2	2	2	1	2	-	-	-	-	-	-	-	2	2	2

1: Low 2: Medium 3: High

TEXTBOOKS:

1.	Stuart Russel and Peter Norvig, "Artificial Intelligence A Modern Approach", Pearson 3rd Edition, 2016
2.	Tom. M. Mitche, "Machine Learning", McGraw Higher Ed, 1st edition 2013.
3.	Understanding Machine Learning – from Theory to Algorithms by Shai Shalev-Shwartz and Shai Ben-David, Cambridge University Press, 2014, ISBN978-1-107-05713-5 Hardback
4.	Neural Networks – A comprehensive Foundation, Simon Haykin, Pearson Prentice Hall, Second Edition, 2005, ISBN 81 – 7808 -300 – 0

REFERENCE BOOKS:

1.	DAN W PATTERSON," Introduction to Artificial Intelligence and Expert Systems", PEARSON, 1st edition 2015.
2.	Elaine Rich, "Artificial Intelligence", Mc Graw Hill 3rd Edition, 2017.
3.	Er. Rajiv Chopra, "Artificial Intelligence – A practical approach", Chand publication, 1st edition 2012

E Books / MOOCs/ NPTEL

1.	https://onlinecourses.nptel.ac.in/noc21_cs42/preview
2.	https://nptel.ac.in/courses/106/105/106105152/
3.	https://nptel.ac.in/courses/106/105/106105079/
4.	https://nptel.ac.in/courses/112/103/112103280/
5.	https://nptel.ac.in/courses/106/105/106105078/
6.	https://onlinecourses.nptel.ac.in/noc21_ge20/preview
7.	http://vlabs.iitb.ac.in/vlabs-dev/labs/machine_learning/labs/index.php

Control Engineering

Course Code:	**RI2102-1**	**Course Type**	**PCC**
Teaching Hours/Week (L: T: P: S)	**2:2:0:0**	**Credits**	**03**
Total Teaching Hours	**40**	**CIE + SEE Marks**	**50+50**
Prerequisite	**EC1001-1, EE1001-1**		

Teaching Department: Robotics and Artificial Intelligence

Course Objectives:

1.	Understand the basic concept of control Engineering and to obtain mathematical model and transfer function of control system.
2.	Obtain overall transfer of the system by reduction algebra and signal flow graph.
3.	Obtain the response equation of control system.
4.	Understand the concept of stability and obtain the stability of system using Nyquist and Bode methods.
5.	Obtain the system gain for stability by root locus plot and to understand the basic concept of control action.

UNIT-I

Modelling of Systems and Block diagram — **07 Hours**

Introduction to Control Systems, Types of Control Systems, with examples. Concept of mathematical modelling of physical systems- Mechanical, Translational (Mechanical accelerometer, systems excluded), and Rotational systems. Introduction to Block diagram algebra, block diagram reduction. Numerical problems on all topics.

Design of Control Systems — **05 Hours**

Introduction, Design with the PD Controller, Design with the PI Controller, Design with the PID Controller, Design with Phase-Lead Controller, Design with Phase - Lag Controller, Design with Lead-Lag Controller

Signal Flow graph — **04 Hours**

Introduction to Signal Flow graph, Mason's gain formula. Obtaining Transfer functions for the given SFG using Mason's gain formula.

UNIT-II

Time response analysis: — **06 Hours**

Introduction. Standard test signals, response of first order & second order systems for unit step input. Steady state errors & Error constants. Numerical problems on all topics.

Concepts of stability — **04 Hours**

The Concept of stability. Necessary conditions for stability. Routh Hurwitz stability criterion. Relative stability analysis using RH Criterion.

Frequency domain Analysis — **04 Hours**

Polar and rectangular plots for the frequency response, Nyquist stability criterion, stability analysis. Phase and gain margin. Bode diagrams: Stability analysis using Bode diagrams.

UNIT-III

The Root Locus Technique — **05 Hours**

Introduction. Root locus concepts. Construction of root loci. Stability analysis using Root locus Technique Numerical problems on all topics.

State space Analysis	**05 Hours**
Concept of state, state variables and state model. State diagrams and State models for Linear continuous-time systems (Electrical systems): State space representation using Physical and Phase variables. Derivation of transfer functions from the state model. Numerical problems on all topics.	

Course Outcomes: At the end of the course student will be able to

1.	Illustrate open loop and closed loop control systems real life examples. Develop the mathematical model and transfer function of mechanical, electrical, hydraulic, and thermal systems by applying the knowledge of mathematics and physics.
2.	Reduce the block diagram to open loop form using block diagram reduction algebra and signal flow graph (Mason's gain formula) in order to calculate overall transfer function of the system.
3.	Develop the time response of 1st and 2nd order systems for unit step input. Calculate parameters of 2nd order under damped system response. Describe stability concept of control system and also Analyse the stability of the control system using R-H criterion.
4.	Analyse the stability of the control system using Nyquist criterion and Bode plot.
5.	Analyse the parameters related to stability of control systems using root locus plot. Describe the different types of control actions in control systems.

Course Outcomes Mapping with Program Outcomes & PSO

Program Outcomes→	1	2	3	4	5	6	7	8	9	10	11	12	PSO↓		
↓ Course Outcomes															
RI2102-1.1	3	3	2	2	2	-	-	-	-	-	-	2	2	-	2
RI2102-1.2	3	3	2	2	2	-	-	-	-	-	-	2	2	-	2
RI2102-1.3	3	3	2	2	2	-	-	-	-	-	-	2	2	-	2
RI2102-1.4	3	3	2	2	2	-	-	-	-	-	-	2	2	-	2
RI2102-1.5	3	3	2	2	2	-	-	-	-	-	-	2	2	-	2

1: Low 2: Medium 3: High

TEXTBOOKS:

1.	Katsuhiko Ogata (2004) " Modern Control Engineering" Prentice Hall of India Ltd., New Delhi
2.	I. J. Nagarath and M. Gopal,(2002) "Control system" New Age International Publisher
3.	Harrison H.L. and Bollinger J.G. (1968) "Automatic controls", 2PndP edition, International Text Book Co. U.S.A.

REFERENCE BOOKS:

1.	Gopal M (2005) " Modern Control Systems", New Age International Publisher
2.	Benjamin.Kuo.C. (1995) "Automatic Control Systems", EEE, 7PthP Edition Prentice Hall of India Ltd. New Delhi
3.	Appukuttan K. K. Control Engineering, Oxford university publication, 2009

E Books / MOOCs/ NPTEL

1.	http://nptel.ac.in/courses/108101037/
2.	Virtual Lab link- http://vlabs.iitkgp.ernet.in/rcs/
3.	https://www.mathworks.com/solutions/control-systems.html

Data Structures and Algorithms

Course Code:	**RI2105-1**	**Course Type**	**PCC**

Teaching Hours/Week (L: T: P: S)	**3:0:0:0**	**Credits**	**03**
Total Teaching Hours	**40**	**CIE + SEE Marks**	**50+50**
Prerequisite	**CS1001-1**		

Teaching Department: Robotics & AI Engineering

Course Objectives:

1.	Explain fundamentals of data structures and their applications essential for programming/problem solving.
2.	Illustrate linear representation of data structures: Stack, Queues, Lists and Trees.
3.	Demonstrate sorting and searching algorithms.
4.	Find suitable data structure during application development/Problem Solving
5.	Apply Algorithm for solving problems like sorting, searching, insertion and deletion of data

UNIT – I

Introduction: Data Structure, Classification (Primitive and non-primitive), data structure operations. Pointers: Definition and Concepts, Array of pointers, Structure and pointers

Linear Data Structures – Stacks: Introduction and Definition, Representation of stack: Array and structure representation of stacks, Operations on stacks.

Applications of Stack: Conversion of Expressions, Evaluation of expressions.

Linear Data Structures – Queues: Introduction and Definition Representation of Queue: Array representation of queues.

Linear Data Structures - **Singly Linked lists:** Dynamic Memory allocation functions. Definition and concepts singly linked List: Representation of link list in memory, Operations on singly Linked List. Linked List representation of stack and queues.

15 Hours

UNIT – II

Linear Data Structures - Doubly Linked lists: Doubly Linked List: Representation and Operations.

Nonlinear Data Structures - Basic Terminologies, Binary Trees: Properties, Representation of Binary Tree: Linear representation, Linked representation, Operations on Binary Tree: Insertion, Simple Deletion, Traversals, Binary search trees. Understanding and representing graphs using adjacency matrix and linked list.

INTRODUCTION TO ALGORITHMS: Fundamentals of Algorithmic Problem Solving,

FUNDAMENTALS OF THE ALGORITHMS EFFICIENCY: Analysis Framework, Asymptotic Notations and Basic Efficiency Classes, Mathematical Analysis of Non-recursive and Recursive Algorithms.

Sorting and Searching Algorithms: Selection Sort, Bubble sort, Merge Sort, Quick sort, Linear Search and Binary Search. **15 Hours**

UNIT – III

DECREASE & CONQUER: Concept of Decrease and Conquer, Graph traversal algorithms - Depth First Search, Breadth First Search.

DYNAMIC PROGRAMMING: Concept of Dynamic Programming, Computing a Binomial Coefficient.

GREEDY METHOD: Concept of Greedy technique, Prims algorithm.

BACKTRACKING: Concept of Backtracking technique, N-Queens problem. **10 Hours**

Course Outcomes: At the end of the course student will be able to

1.	Acquire the fundamental knowledge of various types of data structures and pointers

2.	Apply the fundamental programming knowledge of data structures to analyze and design linear data structures, namely, stack, queue, singly linked list and doubly linked list and use them for solving problems.
3.	Implement and apply the concept of binary trees and graph data structures and also understand their traversals.
4.	Analyze non-recursive and recursive algorithms and to represent in terms of standard Asymptotic notations.
5.	Apply Divide and Conquer, Decrease and Conquer, Dynamic programming, Greedy, and Backtracking algorithm design techniques to solve real time problems.

Course Outcomes Mapping with Program Outcomes & PSO

Program Outcomes→	1	2	3	4	5	6	7	8	9	10	11	12	PSO↓		
↓ Course Outcomes													1	2	3
RI2105-1.1	3	2	1	-	-	-	-	-	-	-	-	1	-	2	1
RI2105-1.2	3	1	2	-	-	-	-	-	-	-	-	1	-	2	1
RI2105-1.3	3	2	2	-	-	-	-	-	-	-	-	1	-	2	1
RI2105-1.4	3	2	3	-	-	-	-	-	-	-	-	1	-	2	1
RI2105-1.5	3	1	3	-	-	-	-	-	-	-	-	1	-	2	1

1: Low 2: Medium 3: High

TEXTBOOKS:

1.	**"Data Structures using C"**, **Aaron M. Tenenbaum, Yedidyah Langsam & Moshe J. Augenstein** Pearson Education/PHI 2006
2.	**"Introduction to the Design & Analysis of Algorithms", Anany Levitin** , 2nd Edition, Pearson Education, 2007.

REFERENCE BOOKS:

1.	**"Fundamentals of Data Structures in C", Ellis Horowitz and Sartaj Sahni**, Universities Press Second edition, 2014.
2.	**"Introduction to Algorithms"**, **Thomas H. Cormen, Charles E.Leiserson, Ronal L. Rivest, Clifford Stein**, 2nd Edition, PHI, 2006.
3.	**"Data Structures", Seymour Lipschutz**, McGraw Hill Revised 1st edition, 2014.

E Books / MOOCs/ NPTEL

1.	Data Structures and Algorithms Specialization https://www.coursera.org/specializations/data-structures-algorithms
2.	Data Structures and Algorithms https://nptel.ac.in/courses/106/102/106102064/
3.	Programming, Data Structures and Algorithms, https://nptel.ac.in/courses/106/106/106106127

E Books / MOOCs/ NPTEL

1.	Data Structures https://cse01-iiith.vlabs.ac.in/List%20of%20experiments.html
2.	http://vlabs.iitb.ac.in/vlabs-dev/labs/mit_bootcamp/dslab/labs/index.php

Drive Systems for Robot

Course Code:	**RI2106-1**	**Course Type:**	**PCC**
Teaching Hours/Week (L: T: P: S):	**3:0:2:0**	**Credits:**	**03**
Total Teaching Hours:	**40**	**CIE + SEE Marks:**	**50+50**
Prerequisite	**EE 1001-1**		

Teaching Department: Robotics & AI Engineering

Course Objectives:

1.	Understand the principles of fluid power and hydraulic pumps, including Pascal's Law and pumping theory.
2.	Gain knowledge of hydraulic actuators and control components, including cylinders, motors, and valves.
3.	Learn about pneumatic circuits and systems, including air properties, compressor design,
4.	Learn about and electro-pneumatic logic circuits.
5.	Understand the working principles of electrical drives such as servo drives, harmonic drives, compact drives and variable frequency drives and their applications.

UNIT – I

FLUID POWER PRINICIPLES AND HYDRAULIC PUMPS

Introduction to Fluid power – Advantages and Applications, Basics of Hydraulics – Pascal's Law – Principles of flow -Friction loss – Work, Power and Torque Problems, Sources of Hydraulic power: Pumping Theory– Pump Classification – Construction, Working, Design, Advantages, Disadvantages, Performance, Selection criteria of pumps – Problems.

07 Hours

PROGRAMMABLE LOGIC CONTROLLER: Introduction to PLC's, basic structure, Principle of operation, Programming and concept of ladder diagram, concept of latching of a PLC. Logic gates using PLC. PLC based electro pneumatic circuits.

03 Hours

UNIT – II

HYDRAULIC ACTUATORS AND CONTROL COMPONENTS

Hydraulic Actuators: Cylinders – Types and construction, Application, Hydraulic cushioning – Hydraulic motors - Control Components: Direction Control, Flow control and pressure control valves – Types, Construction and Operation – Servo and Proportional valves – Applications – Accessories: Reservoirs, Pressure Switches – Applications – Fluid Power ANSI Symbols – Problems. **04 Hours**

PNEUMATIC CIRCUITS AND SYSTEMS

Properties of air – Perfect Gas Laws – Compressor – Filters, Regulator, Lubricator, Muffler, Air control Valves, Quick Exhaust Valves, Pneumatic actuators, Design of Pneumatic circuit – Cascade method – Electro Pneumatic System – Elements – Ladder diagram – Problems, electro pneumatic logic circuits. **06 Hours**

UNIT – III

Electrical Drives: Working principle of Servo Drives, Harmonic Drives, compact drives and Variable frequency drives and its applications.

06 Hours

List of Experiments: **14 Hours**

1.	A furnace door is opened and closed by a double-acting cylinder. The cylinder is activated by a 4/2-way valve with spring return. This ensures that the door opens

	only as long as the valve is actuated. When the valve actuating lever is released, the door closes again.
2.	The cover of a hardening furnace is to be raised by a single-acting cylinder. The cylinder is activated by a 3/2-way valve. A 9 kg weight is attached to the cylinder to represent the load. Measure and calculate the following values: 1. Travel pressure, load pressure, resistances and back pressure 2. Advance-stroke time and speed
3.	Design pneumatic circuit to a sorting device for metal stampings. Through operation of the push button on the actuating valve, metal stampings lying in random positions are sorted out and transferred to a second conveyor belt. The forward motion of the piston rod of a single acting cylinder (1A) takes t = 0.4 seconds. When the push button is released, the piston rod travels to the retracted end position. A pressure gauge is fitted before and after the one-way flow control valve.
4.	A double-acting cylinder (1A) guides cylinder pins towards a measuring device. The pins are separated by means of a continuous to and fro movement. The oscillating motion can be started by means of a valve with selector switch. The duration of the forward stroke of the cylinder is to be t_1 = 0.6 seconds, the return stroke t_3 = 0.4 seconds. The cylinder is to remain in the forward end position for t_2 = 1.0 seconds, resulting in a cycle time of t_4 = 2.0 seconds.
5.	Design a circuit using the cascade system to operate two cylinders (A and B) which, on the operation of a start valve, produces the sequence A + B + B – A-. The cylinders should park in the positions B - A + when the start switch is in the 'off' position.
6.	A sorting device is used to sort heavy steel workpieces. When a START pushbutton is pressed, the piston rod of a double-acting cylinder pushes the adjacent workpiece off the conveyor belt.When the START pushbutton is released, the piston rod returns to its retracted end position.
7.	A double-acting hydraulic cylinder is used to open and close a furnace door. INCHING operation allows the door to be driven to any desired intermediate position. The cylinder is hydraulically clamped in all such positions.
8.	Using a rotary indexing table plastic containers are to be separated in linear sequence. By pressing a pushbutton switch the oscillating piston rod of a cylinder drives the rotary table in sequence via a pawl. When the pushbutton is pressed again, this drive is switched off.
9.	Using a diverting device parts are to be removed from one conveyor track onto another in linear sequence. By pressing a pushbutton switch the oscillating piston rod of a cylinder pushes the turntable via a pawl in stepped sequence. The parts are diverted and transported onwards in the opposite direction. By pressing another pushbutton switch the drive unit is switched off.
10.	Using a transfer station blocks are to be transferred from a magazine to a processing station. The blocks are pushed out of the magazine by cylinder 1A and transferred to the processing station by cylinder 2A. The piston rod of cylinder 2A may only return when the piston rod of cylinder 1A has reached the retracted end position. The magazine is monitored by means of a limit switch. If there are no more blocks in the magazine, it is not possible to start the cycle. This is indicated by means of an audible signal. The control is to be operated in single cycle.
11.	A stamping device can be operated from three sides. A workpiece is inserted via a guide, whereby it touches two of the three proximity swit- ches B1, B2 and B3. This

	causes a pneumatic cylinder 1.0 to extend via a solenoid valve (coil Y1), whereby a recess is to be stamped into the workpiece The stamping cycle is to be triggered only if two signal generators are addressed. For reasons of safety the cylinder must be prevented from advancing, if all three proximity sensors are contacted
12.	Cylinder A extends and brings a job under the stamping cylinder B. Cylinder B then extends and stamps the job. Cylinder A can return only after cylinder B has retracted fully. An electro-pneumatic control circuit has to be developed for realizing the control task.

Course Outcomes: At the end of the course student will be able to

1.	Comprehend the fundamentals of fluid power and hydraulic pumps, including the application of Pascal's Law and pump theory.
2.	Acquire knowledge of hydraulic actuators and control components such as cylinders, motors, and various types of valves.
3.	Understand pneumatic circuits and systems, including air properties, compressor design, and electro-pneumatic circuits.
4.	Develop skills in designing pneumatic circuits using cascade methodology and electro-pneumatic system components.
5.	Learn the operational principles of electrical drives including servo drives, harmonic drives, compact drives and variable frequency drives and their applications.

Course Outcomes Mapping with Program Outcomes & PSO

Program Outcomes→	1	2	3	4	5	6	7	8	9	10	11	12	PSO↓		
↓ Course Outcomes													1	2	3
RI2106-1.1	3	2	1	-	-	-	-	-	-	-	-	1	-	2	1
RI2106-1.2	3	1	2	-	-	-	-	-	-	-	-	1	-	2	1
RI2106-1.3	3	2	2	-	-	-	-	-	-	-	-	1	-	2	1
RI2106-1.4	3	2	3	-	-	-	-	-	-	-	-	1	-	2	1
RI2106-1.5	3	1	3	-	-	-	-	-	-	-	-	1	-	2	1

1: Low 2: Medium 3: High

TEXTBOOKS:

1.	Anthony Esposito, "Fluid Power with Applications", Pearson Education 2005.
2.	Majumdar S.R., "Oil Hydraulics Systems- Principles and Maintenance", Tata McGraw-Hill, 2001.

REFERENCE BOOKS:

3.	Anthony Lal, "Oil hydraulics in the service of industry", Allied publishers, 1982.
4.	Dudelyt, A. Pease and John T. Pippenger, "Basic Fluid Power", Prentice Hall, 1987.
5.	Majumdar S.R., "Pneumatic systems – Principles and maintenance", Tata McGraw Hill, 1995
6.	Michael J, Prinches and Ashby J. G, "Power Hydraulics", Prentice Hall, 1989.
7.	Shanmuga sundaram.K, "Hydraulic and Pneumatic controls", Chand & Co, 2006.

E Books / MOOCs/ NPTEL

1.	https://onlinecourses.nptel.ac.in/noc21_me51/preview
2.	https://www.coursera.org/lecture/fluid-power/hydraulics-and-pneumatics-SD8dv

Microcontroller and Its Application

Course Code:	**RI2109-1**	**Course Type:**	**PCC**
Teaching Hours/Week (L: T: P: S):	**3:0:0:0**	**Credits:**	**03**
Total Teaching Hours:	**39+0+0**	**CIE + SEE Marks:**	**50+50**
Prerequisite	**CS1001-1, EC1001-1**		

Teaching Department: Robotics and AI

Course Objectives:

1.	Identify the architecture of 8 bit Microcontroller.
2.	Develop application using 8051 Interrupts, Timers/Counters and IO port.
3.	Understand ARM architecture.

UNIT-I

Introduction to 8 bit Microcontroller	**07 Hours**
8051 Architecture, Memory organization, addressing modes, Basic instructions format	
Instruction set and Programming	**08 Hours**
Data transfer group, Arithmetic group, logical group, control transfer group, 8051 Assembly Language programs, Machine Cycles, Delay programs	

UNIT-II

Microcontroller Peripheral Modules	**06 Hours**
Programming 8051 I/O port, I/O interfacing examples using C programs (LED, Switch and Seven segment LED using multiplexing technique)	
Timers/Counters and serial communication	**05 Hours**
8051 Timers/Counters in Mode1 & Mode 2, Timer Programming examples using C, Serial Communication, Example C programs on serial communication, I2C and SPI communication protocols	
Interrupts	**04 Hours**
External Interrupts, timer interrupts and serial communication interrupts with example programs.	

UNIT-III

Introduction to ARM processor	**09 Hours**
ARM architecture, Application specific classification of ARM family, Pipeline, programming model, memory organization, processor modes, Instruction encoding format, data processing and arithmetic and branch instructions, call or exceptions in ARM	

Course Outcomes: At the end of the course student will be able to

1.	Describe the architecture and write the assembly language program with relevant instruction set for 8051 microcontroller.
2.	Develop applications using embedded C program with IO Ports, Timers, Serial communication and Interrupts of microcontroller.
3.	Interface different sensors and actuator modules and develop API using embedded C program for any microcontroller
4.	Describe the architecture of ARM processor and instruction formats.
5.	Analyze the working of instruction execution in ARM processor.

Course Outcomes Mapping with Program Outcomes & PSO

Program Outcomes→	1	2	3	4	5	6	7	8	9	10	11	12	PSO↓		
↓ Course Outcomes															
RI2109-1.1	3														
RI2109-1.2	3														
RI2109-1.3	3														
RI2109-1.4	3														
RI2109-1.5	3														

1: Low 2: Medium 3: High

TEXTBOOKS:

1. The 8051 Microcontroller and Embedded Systems – using assembly and C, Muhammad Ali Mazidi and Janice Gillespie Mazidi and Rollin D. McKinlay; PHI, 2006 / Pearson, 2006.
2. Steve Furber, "ARM System Architecture", Edison Wesley Longman 1996

REFERENCE BOOKS:

1. The 8051 Microcontroller, Kenneth J. Ayala, 3rd Edition, Thomson/Cengage Learning.
2. William Hohl, ARM Assembly Language – Fundamentals and Techniques", CRC Press , 2009

E Books / MOOCs/ NPTEL

1. **http://nptel.ac.in/courses/106108100/**
2. http://nptel.ac.in/courses/108107029/

Smart Mobile Robots			
Course Code:	**RI2111-1**	**Course Type:**	**PCC**
Teaching Hours/Week (L: T: P: S):	**(2:0:2:J)**	**Credits:**	**03**
Total Teaching Hours:	**40**	**CIE + SEE Marks:**	**50+50**
Prerequisite	**EC 1001-1 ME 1003-1**		

Course Learning Objectives:

This Course will enable students to:

1. Introduce students to the fundamental concepts of mobile robotics, including various types of mobile robots, their key components, locomotion systems, and wheel configurations.
2. Teach students how to develop kinematic models for holonomic and nonholonomic mobile robots and understand their implications on robot motion and control.
3. Provide students with a thorough understanding of mobile robot dynamics, focusing on Lagrange-Euler and Newton-Euler methods, and instruct them on how to create computer-based dynamic simulations for wheeled mobile robots.
4. Equip students with the skills necessary to implement localization and mapping techniques, such as SLAM and EKF SLAM, and utilize various sensor technologies to enhance mobile robot navigation capabilities.
5. Enable students to apply mobile robot navigation competences, including path planning methods, graph construction and search algorithms, and obstacle avoidance techniques, in order to design and implement effective autonomous navigation strategies for mobile robots.

Unit I

Introduction: Introduction to mobile robots and mobile manipulators. Components of a mobile robot. Types of mobile robots.

Locomotion: Introduction, Key issues for locomotion, Types of land-based mobile robots, wheeled locomotion case studies.

Mobile Robot Kinematics: Introduction, Need of mathematical model, degree of freedom. Differential Kinematics: Representing robot position, forward differential kinematics, Inverse differential kinematics, Degree of manoeuvrability, Types of wheels for mobile robots. Kinematic simulation of a mobile robot. A generalized wheel model, Examples: Differential wheel drive mobile robot, Skid steering wheel drive mobile robot, Omni wheel drive mobile robot, Mecanum wheel drive mobile robot, Tricycle wheel drive mobile robot.

Types of Mobile Robots based on Wheel configuration: Holonomic and non-holonomic systems, kinematic model, Pseudo Inverse.

15 Hours

Unit II

Dynamics of mobile robot: Introduction to Mobile robot dynamics, Equations of Motion, Lagrange-Euler Formulation, Derivation of Mobile robot dynamic relation, Dynamic Models for differential drive robot, skid steering drive robot, Omni wheel drive robot, Mecanum wheel robot, tricycle wheel drive robot.

Perception: Sensors for Mobile Robots, Sensor classification, characterizing sensor performance, Wheel/motor sensors, Heading sensors, Ground-based beacons, Active ranging, Motion/speed sensors, Vision-based sensors.

Mobile Robots – Localisation and Mapping: Autonomy for Robots, Building Blocks of Navigation, Challenges of Localization, Noise and Aliasing, Mobile robot localisation: Odometry, Dead reckoning, Map based localisation, Markov Localisation, Kalman Filter. Autonomous map building: SLAM, EKF SLAM. **15 Hours**

Unit-III

Mobile Robot Navigation: Competences for Navigation, Path Planning Methods, Graph Construction: Visibility graph, Voronoi diagram, Cell decomposition methods. Graph Search Methods and Algorithms: Deterministic Graph Search, Breadth-first search, Depth-first search, Grass fire, Dijkstra's algorithm. Path Planning- A* Algorithm and Potential Field methods. Obstacle Avoidance: Bug Algorithm.

10 Hours

List of Simulation Experiments:

Kinematic simulation and motion animation of a land based mobile robot using a MATLAB

- simulation of mobile robot using MATLAB a general model
- simulation of Deferential wheel drive mobile robot using MATLAB
- simulation of Skid steering wheel drive mobile robot using MATLAB
- simulation of an Omni directional wheel drive mobile robot using MATLAB
- simulation of Mecanum wheel drive mobile robot using MATLAB

05 Hours

List of practical experiments

- Introduction to ESP-32
  - Different ways to program it (Embedded C, micro python) comparison.
  - Simple blinking program with using
    - Analogue write
    - LEDC write (Including parameters such as resolution, frequency)
  - Controlling a motor
    - Circuit connection and Explanation.
    - Calculation for Duty cycle.
    - Effect of Duty cycle on the motor.
    - Effect of frequency on the motor.
  - Communication using ESP32
  - Controlling of Wheeled Mobile Robot of different wheel types using ESP32
- Differential wheel mobile robot using RC control
- Mecanum wheel mobile robot using RC control

10 Hours

Course Outcomes: At the end of the course student will be able to

1.	Develop a comprehensive understanding of the different types of mobile robots and their key components, including locomotion systems and wheel configurations.
2.	Build kinematic models of holonomic and nonholonomic mobile robots
3.	Apply and analyze the principles of mobile robot dynamics to design and develop efficient computer-based dynamic simulations of various wheeled mobile robots, accounting for their motion and control.
4.	Acquire skills in implementing localization and mapping techniques for mobile robots, including SLAM and EKF SLAM, and apply various sensor technologies for robot perception to enhance navigation capabilities.

5.	Apply mobile robot navigation competences, including path planning methods, graph construction and search algorithms, and obstacle avoidance techniques, to effectively design and implement autonomous navigation strategies for mobile robots.

Program Outcomes→	1	2	3	4	5	6	7	8	9	10	11	12	PSO↓		
↓ Course Outcomes													1	2	3
RI2111-1.1	3	2	1	-	-	-	-	-	-	-	-	1	2	1	1
RI2111-1.2	3	2	1	-	-	-	-	-	-	-	-	1	3	1	1
RI2111-1.3	3	2	1	-	1	-	-	-	-	-	-	1	3	2	2
RI2111-1.4	3	2	1	-	1	-	-	-	-	-	-	1	2	2	2
RI2111-1.5	3	2	1	-	1	-	-	-	-	-	-	1	2	2	2

1: Low 2: Medium 3: High

TEXTBOOKS:

1. R Siegwart, IR Nourbakhsh, D Scaramuzza, Introduction to Autonomous Mobile Robots, MIT Press, USA, 2011.
2. SG Tzafestas, Introduction to Mobile Robot Control, Elsevier, USA, 2014.
3. A Kelly, Mobile Robotics: Mathematics, Models, and Methods, Cambridge University Press, USA, 2013.
4. S Thrun, W Burgard, D Fox, Probabilistic Robotics, MIT Press, USA, 2005.
5. G Dudek, M Jenkin, Computational Principles of Mobile Robotics, Cambridge University Press, USA, 2010.

Web links and Video Lectures (e-Resources):

https://onlinecourses.nptel.ac.in/noc22_me38/preview

Professional Core Courses (Lab)

AI and ML Lab

Course Code:	**RI2601-1**	**Course Type:**	**PCC Lab**
Teaching Hours/Week (L: T: P: S):	**0:0:2:0**	**Credits:**	**01**
Total Teaching Hours:	**15**	**CIE + SEE Marks:**	**50+50**
Prerequisite	**CS1001-1**		

Teaching Department: Robotics and Artificial Intelligence

Course Objectives:

1.	Make use of Data sets in implementing the machine learning algorithms
2.	Implement the machine learning concepts and algorithms in any suitable language of choice
3.	Apply metrics and evaluate the models built.

List of Experiments

1.	Introduction to Pandas, dataframes and other libraries of Python
2.	Implement and Demonstrate Depth First Search Algorithm on any AI problem.
3.	Implement and Demonstrate Best First Search Algorithm on any AI problem.
4.	Implement and demonstrate the FIND-S algorithm for finding the most specific hypothesis based on a given set of training data samples. Read the training data from a .CSV file.
5.	Write a program to implement k-Nearest Neighbor algorithm to classify the iris data set. Print the output predictions.
6.	Write a program to construct a Bayesian network considering medical data. Use this model to demonstrate the diagnosis of heart patients using the standard Heart Disease Data Set.
7.	Demonstrate the working of SVM classifier for a suitable data set
8.	Demonstrate the working of the Random Forest algorithm. Use an appropriate data set for building and apply this knowledge to classify a new sample.
9.	Experiment on anomaly detection
10.	Experiment on identifying sound sources.
11.	Experiments on AI Autonomous cars in different track arenas

Course Outcomes: At the end of the course student will be able to

1.	Make use of Data sets in implementing the machine learning algorithms
2.	Implement the machine learning concepts and algorithms in any suitable language of choice
3.	Use metrics and evaluate the models built.

Course Outcomes Mapping with Program Outcomes & PSO

Program Outcomes→	1	2	3	4	5	6	7	8	9	10	11	12	**PSO↓**		
↓ Course Outcomes													1	2	3
RI2601-1.1	3	3	2	3	3	-	-	-	-	-	-	3	3	3	3
RI2601-1.2	3	3	2	3	3	-	-	-	-	-	-	3	3	3	3
RI2601-1.3	3	3	2	3	3	-	-	-	-	-	-	3	3	3	3

1: Low 2: Medium 3: High

REFERENCE BOOKS:

1.	Stuart Russel and Peter Norvig, "Artificial Intelligence A Modern Approach", Pearson 3rd Edition, 2016
2.	Tom. M. Mitche, "Machine Learning", McGraw Higher Ed, 1st edition 2013.
3.	Understanding Machine Learning – from Theory to Algorithms by Shai Shalev-Shwartz and Shai Ben-David, Cambridge University Press, 2014, ISBN978-1-107-05713-5 Hardback
4.	Neural Networks – A comprehensive Foundation, Simon Haykin, Pearson Prentice Hall, Second Edition, 2005, ISBN 81 – 7808 -300 – 0

Control Engineering Lab

Course Code:	**RI2602-1**	**Course Type:**	**PCC Lab**
Teaching Hours/Week (L: T: P: S):	**0:0:2:0**	**Credits:**	**01**
Total Teaching Hours:	**15**	**CIE + SEE Marks:**	**50+50**
Prerequisite	**EC1001-1, EE1001-1**		

Teaching Department: Robotics and Artificial Intelligence

Course Objectives:

1.	To determine the time and frequency domain reposes of a given second order system using software package or discrete components.
2.	To design and analyze Lead, Lag and Lag – Lead compensators for given specifications.
3.	To draw the performance characteristics of ac and DC servomotors and synchro-transmitter receiver pair.
4.	To study the DC position & feedback control system and to study the effect of P, PI, PD and PID controller and Lead compensator on the step response of the system.
5.	To write a script file to plot root locus, bode plot, to study the stability of the system

List of Experiments

1.	Speed control Experiments a) Speed control of DC motor b) Speed control of AC motor c) Speed control of Stepper motor d) Speed control of BLDC motor
2.	Experiment to determine frequency response of a second order system a) To design a passive RC lead compensating network for the given specifications, viz, the maximum phase lead and the frequency at which it occurs and to obtain the frequency response. b) To design a passive RC lag compensating network for the given specifications, viz, the maximum phase lag and the frequency at which it occurs and to obtain the frequency response. c) To determine experimentally the transfer function of the lag compensating network
3.	To study a second order system and verify the effect of (a) P, (b) PI, (c) PD and (d) PID controller on the step response.
4.	To simulate a typical second order system and determine step response and evaluate time response specifications. To evaluate the effect of adding poles and zeros on time response of second order system. To evaluate the effect of pole location on stability
5.	To examine the relationship between open-loop frequency response and stability, open-loop frequency and closed loop transient response
6.	To study the effect of open loop poles and zeros on root locus contour Comparative study of Bode, Nyquist and root locus with respect to stability.
7.	To simulate a D.C. Position control system and obtain its step response.
8.	To verify the effect of input waveform, loop gain and system type on steady state errors.
9.	Inverted Pendulum control Experiment

10.	Experiments on Height and orientation control of a Quadcopter

Course Outcomes: At the end of the course student will be able to

1.	Utilize software package and discrete components in assessing the time and frequency domain response of a given second order system.
2.	Determine the performance characteristics of AC and DC motors used in control systems.
3.	Simulate the DC position and feedback control system to study the effect of P, PI, PD and PID controllerand Lead compensator on the step response of the system.
4.	Develop script files to plot Root locus, Bode plot and Nyquist plot to study the stability of control system.
5.	Stabilization and control of the unstable inverted pendulum system with a close-loop control system and Design a Controller for Quadcopter height and orientation

Course Outcomes Mapping with Program Outcomes & PSO

Program Outcomes→	1	2	3	4	5	6	7	8	9	10	11	12	PSO↓		
↓ Course Outcomes															
RI2602-1.1	3	3	2	2	2	-	-	-	-	-	-	2	2	-	2
RI2602-1.2	3	3	2	2	2	-	-	-	-	-	-	2	2	-	2
RI2602-1.3	3	3	2	2	2	-	-	-	-	-	-	2	2	-	2
RI2602-1.4	3	3	2	2	2	-	-	-	-	-	-	2	2	-	2
RI2602-1.5	3	3	2	2	2	-	-	-	-	-	-	2	2	-	2

1: Low 2: Medium 3: High

REFERENCE BOOKS:

1.	Katsuhiko Ogata (2004) " Modern Control Engineering" Prentice Hall of India Ltd., New Delhi
2.	I. J. Nagarath and M. Gopal,(2002) "Control system" New Age International Publisher
3.	Harrison H.L. and Bollinger J.G. (1968) "Automatic controls", 2PndP edition, Interna¬tional Text Book Co. U.S.A.
4.	Gopal M (2005) " Modern Control Systems", New Age International Publisher
5.	Benjamin.Kuo.C. (1995) "Automatic Control Systems", EEE, 7PthP Edition Prentice Hall of India Ltd. New Delhi
6.	Appukuttan K. K. Control Engineering, Oxford university publication, 2009

Data Structures and Algorithms Lab

Course Code:	**RI2603-1**	**Course Type**	**PCC Lab**
Teaching Hours/Week (L: T: P: S)	**0:0:2:0**	**Credits**	**01**
Total Teaching Hours	**25**	**CIE + SEE Marks**	**50+50**
Prerequisite	**CS1001-1**		

Teaching Department: Robotics & AI Engineering

Course Objectives:

1.	Linear data structures and their applications such as stacks, queues and lists
2.	Non-Linear data structures and their applications such as trees
3.	Sorting and searching algorithms
4.	Basic algorithm implementations
5.	Implementation of DFS, BFS traversals of a graph and Prims algorithm

List of Experiments

1	Pointer implementations using arrays and structures
2	Stack implementation using arrays
3	Queue implementation arrays
4	Evaluation of arithmetic expression using stacks
5	Tower of Hanoi problem using recursion.
6	Singly Linked list implementation.
7	Dynamic implementation of stack data structure (linked list).
8	Dynamic implementation of queue data structure (linked list).
9	Binary Tree Construction and Tree traversal operations.
10	Implementation of quick sort and merge sort algorithms (with calculation of time)
11	Implement Linear search and Binary Search algorithms to search an element in a given array. (with calculation of time)
12	Construction of Binary Search Tree and postfix expression tree.
13	Implement N-Queens problem using Backtracking technique.
14	Implementation of DFS and BFS traversals of a graph
15	Implementation of Prims algorithm

Course Outcomes: At the end of the course student will be able to

1.	Design and Implement various linear data structures and nonlinear data structures like linked list and its different types by applying basic programming concepts.
2.	Implement different types of algorithms and analyse their efficiency

Course Outcomes Mapping with Program Outcomes & PSO

Program Outcomes→	1	2	3	4	5	6	7	8	9	10	11	12	**PSO↓**	
↓ Course Outcomes													1	2
RI2603-1.1	3	2	-	3	3	-	-	-	-	-	-	1	-	3
RI2603-1.2	3	1	-	3	3	-	-	-	-	-	-	1	-	3

1: Low 2: Medium 3: High

E Resources

1.	Data Structures https://cse01-iiith.vlabs.ac.in/

Microcontroller Lab

Course Code:	**RI2604-1**	**Course Type**	**PCC Lab**
Teaching Hours/Week (L: T: P: S)	**0:0:2:0**	**Credits**	**01**
Total Teaching Hours	**25**	**CIE + SEE Marks**	**50+50**
Prerequisite	**CS1001-1, EC1001-1**		

Teaching Department: Robotics & AI Engineering

Course Objectives:

1.	Introduce the instruction set of 8051 microcontrollers
2.	Write program for interface display UNITs
3.	Write program to interface signal processing UNITs
4.	Write program to interface motor control UNITs
5.	Write program to interfacing serial communication

List of Experiments

1.	Data Transfer - Block move, Exchange- Assembly Language
2.	Arithmetic Instructions - Addition/subtraction, multiplication and division , Number conversion – Assembly language
3.	LED, Seven Segment and Switch interface – Embedded C programming
4.	DC Motor speed control using PWM – Embedded C Programming
5.	Interfacing linear actuator using stepper motor – Embedded C Programming
6.	Servo motor interface – Embedded C Programming
7.	Interfacing Robotic ARM with X-Y-Z axis motion – Embedded C Programming
8.	Interfacing Solenoid valve using relay – Embedded C Programming
9.	External ADC and Temperature control interface to 8051.
10.	Generate different waveforms Sine, Square, Triangular, Ramp etc. using DAC interface to 8051; change the frequency and amplitude.
11.	Stepper motor control interface to 8051.
12.	DC motor control interface to 8051.

Course Outcomes: At the end of the course student will be able to

1.	Use instruction set to solve logical problems
2.	Develop embedded C coding to interface LED, Seven segment and LCD, embedded C coding to interface ADC and DAC
3.	Develop embedded C coding to interface stepper motor and DC motor control and Develop embedded C coding to demonstrate serial communication

Course Outcomes Mapping with Program Outcomes & PSO

Program Outcomes→	1	2	3	4	5	6	7	8	9	10	11	12	**PSO↓**		
↓ Course Outcomes													1	2	3
RI2604-1.1	3	2	1	-	-	-	-	-	-	-	-	1	2	1	2
RI2604-1.2	3	2	1	-	-	-	-	-	-	-	-	1	2	2	2
RI2604-1.3	3	2	1	-	-	-	-	-	-	-	-	1	2	2	2

1: Low 2: Medium 3: High

REFERENCE BOOKS:

1. Laboratory Manual for **MICROCONTROLLER LABORATORY** http://vlabs.iitb.ac.in/vlabs-dev/labs/8051-Microcontroller-Lab/labs/index.php

Robot Programming and Simulation Lab

Course Code:	**RI2605-1**	**Course Type:**	**PCC Lab**
Teaching Hours/Week (L: T: P: S):	**0:0:2:0**	**Credits:**	**01**
Total Teaching Hours:	**15**	**CIE + SEE Marks:**	**50+50**
Prerequisite	**CS1001-1**		

Teaching Department: Robotics & AI Engineering

Course Objectives:

1.	Understand the features of Dobot Magician and Dobot Studio Software
2.	Understand the concept of RAPID Programming
3.	Understand the hardware configuration and abilities of ABB IRB 1600 Robot
4.	Understand the features of COGNIX camera and its application

List of Experiments

1.	Experiment on pick and place operation using DOBOT Magician (mini robot) Using Suction Cup and b) Using Pneumatic Gripper
2.	Experiment to perform different operations using DOBOT Magician (mini robot) (a) Sorting operation (b) Stacking operation (c) Palletising operation
3.	Experiment to Write and Draw with pen tool using DOBOT Magician (mini robot)
4.	Demonstration of 3D Printing an object using DOBOT magician (mini robot)
5.	Software simulation in Robot Studio Software: Introduction to Robot Studio, Programming concepts, Libraries, geometries, and CAD files.
6.	Introduction to RAPID programming: - Basics of RAPID Programming, Loops, Rules and recommendations for RAPID syntax. RAPID robot functionality: Instructions, I/O signals, RAPID Programming Structure: Rapid Procedure, Modules, Data with Multiple Values: Arrays, Composite Data types
7.	Simulation to perform pick and place operation of an object in Robot Studio Software
8.	Simulation to perform conveyor tracking and palletizing operation in Robot Studio Software
9.	Simulation to perform sorting operation of an object in Robot Studio Software
10.	Introduction to COGNEX Camera: basics of COGNEX camera, introduction to camera programming using insight explorer software.
11.	ABB IRB 1600 robot: Introduction to ABB robot, IRC5 single cabinet controller, teach pendent, hardware connection diagrams, end effectors,
12.	Demonstration of ABB IRB 1600 robot: Pick and place operation using two jaw gripper, three jaw gripper and suction cup. Welding operation.
13.	Demonstration of RAPID programming in teach pendant and execution of the same using ABB robot.

Course Outcomes: At the end of the course student will be able to

1.	Develop ABB program for executing any defined task

2.	Perform process automation using involved with Robots

Course Outcomes Mapping with Program Outcomes & PSO

Program Outcomes→	1	2	3	4	5	6	7	8	9	10	11	12	**PSO↓**		
↓ Course Outcomes													1	2	3
RI2605-1.1	3	2	-	3	3	-	-	-	-	-	-	1	-	3	2
RI2605-1.2	3	1	-	3	3	-	-	-	-	-	-	1	-	3	2

1: Low 2: Medium 3: High

REFERENCE BOOKS:

1. ROBOTICS Product specification IRB 1600/1660,ABB Robots

2. ABB Robotics Operating Manual Robotstudio

Program Specific Ability Enhancement Courses (AEC)

INNOVATIONS AND DESIGN THINKING

Course Code:	**ME1654-2**	**Course Type**	**AEC**
Teaching Hours/Week (L: T: P: S)	**1:0:0:0**	**Credits**	**01**
Total Teaching Hours	**15+0+0+0**	**CIE + SEE Marks**	**50+50**

Teaching Department: Robotics and Artificial Intelligence

Course Objectives:

1.	To explain the concept of design thinking for product and service development
2.	To explain the fundamental concept of innovation and design thinking
3.	To discuss the methods of implementing design thinking in the real world.

UNIT-I

Design Thinking — **03 Hours**

Understanding Design Thinking:
Shared model in team-based design – Theory and practice in Design thinking – Explore the presentation.
Tools for Design Thinking:
Real-Time design interaction capture and analysis – Empathy for design
Teaching-Learning Process:
Introduction about the design thinking: Chalk and Talk method
Theory and practice through presentation
Case studies on design thinking for real-time interaction and analysis

UNIT-II

Design Thinking for Strategic Innovations — **05 Hours**

Design Thinking in IT
Design Thinking to Business Process modeling – Scenario-based Prototyping

Design Thinking for Strategic Innovations
Growth – Storytelling representation – Strategic Foresight - Change – Sense Making – Maintenance - Relevance – Value redefinition - Extreme Competition – experience design - Standardization – Humanization - Creative Culture – Rapid prototyping, Strategy and Organization – Business Model design.

Teaching-Learning Process
Case studies on design thinking and business acceptance of the design
Business model examples of successful designs

UNIT-III

Design Thinking Workshop — **07 Hours**

Design Thinking Workshop Empathize, Design, Ideate, Prototype and Test

Teaching-Learning Process
Presentation by the students on the success of Live project on design thinking in a group of 4 students

Course Outcomes: At the end of the course student will be able to

1.	Explain various design process procedure
2.	Generate and develop design ideas through different techniques
3.	Explain the significance of Design Thinking to Understand products

Course Outcomes Mapping with Program Outcomes & PSO

Program Outcomes→	1	2	3	4	5	6	7	8	9	10	11	12	**PSO↓**		
↓ Course Outcomes													1	2	3
ME1013-1.1	2	-	2	-	-	-	-	-	-	-	-	-			
ME1013-1.2	-	-		-	-	-	2	2	-	-	-	-			
ME1013-1.3	-	-		-	-	-	-	-	-	3	3	-			

1: Low 2: Medium 3: High

TEXTBOOKS:

1.	John.R.Karsnitz, Stephen O'Brien and John P. Hutchinson, "Engineering Design", Cengage learning (International edition) Second Edition, 2013.
2.	Roger Martin, "The Design of Business: Why Design Thinking is the Next Competitive Advantage", Harvard Business Press , 2009.
3.	Hasso Plattner, Christoph Meinel and Larry Leifer (eds), "Design Thinking: Understand – Improve– Apply", Springer, 2011.
4.	Idris Mootee, "Design Thinking for Strategic Innovation: What They Can't Teach You at Business or Design School", John Wiley & Sons 2013.
5.	Yousef Haik and Tamer M.Shahin, "Engineering Design Process", Cengage Learning, Second Edition, 2011.
6.	Jeanne Liedtka, Andrew King and Kevin Bennett, "Solving Problems with Design Thinking - Ten Stories of What Works", Columbia Business School Publishing, Sep 2013.

E Books / MOOCs/ NPTEL

1.	www.tutor2u.net/business/presentations/. /productlifecycle/default.html
2.	https://docs.oracle.com/cd/E11108_02/otn/pdf/. /E11087_01.pdf
3.	www.bizfilings.com › Home › Marketing › Product Developmen
4.	https://www.mindtools.com/brainstm.html
5.	https://www.quicksprout.com/. /how-to-reverse-engineer-your-competit
6.	www.vertabelo.com/blog/documentation/reverse-engineering
7.	https://support.microsoft.com/en-us/kb/273814
8.	https://support.google.com/docs/answer/179740?hl=en
9.	https://www.youtube.com/watch?v=2mjSDIBaUlM
10.	thevirtualinstructor.com/foreshortening.html
11.	https://dschool.stanford.edu/.../designresources/.../ModeGuideBOOTCAMP2010L.pdf
12.	https://dschool.stanford.edu/use-our-methods/ 6. https://www.interactiondesign.org/literature/article/5-stages-in-the-design-thinking-process 7.
13.	http://www.creativityatwork.com/design-thinking-strategy-for-innovation/ 49 8.
14.	https://www.nngroup.com/articles/design-thinking/ 9.
15.	https://designthinkingforeducators.com/design-thinking/ 10.

Research Methodology

Course Code	**RI1659-1**	**Course Type**	**AEC**
Teaching Hours/Week (L: T: P: S)	**2:0:0:0**	**Credits**	**02**
Total Teaching Hours	**25**	**CIE + SEE Marks**	**50+50**
Prerequisite	**HU 1001-1, MA 1001-1, MA 1003-1**		

Teaching Department: Robotics & AI

Course Objectives:

1.	Explain the importance of research methodology, Explain the steps in defining the research problem.
2.	Explain methods of reviewing the literature and research design.
3.	Discuss the methods of designing sampling survey. Discuss methods of scaling and measuring of the data.
4.	Perform Hypothesis testing using the concept of mean and variance.
5.	Discuss interpretation and report writing techniques.

Unit-1

Research Methodology: Introduction, Meaning of Research, Objectives of Research, Types of Research, Research Approaches, Significance of Research, Research and Scientific Method, Research Process
Defining the Research Problem: Research Problem, Selecting the Problem
Reviewing the literature: Place of the literature review in research, Bringing clarity and focus to research problem
Research Design: Meaning of Research Design, Need for Research Design, Features of a Good Design -
10 hours

Unit-2

Design of Sample Surveys: Design of Sampling: Introduction, Sample Design, Sampling and Non-sampling Errors,
Data Collection: Introduction, Experimental and Surveys, Collection of Primary Data, Collection of Secondary, Data, Selection of Appropriate Method for Data Collection, Case Study Method.
Testing of Hypotheses: Hypothesis, Basic Concepts Concerning Testing of Hypotheses, -
7 hours

Unit-3

Interpretation and Report Writing: Meaning of Interpretation, Technique of Interpretation, Precaution in Interpretation, Significance of Report Writing, Different Steps in Writing Report, Layout of the Research Report, Types of Reports, Oral Presentation, Mechanics of Writing a Research Report, Precautions for Writing Research Reports. – **8 hours**

Course Outcomes: At the end of the course student will be able to

1.	Explain the importance of research methodology, Explain the steps in defining the research problem.
2.	Explain methods of reviewing the literature and research design.
3.	Discuss the methods of designing sampling survey.
4.	Perform Hypothesis testing using the concept of mean and variance
5.	Discuss interpretation and report writing techniques.

Course Outcomes Mapping with Program Outcomes & PSO

Program Outcomes→	1	2	3	4	5	6	7	8	9	10	11	12	**PSO↓**		
↓ Course Outcomes													1	2	3
RI1653-1.1	3	2								3					1
RI1653-1.2	3	2								3					1
RI1653-1.3	3	2								3					1
RI1653-1.4	3	2								3					1
RI1653-1.5	3	2								3					1

1: Low 2: Medium 3: High

REFERENCE MATERIALS:

1.	Research Methodology: Methods and Techniques, C.R. Kothari, Gaurav Garg, New Age International 4th Edition, 2018
2.	Research Methodology a step-by step guide for beginners. (For the topic Reviewing the literature under Unit 2), Ranjit Kumar, SAGE Publications Ltd . 3rd Edition, 2011
3.	Research Methods: the concise knowledge base Trochim Atomic Dog Publishing 2005
4.	Conducting Research Literature Reviews: From the Internet to Paper Fink A Sage Publications, 2009

E Resources

1.	NPTEL course material related to operations management, operations research and entrepreneurship

SOCIAL CONNECT AND RESPONSIBILITY

Course Code:	**HU1007-1**	**Course Type:**	**AEC**
Teaching Hours/Week (L: T: P: S):	**1:0:0:0**	**Credits:**	**01**
Total Teaching Hours:	**15**	**CIE + SEE Marks:**	**50+50**

Teaching Department: Respective Department

Course Objectives:

1.	Understand Rural Society
2.	Acquire the knowledge about Rural Economy
3.	Know the working of rural administration
4.	Familiarize the different rural schemes of Governance

UNIT-I

Appreciation of Rural Society	**3 Hours**

Rural Society, Caste and Gender relations, Rural values, Nature and Resources, Rural infrastructure.

Understanding Rural Economy & Livelihood	**3 Hours**

Agriculture, Farming, Landownership, Water Management, Animal Husbandry, Non-Farm Livelihoods And Artisans, Rural Entrepreneurs.

UNIT-II

Rural Institutions	**3 Hours**

Traditional Rural Organizations, Self-help Groups, Panchayat Raj Institutions - Gram Sabha, Gram Panchayat, Standing Committees

Rural Development Programmes	**3 Hours**

History of Rural Development in India, Current National Programmes - Sarva Shiksha Abhiyaan, Beti Bachao – Beti Padhao, Ayushmaan Bharath, Swachh Bharath, PM Awaas Yojana, Skill India, Decentralised Planning, NRLM, MNREGA

UNIT-III

Corporate Social Responsibility (CSR)	**3 Hours**

Global Guidelines on CSR, Growing Importance of CSR, CSR in India

Course Outcomes: At the end of the course student will be able to

1.	Comprehend Rural Society and its Economy
2.	Identify the working of Rural Administration and different rural schemes
3.	Grasp the working of Corporate Social Responsibility

Course Outcomes Mapping with Program Outcomes & PSO

Program Outcomes→	1	2	3	4	5	6	7	8	9	10	11	12	**PSO↓**	
↓ Course Outcomes													1	2
HU1007-1.1	-	-	-	-	-	-	-	-	-	-	2	3	-	-
HU1007-1.2	-	-	-	-	-	-	-	-	-	-	2	3	-	-
HU1007-1.3	-	-	-	-	-	-	-	-	-	-	2	3	-	-

1: Low 2: Medium 3: High
REFERENCES:
UGC., "Unnat Bharat Abhiyan", 2020
Agarwal, S.K., "Corporate Social Responsibility in India", SAGE Publication, 2008.
Unnat Bharat Abhiyan. (n.d.). Unnat Bharat Abhiyan Brochure. Retrieved from https://unnatbharatabhiyan.gov.in/app/webroot/files/brochure.pdf

EMPLOYABILITY SKILL DEVELOPMENT

Course Code:	**UM1003-1**	**Course Type**	**AEC**
Teaching Hours/Week (L: T: P: S)	**1:0:0:0**	**Credits**	**00**
Total Teaching Hours	**15+0+0+0**	**CIE + SEE Marks**	**50+00**

Teaching Department: Robotics and Artificial Intelligence

Course Objectives:

1.	To explain the students the necessity of clearing the aptitude tests irrespective of the written test is for jobs or higher education.
2.	To assess the readiness of the students to appear for the aptitude test and assisting them to better it if already ready, else train them.
3.	To evaluate the understanding of the students in answering quantitative multiple-choice questions and guide them to improve it.
4.	To evaluate the preparedness of the students to answer the analytical and logical questions.
5.	To evaluate the quality of the students with regard to their professional language grammar, vocabulary and communication skills.

UNIT-I

Quantitative	**06 Hours**
Numbers (Odd, even, H.C.F & L.C.M, Square roots & cube roots, Average, Percentage), Ratios & Proportions, Partnership, Time & work, Pipes & Cistern, Speed, Problems on trains, Problems on boats & streams, Allegation & Mixtures.	

UNIT-II

Analytical/ Logical	**06 Hours**
Numerical logic (next number in series, odd man out), Coded language, Syllogism, Direction (N-E-W-S), Seating arrangement, Blood relations, Statement & Conclusion	

UNIT-III

Verbal	**03 Hours**
Vocabulary (root words, prefix, suffix, synonyms, antonyms), One word substitution, Idiom/phrases, Sentence completion, Active & Passive voice, Direct and indirect speech.	

Course Outcomes: At the end of the course student will be able to

1.	Answer the quantitative multiple-choice questions.
2.	Analyse the analytical and logical questions.

3.	Improve the professional language grammar, vocabulary and communication skills.
4.	Clear the aptitude tests of any employer or higher educational institution.
5.	Advance in the chosen field of interest by appending aptitude skills with the technical skills

Course Outcomes Mapping with Program Outcomes & PSO

Program Outcomes→	1	2	3	4	5	6	7	8	9	10	11	12	**PSO↓**		
↓ Course Outcomes													1	2	3
UM1003-1.1	3	3	-	-	-	-	-	-	2	2	1	-			
UM1003-1.2	3	3	-	-	-	-	-	-	2	2	1	-			
UM1003-1.3	3	3	2	-	-	-	-	-	2	2	1	-			
UM1003-1.4	3	3	2	-	-	-	-	-	2	2	1	-			
UM1003-1.5	3	3	2	-	-	-	-	-	2	2	1	-			

1: Low 2: Medium 3: High

TEXTBOOKS:

1.	Aggarwal R.S, "Quantitative Aptitude for Competitive Examinations", S Chand Publishing.
2.	Aggarwal R.S, "A modern approach to verbal and non-verbal reasoning", S Chand Publishing.

REFERENCE BOOKS:

1.	Bharath Patodi and Aditya Choudhary, "Verbal Ability & Comprehension", Disha Publication, Second edition, 2015.
2.	Shakuntala Devi, "Joy of numbers", Orient Black Swan.
3.	Shakuntala Devi, "More puzzles to puzzle you", Orient Black Swan.

E Books / MOOCs/ NPTEL

1.	https://www.indiabix.com
2.	https://www.faceprep.in

LIFE SKILLS FOR ENGINEERS			
Course Code:	**HU1008-1**	**Course Type:**	**AEC**
Teaching Hours/Week (L: T: P: S):	**1:0:0:0**	**Credits:**	**01**
Total Teaching Hours:	**15**	**CIE + SEE Marks:**	**50+50**
Teaching Department: Respective Department			

Course Objectives:

1.	Understand Time Management, Managing Information Overload, Coping with Peer pressure and Stress Management
2.	Familiarize the Science behind Personal Health Management and Addictions
3.	Appreciate the importance of cultivating good hobbies, need for forming good habits and discarding bad habits and holding difficult conversations during crises
4.	Comprehend the importance of Creative Thinking, Continuous and Lifelong Learning, Collaboration and Team Work
5.	Equip them to excel in real work environment proactively

UNIT-I

Introduction to Life Skills	**3 Hours**
Meaning and Importance of Life Skills, Competitive Job market, Fast paced changes in Technology, Proliferation of Electronic Gadgets and harmful online content. **Time Management** Introduction to Time Management, Impulsive Behaviour vis-a-vis goal Directive Behaviour, Time log, Information Overload and coping with Information & Communication Technology (ICT) Revolution; Proliferation of Electronic Media; Exponential growth in online content; Impact of Information Overload on human brain	
Science behind Personal Health Management	**3 Hours**
Ignorance in Society on health issues, World Health Organization (WHO) - Definition of Health, Human Evolution, Importance of physical work for human body & mind, Dangers of sedentary lifestyle, Germ diseases versus Lifestyle diseases, Integrating physical exercise into daily life **Science behind Addictions** Addiction - Meaning, Neurology and Hormonal basics of Addictive Behaviour, How addictions are formed; Harmful effects of addictions on Physical and Mental Health, Recognizing addictions in oneself, Coming out of addictions	

UNIT-II

Need for cultivating good hobbies	**3 Hours**
Need for Hobbies in maintaining Work-Life Balance; how hobbies help in maintaining good physical and mental health, Various Hobbies	

Habits

Difference between hobbies & habits, Cultivating good habits & discarding bad habits: Role of habits for a successful life, How habits form; Analyzing one's own habits; Recognizing useless & harmful habits, Cultivating & Sustaining useful habits

Peer pressure and How to cope with it — **3 Hours**

Human being as a Social Animal, Physical Pain & Social Pain; Awareness of Harmful Social Pressure, Role of Prefrontal Cortex in Judgement and Decision Making, why teenagers are vulnerable to peer pressure, strategies to overcome harmful peer pressure

Stress Management

Stress, Types of Stress, Fight & Flight Response of Humans; Harmful effects of chronic stress; Symptoms of Poor Coping Skills of Stress, Stress & Psychiatric problems, Easy coping strategies for stress

UNIT-III

Continuous & Lifelong Learning — **3 Hours**

Accelerated change in Technology Landscape, Shorter Life Cycles of Technologies, Need for Continuous Learning of other skills

Team Working Skills & Collaboration

Team Work – Meaning, Skills and Relevance, Importance of Collaboration to succeed in one's own career, How to be a good team member

Course Outcomes: At the end of the course student will be able to

1.	Apply the concept of Time Management, cope with Information Overload and withstand harmful peer pressure
2.	Comprehend the need to stay away from addictions by realizing the biological basis behind these concepts
3.	Develop good hobbies to maintain ideal work-life balance
4.	Develop the aptitude for finding creative solutions to problems and realize the importance of continuous and lifelong learning
5.	Demonstrate positive and progressive abilities

Course Outcomes Mapping with Program Outcomes & PSO

Program Outcomes→	1	2	3	4	5	6	7	8	9	10	11	12	**PSO↓**	
↓ Course Outcomes													1	2
HU1008-1.1	-	-	-	-	-	-	-	-	-	2	1	3	-	-
HU1008-1.2	-	-	-	-	-	-	-	-	-	3	2	3	-	-
HU1008-1.3	-	-	-	-	-	-	-	-	-	3	1	3	-	-
HU1008-1.4	-	-	-	-	-	-	-	-	2	2	1	2	-	-
HU1008-1.5	-	-	-	-	-	-	-	-	1	2	1	2	-	-

1: Low 2: Medium 3: High

REFERENCES:

1. Lieberman, D.E., "The Story of the Human Body", Pantheon Books, 2013.
2. Ratey, J.J., "Spark. Little Brown Spark", 2013.
3. De Bono, E., "Creative Thinking", Penguin UK, 2016.
4. Pachter, B., "The Power of Positive Confrontation", Da Capo Lifelong Books, 1999.
5. Duhigg, C., "The Power of Habit", Random House Trade Paperbacks, 2012.

6.	Sharma, S., & Mishra, B., "Communication Skills for Engineers and Scientists", PHI Learning, 2009.
7.	Tracy, B., "Time Management", AMACOM, 2014.

Vocational Education Courses (VEC)

Motion Control Using PLC

Course Code:	**RI2551-1**	**Course Type**	**VEC**
Teaching Hours/Week (L: T: P: S)	**2:0:0:0**	**Credits**	**02**
Total Teaching Hours	**25**	**CIE + SEE Marks**	**50+50**
Prerequisite	**EE 1001-1, EC 1001-1**		

Teaching Department: Robotics and Artificial Intelligence

Course Objectives:

1.	To control Stepper motor with PLC program and DC motor with PLC program
2.	To control AC motor with PLC program and To understand HMI programing and interfacing.

UNIT-I

Stepper Motor Control using PLC — **05 Hours**

Understanding the construction and lead identification of stepper motors, rating checking stepper motor driver selection and connection.

DC Motor Control using PLC — **05 Hours**

construction and working of a DC motor, meaning of pulse width modulation, understanding relationship between duty cycle and speed of the motor. Establishing a relationship between duty cycle and speed experimentally.

AC Motor Control using PLC — **05 Hours**

Construction and working of AC induction motors, its different types and interfacing AC motors and PLC.

UNIT-II

HMI programming and Interfacing — **05 Hours**

Need for human machine interfacing, creation of an interface for controlling an industrial machine linking of control switches and data registers to the ladder instruction through HMI tools.

Mini Project — **05 Hours**

Application of PLC control and HMI to and actual machine, testing the correctness of the instruction, and reiterating after improvements.

Course Outcomes: At the end of the course student will be able to

1.	Control of Stepper motor, DC motor, AC motor with PLC
2.	Operate various devices using HMI through programing and interfacing, Interface PLC circuit, write programs in PLC to control motion in different motors and use HMI for easier operations of machines.

Course Outcomes Mapping with Program Outcomes & PSO

Program Outcomes→	1	2	3	4	5	6	7	8	9	10	11	12	**PSO↓**		
↓ Course Outcomes													1	2	3
RI2551-1.1	1	2	1	-	-	-	-	-	-	-	-	1	3	3	3
RI2551-1.2	2	2	1	-	-	-	-	-	-	-	-	1	3	3	3

1: Low 2: Medium 3: High

TEXTBOOKS:

1.	Control of electrical machines by S.K.Bhattacharya Birjindersingh, New Age International.
2.	Robotics and Industrial Automation by R.K. Rajput, S. CHAND PUBLISHING.
3.	Introduction to PLC by Gary Dunning, Cengage Learning.
4.	PLC, Principles and Applications by John W. Webb and Ronald A. Reis
Web links and Video Lectures (e-Resources):	
1.	https://www.udemy.com/course/siemens-s71200-motion-control-training/ https://www.udemy.com/course/plc-programming-100/

METROLOGY & MEASUREMENTS

Course Code:	**RI2552-1**	**Course Type**	**VEC**
Teaching Hours/Week (L: T: P: S)	**3:0:0:0**	**Credits**	**03**
Total Teaching Hours	**39**	**CIE + SEE Marks**	**50+50**
Prerequisite	**ME 1003-1**		

Teaching Department: Robotics & AI

Course Objectives:

1.	Appreciate various standards of measurements, their classification and various terms related to measurements.
2.	Appreciate working principle, construction, and use of different comparators and angle measuring instruments.
3.	Appreciate important parameters of screw threads and gears and their measurement designing of fits according to IS: 919-1963 and design gauges to inspect the fits.
4.	Explain the generalized measurement system and various elements used in different stages.
5.	Explain the principle, operation and characteristics of different measuring instruments used for the measurement of different physical parameters.

UNIT-I

Standards of measurement:	**08 Hours**
Definition and Objectives of metrology. Standards of length - International prototype meter, Imperial standard yard, Wave length standard, subdivision of standards, line and end standard. Calibration of end bars. Slip gauges, wringing phenomena, Indian Standards (M-81, M-112), and numerical problems on building of slip gauges. Errors in Measurements	
Comparators:	**09 Hours**
Introduction to Comparators, Classification and Characteristics of comparators. Principles of mechanical, optical, electrical & electronic and pneumatic comparators. Working of Sigma, Zeiss, LVDT and Solex comparators.	

UNIT-II

System of limits, Fits, Tolerances and gauging	**08 Hours**
Definition of tolerance and its Specification in assembly, concept of limits of size and tolerances, compound tolerances, accumulation of tolerances, definition of fits, types of fits and their designation (IS 919 -1963,). Principle of inter changeability and selective assembly, hole basis system and shaft basis of system. Design of clearance, transition and interference fit. Design of gauges.	
Measurement systems:	**06 Hours**
Generalized measurement system. Definition and concept of accuracy, precision, calibration, threshold, sensitivity, repeatability, linearity. Hysteresis and loading effect. Transducers, Transfer efficiency, Primary and Secondary transducers, electrical, Mechanical, electronic transducers, advantages of each type transducers.	

UNIT-III

Advances in metrology:	**06 Hours**
Basic concepts of lasers, advantages of lasers, laser interferometers, types, applications. Basic concepts of Coordinate Measuring Machines-constructional features, applications.	

Course Outcomes: At the end of the course student will be able to

1.	Explain classification and application of material and wavelength standards used in engineering measurements and the terms related to measurements
2.	Describe working principle, construction, and use of different comparators and angle measuring instruments.
3.	Explain the important parameters of screw threads and gears and their measurement designing of fits according to IS: 919-1963 and design gauges to inspect the fits.
4.	Explain the elements of generalized measurement system.
5.	Explain the advances in metrology

Course Outcomes Mapping with Program Outcomes & PSO

Program Outcomes→	1	2	3	4	5	6	7	8	9	10	11	12	**PSO↓**		
↓ Course Outcomes													1	2	3
RI2552-1.1	3	2	1										1		
RI2552-1.2	3	2	1										1		
RI2552-1.3	3	2	1										1		
RI2552-1.4	3	2	1										1		
RI2552-1.5	3	2	1										1		

1: Low 2: Medium 3: High

TEXTBOOKS:

1.	Mechanical measurements" by Beckwith Marangoni and Lienhard, Pearson Education, 6th Ed., 2006
2.	"Engineering Metrology" by R.K.Jain, Khanna Publishers.20/e-2004

REFERENCE BOOKS:

1.	"Mechanical Measurements" by Thomas G Beckwith, Prentice-Hall, Pearson Education Limited.
2.	"Engineering Metrology" by I.C.Gupta, Dhanpat Rai Publications, 7th Edition,2012
3.	"Measurement Systems Applications and Design" by Ernest O, Doblin, McGRAW Hill Book Co. 5th Ed.,2003
4.	"A Textbook of Measurements and Metrology" M.Mahajan, Dhanpat Rai &Co.2014

E Books / MOOCs/ NPTEL

1.	ENGINEERING METROLOGY https://nptel.ac.in/courses/112/104/112104250/
2.	Mechanical Measurements and Metrology https://nptel.ac.in/courses/112/106/112106138/
3.	MECHANICAL MEASUREMENT SYSTEM https://nptel.ac.in/courses/112/107/112107242/

Program Specific Ability Enhancement Course (AEC)

Data Acquisition and Measurements

Course Code:	**RI2652-1**	**Course Type**	**AEC**
Teaching Hours/Week (L: T: P: S)	**2:0:0:0**	**Credits**	**02**
Total Teaching Hours	**25**	**CIE + SEE Marks**	**50+50**
Prerequisite	**EC 1001-1**		

Teaching Department: Robotics and Artificial Intelligence

Course Objectives:

1.	To understand the type of sensor required for the measurement of physical phenomenon, to study the signal characteristics and the signal conditioning required for the signal measurement.
2.	To study the calibration method for a given sensor for the measurement of a physical phenomenon

UNIT-I

Data Acquisition System Features — **10 Hours**

System Components, Signal Characteristics, Signal Conditioning, Signal Source and Measurement System Configuration, Introduction to data acquisition hardware

UNIT-II

Sensor calibration: — **15 Hours**

Calibration of force sensors and measurement: Calibration of force sensors and measurement types of load cells and H bridge circuits for load cells, Force sensing Resistors, Piezo-electric based force sensors and charge amplifiers

Calibration of linear and angular motion sensors and measurement: Laser sensors, inductive, capacitive sensor, ultrasonics sensors, IR sensors, LVDT, Rotary and linear optical encoders, draw wire sensors.

Calibration of accelerometers, gyroscopes, LIDAR sensors, RADAR sensors, and their measurements.

Course Outcomes: At the end of the course student will be able to

1.	To identify the sensor required for the measurement of physical phenomenon and to recommend the signal conditioning required for the sensor selected
2.	To perform the calibration method for a given sensor for the measurement of a physical phenomenon

Course Outcomes Mapping with Program Outcomes & PSO

Program Outcomes→	1	2	3	4	5	6	7	8	9	10	11	12	**PSO↓**		
↓ Course Outcomes													1	2	3
RI2552-1.1	3	3	3	3	3	-	-	-	-	-	-	3	3	2	3
RI2552-1.2	3	3	3	3	3	-	-	-	-	-	-	3	3	2	3

1: Low 2: Medium 3: High

TEXTBOOKS:

1.	LabView Student Edition, 1st. Edition by Robert H. Bishop ISBN-13: 978-0134011332
2.	Introduction to Data Acquisition with LabView 2nd. Edition by Robert King, ISBN-13: 9780073385877

Engineering Economics

Course Code:	**RI2652-1**	**Course Type**	**AEC**
Teaching Hours/Week (L: T: P: S)	**1:0:2:0**	**Credits**	**03**
Total Teaching Hours	**40**	**CIE + SEE Marks**	**50+50**
Prerequisite	**PH1001 -1**		

Course objectives:

- Evaluate the worth of creations, by comparing the alternatives visa, visa the cost (cost-benefit analysis) and take decisions with the limited resources, the relevant course of action, with the help of suitable tools.
- Determine the cost involved in each operation, a product should undergo with an aim to fix suitable selling price for the product and know the different terminology of Economics and to prepare ledgers, journals, balance sheets and profit and loss accounts

Unit-I

Fundamental economic concepts: Consumer goods, Producer goods, Factors of production, Economy of organization, Demand theory, Law of demand, Exceptions to law of demand, Law of supply, Determinants of supply, Law of increasing returns and law of diminishing returns(No exercises)

Interest: Rate of interest, Determining rate of interest, Time value of money, Simple interest, Compound interest, Nominal and effective interest rate, Equivalence involving interest, Interest formulae [single payment, uniform series and arithmetic gradient only], problems using interest formulae [discrete compounding only].

Economic Analysis of Alternatives Analysis based on: Present Worth [equal life and unequal life situations], Future Worth, Payback Period, Capitalized Worth, Equivalent Annual Worth, Exercises. **08 Hours**

Pedagogy	Chalk and talk method, Power Point Presentation

Unit-II

Rate of Returns: Analysis based on Rate of Return, Exercises, cost of capital concepts

Depreciation: Causes of depreciation, Depletion, Methods of depreciation [Straight line, Declining balance, Double declining balance, SYD method, Sinking Fund method], Exercises

Financial management: Terminologies used in accounting, Journal and ledger, Profit and loss statement, Balance sheet, Understanding basic financial ratios, Simple exercises.

Estimating and Costing: Components of cost [Material cost, Labour cost, Overhead expenses, Prime cost, Factory cost, Total cost], Determination of selling price of a product, Exercises

Mensuration: Machine shop calculations, Forging shop calculations, Exercises **07 Hours**

Pedagogy	Chalk and talk method, Power Point Presentation

Course outcome (Course Skill Set)

At the end of the course the student will be able to:

1. Evaluate the worth of creations, by comparing the alternatives visa, vis the cost (cost-benefit analysis) and take decisions with the limited resources, the relevant course of action, with the help of suitable tools.
2. Determine the cost involved in each operations, a product should undergo with an aim to fix suitable selling price for the product and Know the different terminology of Economics and to prepare ledgers, journals, balance sheets and profit and loss accounts.

Assessment Details (both CIE and SEE)

(methods of CIE need to be define topic wise i.e.- MCQ, Quizzes, Open book test, Seminar or micro project)

The weightage of Continuous Internal Evaluation (CIE) is 50% and for Semester End Exam (SEE) is

50%. The student has to obtain minimum of 40% marks individually both in CIE and SEE to pass. Theory Semester End Exam (SEE) is conducted for 100 marks (3 Hours duration). Based on this grading will be awarded.

Continuous Internal Evaluation:

1. Methods suggested: Test, Open Book test, Written Quiz, Seminar, report writing etc.
2. The class teacher has to decide the topic for closed book test, open book test, Written Quiz and Seminar. In the beginning only teacher has to announce the methods of CIE for the subject.

Semester End Examination:

Theory SEE will be conducted by University as per scheduled time table, with common question papers for subject

- The question paper will have ten questions. Each question is set for 20 marks.
- There will be 2 questions from each module. Each of the two questions under a module (with a maximum of 3 sub questions), should have a mix of topics under that module.
- The students have to answer 5 full questions, selecting one full question from each module

Suggested Learning Resources:

Books

1. Engineering Economics, Riggs J.L.,4th edition, Tata McGraw-Hill, 2004
2. Mechanical Estimating and Costing, Banga and Sharma, 16th edition, Khanna Publishers, 2012
3. Engineering Economy, E Paul Degarmo, Macmillan Publishing, 2001
4. Engineering Economy, Gerald J Thuesen & W J Fabrycky, Prentice Hall of India, 9th ed.
5. Engineering Economics, Tarachand, Nemchand & Bros, 1996
6. Financial Management, I M Pandey, Vikas Publishing House, 2002

<u>COURSE ARTICULATION MATRIX:</u>

Course Code / Name : RI2652/ Engineering Economics															
Course Outcomes (CO)	**Program Outcomes (PO)**											**PSO**		
	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3
C- **RI2652**.1	3	2	2	1	2	-	-	-	-	-	3	3	-	-	-
C- **RI2652**.2	3	2	2	1	2	-	-	-	-	-	3	3	-	-	-

1: 1ow 2: Medium 3: High

PLC CONTROL OF HYDRAULIC AND PNEUMATIC CIRCUITS

Course Code:	**RI2653-1**	**Course Type**	**AEC**
Teaching Hours/Week (L: T: P: S)	**1:0:2:0**	**Credits**	**02**
Total Teaching Hours	**25**	**CIE + SEE Marks**	**50+50**
Prerequisite	**EE 1001-1, EC 1001-1**		

Teaching Department: Robotics and Artificial Intelligence

Course Objectives:

1.	To understand the fundamentals of fluid power transmission systems
2.	To design various hydraulic system components.
3.	To design various pneumatic system components.
4.	Learn various types of hydraulic and pneumatic power circuits.
5.	Learn various types of applications in fluid power circuits using PLC.

UNIT-I

Fluid power systems and fundamentals — **06 Hours**

Introduction to fluid power, Advantages of fluid power, Application of fluid power system. Types of fluid power systems, General types of fluids - Properties of hydraulic fluids -Fluid power symbols. Basics of Hydraulics-Applications of Pascal's Law

Hydraulic system components — **05 Hours**

Sources of Hydraulic Power: Pumping theory - Pump classification - construction and working of pumps - Variable displacement pumps, pump performance. Actuators: Linear hydraulic actuators-Single acting and double acting cylinders, Rotary actuators - Fluid motors.

Control Components — **04 Hours**

Direction control valve - Valve terminology - Various center positions. Shuttle valve - check valve - pressure control valve - pressure reducing valve, sequence valve. Flow control valves - Fixed and adjustable Safety valves.

UNIT-II

Pneumatic system components — **07 Hours**

Pneumatic Components: Properties of air. Compressors. FRL Unit -Air control valves, Quick exhaust valves and pneumatic actuators- cylinders, air motors. Basics of low-cost automation

Fluidics & Pneumatic circuit design — **08 Hours**

Fluidics - Introduction to fluidic devices, simple circuits. Introduction to Electrohydraulic Pneumatic logic circuits, PLC applications in fluid power control, Sequential circuit design for simple applications using classic, cascade, logic with Karnaugh- Veitch Mapping and combinational circuit design methods.

UNIT-III

Fluid power circuits — **10 Hours**

Electrical control of pneumatic and hydraulic circuits-use of relays, timers, counters, Ladder diagram. Programmable logic control of Hydraulics Pneumatics circuits, PLC ladder diagram for various circuits, motion controllers, use of field busses in circuits. Electronic drive circuits for various Motors.

Course Outcomes: At the end of the course student will be able to

1.	Compare the basics of hydraulics to the performance of fluid power systems
2.	Explain the working principle of hydraulic systems including pumps and control components.
3.	Explain the working principle of pneumatic systems and their components.
4.	Design various types of Electrohydraulic and electro pneumatic circuits
5.	Design various types of applications in fluid power circuits using PLC.

Course Outcomes Mapping with Program Outcomes

Program Outcomes→ / **↓ Course Outcomes**	1	2	3	4	5	6	7	8	9	10	11	12
RI2652-1.1	3	2	3	2	3	-	-	-	-	-	-	3
RI2652-1.2	3	2	3	2	3	-	-	-	-	-	-	3
RI2652-1.3	3	2	3	2	3	-	-	-	-	-	-	3
RI2652-1.4	3	2	3	2	3	-	-	-	-	-	-	3
RI2652-1.5	3	2	3	2	3	-	-	-	-	-	-	3

1: Low 2: Medium 3: High

TEXTBOOKS:

1.	Majumdar S.R., "Pneumatic systems - Principles and maintenance", Tata McGraw Hill, 2008.
2.	Anthony Esposito, "Fluid Power with Applications", Pearson Education 2009.

REFERENCE BOOKS:

1.	Majumdar S.R., "Oil Hydraulics", Tata McGraw-Hill, 2000.
2.	Harry L. Stevart D. B, "Practical guide to fluid power", Taraoeala sons and Port Ltd.Broadey, 2010.
3.	Michael J, Prinches and Ashby J. G, "Power Hydraulics", Prentice Hall, 2011.
4.	Dudelyt, A. Pease and John T. Pippenger, "Basic Fluid Power", Prentice Hall, 2011.

E Books / MOOCs/ NPTEL

1.	https://nptel.ac.in/courses/108/105/108105088/
2.	https://plc-coep.vlabs.ac.in/List%20of%20experiments.html?domain=Electrical%20Engineering
3.	http://vlabs.iitb.ac.in/vlabs-dev/vlab_bootcamp/bootcamp/COEP_KNOWLEDGE_SEEKERS/labs/exp1/theory.html

Professional Elective Courses (Automation Stream)

GROUP-I

Automation in Manufacturing Systems

Course Code:	**RI2201-1**	**Course Type**	**PEC**
Teaching Hours/Week (L: T: P: S)	**3:0:0:0**	**Credits**	**03**
Total Teaching Hours	**40**	**CIE + SEE Marks**	**50+50**
Prerequisite	**ME 1003-1, IS 1001-1**		

Teaching Department: Robotics and Artificial Intelligence

Course Objectives:

1.	To understand the concepts of automation in manufacturing systems
2.	To impart the knowledge of a line balancing and assembly systems
3.	To explore the idea of robotics and understand the computerized manufacturing planning
4.	To gain the knowledge of automated inspection and shop floor control
5.	To understand the concepts of additive manufacturing and latest trends in manufacturing

UNIT-I

Introduction	**03 Hours**
Production system facilities, Manufacturing support systems, Automation in production systems, Automation principles &strategies	
Manufacturing Operations:	**04 Hours**
Manufacturing operations, Product/production relationship, Production concepts and Mathematical models & costs of manufacturing operations. Problems on mathematical models	
Line Balancing	**05 Hours**
Methods of line balancing, Numerical problems on largest candidate rule, Kilbridge's and Wester's method, and ranked positional weights method, computerized line balancing methods.	
Automated Assembly System	**04 Hours**
Design for automated assembly, types of automated assembly system, Parts feeding devices, Analysis of single and multi-station assembly machines	

UNIT-II

Computerized Manufacture Planning and AGVS	**06 Hours**
Computer aided process planning (CAPP), Retrieval and Generative systems, and benefits of CAPP. Material requirement planning, Inputs to MRP system, working of MRP, Outputs and benefits. Automated Guided Vehicles System: Applications, Guidance and routing,	
Industrial Robotics	**04 Hours**
Definition, Robot anatomy, Joints and links, Robot configurations, Robot control systems, Accuracy and repeatability, End effectors, Sensors in robotics. Industrial robot applications: Material handling, Processing, assembly and inspection.	
Inspection Technologies	**04 Hours**
Automated inspection, coordinate measuring machines construction, Operation & programming, Software, application &benefits, Flexible inspection system, Inspection probes on machine tools, Machine vision, Optical inspection techniques & non-contact non-optical inspection technologies.	

UNIT-III	
Shop Floor Control and Automatic Identification Techniques	**05 Hours**
Shop floor control, Factory data collection system, Automatic identification methods, Bar code technology, Automatic data collection systems. An Introduction to QR Code Technology	
Additive Manufacturing Systems	**03 Hours**
Basic principles of additive manufacturing, Slicing CAD models for AM, Advantages and limitations of AM technologies, Recent trends in manufacturing, Hybrid manufacturing.	
Future of Automated Factory:	**02 Hours**
Trends in manufacturing, the future automated factory, Human workers in future automated factory, Social impact.	

Course Outcomes: At the end of the course student will be able to

1.	Explain the basics of productions, automation system and manufacturing operations. Solve the simple problems on mathematical model.
2.	Analyze and solve problems on line balancing
3.	Explain CAPP and MRP system and analyze the AGVS
4.	Understand the inspection technologies and shop floor control
5.	Explain the modern trends in additive manufacturing and automated factory

Course Outcomes Mapping with Program Outcomes & PSO

Program Outcomes→	1	2	3	4	5	6	7	8	9	10	11	12	PSO↓		
↓ Course Outcomes															
RI2201-1.1	3	3	2	2	2	-	-	-	-	-	-	2	2	-	2
RI2201-1.2	3	3	2	2	2	-	-	-	-	-	-	2	2	-	2
RI2201-1.3	3	3	2	2	2	-	-	-	-	-	-	2	2	-	2
RI2201-1.4	3	3	2	2	2	-	-	-	-	-	-	2	2	-	2
RI2201-1.5	3	3	2	2	2	-	-	-	-	-	-	2	2	-	2

1: Low 2: Medium 3: High

TEXTBOOKS:

1. Mikell PGroover, Automation, Production Systems and Computer-Integrated Manufacturing, PHI Learning, 3rd Edition, 2009
2. P N Rao, CAD / CAM Principles and Applications, Tata McGraw-Hill, 3rd Edition, 2015
3. Ian Gibson, David W. Rosen, BrentStucker, Additive Manufacturing Technologies: Rapid Prototyping to Direct Digital Manufacturing, Springer, 2nd Ed. (2015)

REFERENCE BOOKS:

1. Dr.Nanua Singh, Systems Approach to Computer Integrated Design & Manufacturing, Wiley, 1996
2. P. Radhakrishnan, S. Subramanyan, U.Raju, CAD/CAM/CIM, Revised Third Edition 2007

CNC Machining

Course Code:	**RI2202-1**	**Course Type**	**PEC**
Teaching Hours/Week (L: T: P: S)	**3:0:0:0**	**Credits**	**03**
Total Teaching Hours	**40**	**CIE + SEE Marks**	**50+50**
Prerequisite	**ME 1003-1**		

Teaching Department: Robotics and Artificial Intelligence

Course Objectives:

1.	Evaluate manufacturing assignment based on critical thinking and problem solving skills. Become a good communicator and effective team member.
2.	Practice writing complex "G" code programs for CNC turning centers that meet the part specification
3.	Interpret and demonstrate complex "G" code programs for CNC milling centers that meet the part specification
4.	Prepare "G: code programs to perform secondary operations including tapping, countersinking, counter boring, and threading.
5.	Describe and illustrate common problems with tooling and fixtures in CNC programming and machining.

UNIT-I

Introduction to CNC technology & programming	**07 Hours**

Introduction to CNC technology – CNC machines controls. History & development of CNC technology. Conventional Vs. non-conventional machine tool. Numerical control on CNC machine tools CNC control and CNC Control and types of CNC control Calculation of technological data for CNC machining. CNC clamping system.

CNC programming	**09 Hours**

Introduction to CNC programming, Introduction and demonstration of line programs CNC programming or lathe & milling machine using iso codes into the CNC simulator. CNC programming for lathe and milling machines using different machining cycles into the CNC simulator. Procedures Associated with part programming, Cutting process parameter selection, Process planning issues and path planning, G & M Codes, Interpolations, Canned Cycles and Subprograms

UNIT-II

Program generation for CNC milling and turning	**04 Hours**

Tool compensations Exposure for programming and simulator of FANUC, SINUMERIC, Programming exercise.

CNC Turning	**05 Hours**

Plan and optimize programs for CNC turning operations. Calculate parameters like speed feed etc. and set a references for the various operations. Prepare operation and operation sequence for the lathe operations like turning, grooving etc. Prepare & set CNC lathe operations and test run programmed Execute program and inspect simple geometrical forms / standard parts Use of various PPE's on CNC lathe machine.

CNC Milling	**05 Hours**

Plan and optimize programs for CNC Milling operations. Calculate parameters like speed feed, depth of cut etc. and set a references for the various operations. Various methods of work process like edge finding block center etc. Prepare & set CNC Milling operations and test run programmed. Execute program and inspect simple geometrical forms / standard parts. Use of various PPE's on CNC milling machine

UNIT-III

Modern CNC systems	**10 Hours**

Introduction to advanced CNC systems: Computer Aided Part Programming (CAPP), it's application using Solidworks/MasterCAM. comparison of manual part programming and CAPP for a simple component, Automatic Tool Changer, Automatic Pallet Control, Automatic Storage & Retrieval Systems.

Course Outcomes: At the end of the course student will be able to

1.	Explain applications and advantages of CNC machines and technology. Demonstrate and explain various CNC control Calculate technological data for CNC machining
2.	Understand the importance and use of PPE's. Prepare and understand line program for various profiles Identify and set parameters for various simulators
3.	Prepare programs , demonstrate , simulate and operate CNC lathe machines for various machining operations
4.	Prepare programs , demonstrate , simulate and operate CNC milling machines for various machining operations
5.	Define and explain Modern CNC systems and explain its importance in manufacturing

Course Outcomes Mapping with Program Outcomes & PSO

Program Outcomes→	1	2	3	4	5	6	7	8	9	10	11	12	PSO↓		
↓ Course Outcomes															
RI2202-1.1	1	2	1	-	-	-	-	-	-	-	-	1	-	-	3
RI2202-1.2	2	2	1	-	-	-	-	-	-	-	-	1	-	-	3
RI2202-1.3	2	2	2	-	-	-	-	-	-	-	-	2	-	-	2
RI2202-1.4	2	2	2	-	-	-	-	-	-	-	-	2	-	-	2
RI2202-1.5	2	2	2	-	-	-	-	-	-	-	-	2	-	-	2

1: Low 2: Medium 3: High

TEXTBOOKS:

1. Programming of CNC machines, by Ken Evans
2. CNC Programming Handbook by Peter Smid
3. NC Control by Kundra Rao, Tewari CNC Machines, Pabla B.S., Adithan M., New Age International, New Delhi,2014(reprint).

REFERENCE BOOKS:

1. CAD/CAM: computer aided design and manufacturing, Groover Mikell P, Zimmered W Emory, Prentice Hall 2014
2. Computer Numerical Control- Turning and Machining centers. Quesada Robert, Prentice Hall 2014
3. https://cache.industry.siemens.com/dl/files/554/74475554/att_56792/v1/PGsl_0313_en_en-US.pdf

4.	G codes, M codes Handbook, by Mazak Corporation, sources: available at Mini Tool Room, Parlakhemundi campus, CUTM https://gist.github.com/anonymous/f14c73a7174bf8a43f0c970817897454
E Books / MOOCs/ NPTEL	
1.	https://cache.industry.siemens.com/dl/files/554/74475554/att_56792/v1/PGsl_0313_en_en-US.pdf
2.	https://www.classcentral.com/course/youtube-computer-numerical-control-cnc-of-machine-tool-and-process-47871
3.	https://www.udemy.com/course/mastering-artcam-2017/
4.	https://fabcoep.vlabs.ac.in/exp1/Video.html?domain=Mechanical%20Engineering&lab=FAB%20laboratory
5.	http://vlabs.iitkgp.ac.in/psac/newlabs2020/vlabiitkgpAM/exp2/index.html#

Industrial Automation and Control

Course Code:	**RI2203-1**	**Course Type**	**PEC**
Teaching Hours/Week (L: T: P: S)	**3:0:0:0**	**Credits**	**03**
Total Teaching Hours	**40**	**CIE + SEE Marks**	**50+50**
Prerequisite	**EE 1001-1, IS 1001-1**		

Teaching Department:

Course Objectives:

1.	Understand the fundamentals of industrial automation system and various control process.
2.	Understand the various sequence controls used in industries.
3.	Understand the various hydraulic control systems to control the flow valves.
4.	Understand the different types of electric drives used in industrial automation
5.	Understand the different types of electric motor drives used in industrial automation

UNIT-I

Introduction — **07 Hours**

Architecture of Industrial Automation Systems, Measurement Systems Characteristics, Data Acquisition Systems Introduction to Automatic Control, P-I-D Control, PID Control Tuning, Feed forward Control Ratio Control, Time Delay Systems and Inverse Response Systems, Special Control Structures, Concluding Lesson on Process Control (Self-study).

Introduction to Sequence Control — **07 Hours**

PLC, RLL, Sequence Control. Scan Cycle, Simple RLL Programs,
Sequence Control. More RLL Elements, RLL Syntax, A Structured Design Approach to Sequence Control, PLC Hardware Environment

UNIT-II

Flow Control Valves, Hydraulic Control Systems — **08 Hours**

Flow Control Valves, Hydraulic Control Systems – I, Hydraulic Control Systems – II, Industrial Hydraulic Circuit, Pneumatic Control Systems – I, Pneumatic Systems – II, Energy Savings with Variable Speed Drives, Introduction to CNC Machines The Field bus Network – I, Higher Level Automation Systems

Electric Drives — **08 Hours**

Introduction, Energy Saving with Adjustable Speed Drives, Step motors: Principles, Construction and Drives, DC Motor Drives: Introduction, DC Converters, Adjustable Speed Drives

UNIT-III

Induction Motor Drives — **10 Hours**

Introduction, Characteristics, Adjustible Speed Drives Synchronous Motor Drives: Motor Principles, Adjustible Speed and Servo Drives, Networking of Sensors, Actuators and Controllers: The Fieldbus The Fieldbus Communication Protocol Introduction to Production Control Systems.

Course Outcomes: At the end of the course student will be able to

1.	Describe the various elements of an Industrial Automation Systems and how they are organized hierarchically in levels
2.	Create the input-output relationship of a P-I-D controller
3.	Describe the physical organization of hardware in the PLC.

4.	Describe motivations for formal modeling in the design of sequence control programs for an
5.	Industrial control problem

Course Outcomes Mapping with Program Outcomes & PSO

Program Outcomes→	1	2	3	4	5	6	7	8	9	10	11	12	**PSO↓**		
↓ Course Outcomes													1	2	3
RI2203-1.1	3	-	1		3		-	-			-	2	-	2	
RI2203-1.2	3	-	1		3		-	-			-	2	-	2	
RI2203-1.3	3	-	2		3		-	-			-	2	-	2	
RI2203-1.4	3	-	3		2		-	-			-	2	-	2	
RI2203-1.5	3	-	1		3		-	-			-	2	-	2	

1: Low 2: Medium 3: High

TEXTBOOKS:

1.	Introduction to Industrial Automation, Stamatios Manesis, George Nikolakopoulo CRC press 1st Edition, 2018
2.	Drives and Control for Industrial Automation, Kok Kiong Tan, Andi Sudjana Putra Springer-verlag Londoan limited 11th Edition, 2018
3.	Electrical Measurement and Control (WBSCTE), S.K. Bhattacharya & S. Vikas Publishing House Pvt Ltd 2nd Edition, 2015

REFERENCE BOOKS:

1.	Introduction to Industrial Automation, Stamatios Manesis, George Nikolakopoulo CRC press 1st Edition, 2018
2.	Drives and Control for Industrial Automation, Kok Kiong Tan, Andi Sudjana Putra Springer-verlag Londoan limited 11th Edition, 2018
3.	Electrical Measurement and Control (WBSCTE), S.K. Bhattacharya & S. Vikas Publishing House Pvt Ltd 2nd Edition, 2015

NPTEL

https://nptel.ac.in/courses/108105063

NITTE (Deemed to be University)

Medical Robotics

Course Code:	RI2204-1	Course Type	PEC
Teaching Hours/Week (L: T: P: S)	3:0:0:0	Credits	03
Total Teaching Hours	40	CIE + SEE Marks	50+50
Prerequisite	PH 1001-1, IS 1001-1, CY 1001-1		

Teaching Department: Robotics & AI

Course Objectives:

1.	Understand the types of medical robots used in the field of healthcare.
2.	Explain the various localization and tracking sensors
3.	Understand the applications of surgical robots with the help of few case studies
4.	Understand Rehabilitation of limbs and brain machine interface with the help of few case studies
5.	Understand the design methodology of medical robots.

UNIT-I

Introduction	**08 Hours**
Types of medical robots - Navigation - Motion Replication - Imaging - Rehabilitation and Prosthetics - State of art of robotics in the field of healthcare. Localization And Tracking	
Position sensors requirements	**07 Hours**
Tracking - Mechanical linkages - Optical - Sound-based - Electromagnetic -Impedance-based - In-bore MRI tracking - Video matching - Fiber optic tracking	

UNIT-II

Control Modes	**07 Hours**
Radiosurgery - Orthopedic Surgery - Urologic Surgery and Robotic Imaging - Cardiac Surgery – Neurosurgery – case studies.	
Rehabilitation	**08 Hours**
Rehabilitation for Limbs - Brain-Machine Interfaces - Steerable Needles – case studies.	

UNIT-III

Design of Medical Robots	**10 Hours**
Characterization of gestures to the design of robots- Design methodologies- Technological choices - Security.	

Course Outcomes: At the end of the course student will be able to

1.	Describe the types of medical robots and the concepts of navigation and motion replication.
2.	Describe about the sensors used for localization and tracking
3.	Explain the applications of surgical robots
4.	Explain the concepts in Rehabilitation of limbs and brain machine interface
5.	Classify the types of assistive robots and analyze the design characteristics, methodology and technological choices for medical robots.

Course Outcomes Mapping with Program Outcomes & PSO

Program Outcomes→	1	2	3	4	5	6	7	8	9	10	11	12	PSO↓		
↓ Course Outcomes													1	2	3
RI2204-1.1	3	-	1				-	-			-	2	-	2	2
RI2204-1.2	3	-	1				-	-			-	2	-	2	2
RI2204-1.3	3	-	2				-	-			-	2	-	2	2
RI2204-1.4	3	-	2				-	-			-	2	-	3	3
RI2204-1.5	3	-	3				-	-			-	2	-	2	3

1: Low 2: Medium 3: High

TEXTBOOKS:

1. Robot Modeling and Control, Mark W. Spong, Seth Hutchinson, and M. Vidyasagar, Wiley Publishers, 2006
2. Medical robotics- Minimally, Invasive surgery, Paula Gomes, Woodhead, 2012
3. Medical Robotics, Achim Schweikard, Floris Ernst, Springer, 2015

REFERENCE BOOKS:

1. Medical Robotics, Jocelyne Troccaz, Wiley-ISTE, 2012
2. Medical Robotics, Vanja Bonzovic, I-tech Education publishing Austria, 2008
3. Medical Robotics, Daniel Faust, Rosen Publishers, 2016
4. Medical Robotics, Jocelyne Troccaz, Wiley-ISTE, 2012

E Books / MOOCs/ NPTEL

1. https://www.futurelearn.com/courses/medtech-ai-and-medical-robots
2. https://web.stanford.edu/class/me328/

Micro-Electro-Mechanical Systems

Course Code:	**RI2205-1**	**Course Type**	**PEC**
Teaching Hours/Week (L: T: P: S)	**3:0:0:0**	**Credits**	**03**
Total Teaching Hours	**40**	**CIE + SEE Marks**	**50+50**
Prerequisite	**EC 1001-1**		

Teaching Department: Robotics and Artificial Intelligence

Course Objectives:

1.	Understand the fundamental principles of MEMS and their applications.
2.	Explain the capabilities and limitations of important micromachining techniques
3.	Understand the concepts of Micro-mechanics micromachining
4.	Understand the applicability of various sensors and actuation systems of MEMS
5.	Understand the basic concepts of thermal and fluidic MEMS.

UNIT-I

Micro-Electro-Mechanical Systems — **04 Hours**

Introduction and overview, Principles of MEMS, Silicon as a Mechanical Material, Benefits of MEMS, Scaling and performance, Cost reduction, complexity, Issues to consider, MEMS Markets, Overview of MEMS applications.

Micromachining Techniques — **07 Hours**

Overview, Capabilities and limitations of micromachining, Materials for micromachining, Substrates, Additive films and materials, Micromachining terms, General properties of common semiconductors, Mechanical properties, Native oxides of silicon, Typical silicon wafer types, Micromachining Techniques – Bulk Micromachining, Wet etching of silicon, Isotropic etching, Anisotropic etching, EDP, KOH, TMAH, Etch stop layers, Masking, Mask erosion around edges, bulk micromachining process flow, Electrochemical etching, Etch stop, Porous silicon, One- sided wafer etching, Vapor phase etching (XeFR2R), Dry etching, SFR6R, DRIE, Bosch process, Cryogenic dry etching, Sidewall roughness, Etch lag, Combined isotropic and anisotropic dry etching, SCREAM, ASIP

Micromachining Techniques — **05 Hours**

Surface Micromachining, Thin film processes, Oxide (thermal, deposited LTO), Nitride (stoichiometric, low-stress), Poly (stress, stress-gradients), Metal, surface micromachining process flow, Release, Wet–Stiction, Dry - Critical point drying, Vapor HF, Microelectronic integration – prior, mixed and post, Electro-deposition, Hybrid Micromachining

UNIT-II

Micro-Mechanics — **06 Hours**

Basic Mechanics, Axial stress & strain, Shear stress & strain, Poisson's Ratio, Commonly used deflection equations, Static beam equations, Static torsion equations, Static plate equations, Cantilever beams, Clamped-clamped beams, Membranes,

Springs – folded, torsional, Dynamics, Spring-mass-damper system, resonance, Test structures, Elastic properties, Bent Beam Method for determining Young's modulus,

Resonant beam structures — **04 Hours**

Cantilever beam, Comb drive resonator, Stress/Strain Gauges - Bent beam strain sensor, Cantilever beams, Buckling beam structures, Substrate analysis; Stoney Equation, Basic mechanisms and structures, In-plane rotary mechanisms, Out-of-plane mechanisms, Bistable mechanisms, Mechanical Sensors, Resistive and piezoresistive strain sensors, Semiconductor strain gauges, Capacitive sensing, Micromachined mechanical sensors,

Accelerometers	**04 Hours**

Basic accelerometer concepts, Force-balanced accelerometer concepts, Strain guage accelerometers, Capacitive accelerometers, Gyroscopes, Pressure sensors, Piezoresistive pressure sensors, Capacitive pressure sensors, Electrostatics, Actuation mechanisms, Electrostatic actuation, Parallel plate actuators, Torsional electrostatic actuators, Electrostatic comb drives, Electrostatic cantilever actuators, Electrostatic linear micromotors (scratch drive), Electrostatic rotary micro-motors.

UNIT-III

Thermal MEMS	**05 Hours**

Thermal actuators, Thermal expansion of solids, Bimorph thermal actuators, Bent beam actuators, Thermal array actuators, Volume expansion and phase-change actuators, Thermal sensors, Bolometers, Uncooled bolometers, Air flow sensor.

Fluidic MEMS	**05 Hours**

Introduction, Basic fluid properties and equations, Types of flow, Bubbles and particles in microstructures, Capillary forces, Fluidic resistance, Fluidic capacitance, Fluidic inductance, Flow channels, Bulk micromachined channels, Surface micromachined channels, Valves – Passive valve, Active valves, Pumps, Bubble pumps, Membrane pumps, Diffuser pumps, Rotary pumps, Electro-hydrodynamic pumps, Electrophoretic pumps, Droplet generators

Course Outcomes: At the end of the course student will be able to

1.	Describe the basics and capabilities and limitation of MEMS.
2.	Explain and differentiate important micromachining techniques
3.	Apply the concepts of Micro mechanics and materials for micromachining
4.	Describe sensors and actuation systems used in MEMS
5.	Explain the basics of thermal and fluidic MEMS.

Course Outcomes Mapping with Program Outcomes & PSO

Program Outcomes→	1	2	3	4	5	6	7	8	9	10	11	12	PSO↓		
↓ Course Outcomes															
RI2205-1.1	3	-	1	-	-	-	-	-			-	1	3		2
RI2205-1.2	3	-	1	-	-	-	-	-			-	1	3		2
RI2205-1.3	3	-	2	-	-	-	-	-			-	1	3		2
RI2205-1.4	3	-	2	-	-	-	-	-			-	1	3		2
RI2205-1.5	3	-	1	-	-	-	-	-			-	1	3		2

1: Low 2: Medium 3: High

TEXTBOOKS:

1.	Micromachined Transducers Sourcebook, Greg Kovacs, McGraw-Hill publications, New York, 1998
2.	Microsystem Design, Stephen D. Senturia, Kluwer Publications, Boston, 2001

REFERENCE BOOKS:

1.	MEMS/NEMS – Handbook: Techniques and Applications, Cornelius T. Leondes, Springer-Verlag Publications, 2005

2.	Fundamentals of Microfabrication, Marc J. Madou, Taylor & Francis Publications, 2nd, 2002
E Books / MOOCs/ NPTEL	
1.	https://nptel.ac.in/courses/117/105/117105082/
2.	https://nptel.ac.in/courses/108/108/108108113/
3.	https://nptel.ac.in/courses/112/108/112108092/
4.	https://nptel.ac.in/courses/108/106/108106165/
5.	https://www.udemy.com/course/introduction-to-micro-and-nano-fabrication-techniques-by-essamberikaa/
NPTEL	
	https://nptel.ac.in/courses/117105082

GROUP-II

Digital Manufacturing

Course Code:	**RI2301-1**	**Course Type**	**PEC**
Teaching Hours/Week (L: T: P: S)	**3:0:0:0**	**Credits**	**03**
Total Teaching Hours	**40**	**CIE + SEE Marks**	**50+50**
Prerequisite	**ME 1003-1**		

Teaching Department: Robotics and Artificial Intelligence

Course Objectives:

1.	Learn the fundamentals of Digital manufacturing, Design processes and methods and CAD/CAM/CAE technologies and product lifecycle management (PLM)
2.	Use of Finite Element Analysis (FEA) to validate functional performance
3.	Learn the General stages of the process, solid and FEA models, materials definition, loading (loads, displacements constraints...), post-processing, results and verifications
4.	Learn about the Digitizing methods and main technologies: applications and selection of reverse engineering systems.
5.	Know about the Main additive manufacturing technologies, principles and applications

UNIT-I

Introduction	**07 Hours**
Importance of Digital manufacturing, Fundamental concepts of Industry 4.0 & Industrial Robotics	
Conception and development of products	**09 Hours**
Design processes and methods. CAD/CAM/CAE technologies and product lifecycle management (PLM). Concepts generation and embodiment. Expression of product design ideas using 2D sketches Drivers for digital transformations, Digital transformation challenges	

UNIT-II

Computer Aided Design (CAD)	**06 Hours**
3D modeling. Parametric design. Assembly modeling. Render the appearance of a product CAD	
Computer Aided Engineering (CAE)	**08 Hours**
Finite Element Analysis (FEA) to validate functional performance: general stages of the process, solid and FEA models, materials definition, loading (loads, displacements constraints...), post-processing, results and verifications. Topology optimization in additive manufacturing.	

UNIT-III

Reverse engineering	**05 Hours**
General methodology: point clouds, meshes (.stl), NURBS surface models and parametric CAD models. Digitizing methods and main technologies: applications and selection of reverse engineering systems. Hardware and software involved. Reverse engineering and additive manufacturing	
Additive manufacturing	**05 Hours**
General methodology, stages and components of the process. Main technologies, principles and applications. Strengths, weaknesses, challenges, and limitations of additive	

manufacturing technologies. Main brands and suppliers available. Design for Additive Manufacturing (DFAM). Design for functionality and 3D printability. Planning and slicing additive manufacturing software

Course Outcomes: At the end of the course student will be able to

1.	Explain the fundamental concepts of Digital manufacturing, about product development and the drivers and challenges regarding digital transformation.
2.	Discuss the use of CAD in product development.
3.	Discuss about FEA for validating the functional performance of products.
4.	Discuss the application and selection of reverse engineering systems.
5.	Discuss about the major additive manufacturing technologies, its principles and applications.

Course Outcomes Mapping with Program Outcomes & PSO

Program Outcomes→	1	2	3	4	5	6	7	8	9	10	11	12	PSO↓		
↓ Course Outcomes															
RI2301-1.1	3					1	2			1		1			2
RI2301-1.2	3					1	2			1		1			2
RI2301-1.3	3					1	2			1		1			2
RI2301-1.4	3					1	2			1		1			2
RI2301-1.5	3					1	2			1		1			2

1: Low 2: Medium 3: High

TEXTBOOKS:

1.	K. T. Ulrich and S. D. Eppinger, Product Design and Development, 6th Ed., McGraw-Hill Education, 2015. ISBN-13: 978-0-078-02906-6
2.	Parametric Technology Corporation (PTC), Simulation using Creo Parametric user guides.
3.	V. Raja and K. J. Fernandes (eds.), Reverse Engineering. An Industrial Perspective, 1st Ed., Springer-Verlag London, 2008. ISBN-13: 978-1-849-96660-3

REFERENCE BOOKS:

1.	N. Hopkinson, R. J. M. Hague and P. M. Dickens (eds.), Rapid Manufacturing: An Industrial Revolution for the Digital Age, 1st Ed., John Wiley & Sons, 2005. ISBN-13: 978-0-470-01613-8
2.	K. Otto and K. Wood, Product Design: Techniques in Reverse Engineering and New Product Development, 1st Ed., Prentice Hall, 2000. ISBN-13: 978-0-130-21271-9
3.	Z. Zhou, S. Xie, and D. Chen, Fundamentals of Digital Manufacturing Science, 1st Ed., Springer-Verlag London, 2012. ISBN-13: 978-1-447-12714-7
4.	I. Gibson, D. W. Rosen, and B. Stucker, Additive Manufacturing Technologies: Rapid Prototyping to Direct Digital Manufacturing. Springer-Verlag Boston, 2010. ISBN-13: 978-1-441-91119-3
5.	C. K. Chua, K. F. Leong, and C. S. Lim, Rapid Prototyping: Principles and Applications, 3rd Ed., World Scientific, 2010. ISBN-13: 978-9-812-77898-7

E Books / MOOCs/ NPTEL

1.	Jack C Chaplin, Claudia Pagano & Santi Fort, "Digital Manufacturing for SMEs – An Introduction", Digit –T, Digital Manufacturing Training, file:///G:/digital%20manufacturing/Digital%20Manufacturing%20for%20SMEs.pdf
2.	Mark J. Barrenechea & Tom Jenkins, "Digital Manufacturing", Open Text Corporation, Canada, ISBN 978-0-9936047-8-2, 2018. file:///G:/digital%20manufacturing/opentext-wp-digital-manufacturing-ebook-en.pdf

Intelligent Manufacturing

Course Code:	**RI2302-1**	**Course Type**	**PEC**
Teaching Hours/Week (L: T: P: S)	**3:0:0:0**	**Credits**	**03**
Total Teaching Hours	**40**	**CIE + SEE Marks**	**50+50**
Prerequisite	**IS1001-1**		

Teaching Department: Robotics and AI

Course Objectives:

1.	Describe the structure and function of manufacturing systems
2.	Discuss the manufacturing communication systems and the components and architecture of intelligent manufacturing systems.
3.	Apply the understanding of components in knowledge-based systems and machine learning develop a systematic approach for design and implementation of manufacturing systems.
4.	Apply the understanding of Automated process planning approaches and KBSES systems and machine learning to develop a systematic approach for design and implementation of manufacturing systems.
5.	Design the Information dashboard for intelligent manufacturing systems using models, algorithms and methods.

UNIT-I

Computer integrated manufacturing systems	**08 Hours**
structure and functional areas of CIM system - AD, CAPP, CAM, CAQC, ASRS and advantages of CIM	
Manufacturing communication systems	**08 Hours**
MAP/TOP OSI model, data redundancy, top-down and bottom-up approach, volume of information. Intelligent manufacturing – system components, system architecture and data flow, system operation	

UNIT-II

Components of knowledge-based systems	**08 Hours**
basic components of knowledge based systems, knowledge representation, comparison of knowledge representation schemes, interference engine, knowledge acquisition Machine learning – concept of artificial intelligence, conceptual learning, artificial neural networks - biological neuron, artificial neuron, types of neural networks, applications in manufacturing	
Automated process planning	**08 Hours**
variant approach, generative approach, expert systems for process planning, feature recognition, phases of process planning Knowledge Based System for Equipment Selection (KBSES) – Manufacturing system design, equipment selection problem, modelling the manufacturing equipment selection problem, problem solving approach in KBSES, structure of the KBSES	

UNIT-III

Information Dashboard Design	**08 Hours**
Group technology: models and algorithms – visual method, coding method, cluster analysis method, matrix formation – similarity coefficient method, sorting-based algorithms, bond energy algorithm, cost-based method, cluster identification method, extended CI method.	

Course Outcomes: At the end of the course student will be able to

1.	Explain the structure and function of manufacturing systems
2.	Discuss the manufacturing communication systems and the components and architecture of intelligent manufacturing systems.
3.	Apply the understanding of components in knowledge-based systems and machine learning develop a systematic approach for design and implementation of manufacturing systems.
4.	Apply the understanding of Automated process planning approaches and KBSES systems and machine learning to develop a systematic approach for design and implementation of manufacturing systems.
5.	Design the Information dashboard for intelligent manufacturing systems using models, algorithms and methods

Course Outcomes Mapping with Program Outcomes & PSO

Program Outcomes→	1	2	3	4	5	6	7	8	9	10	11	12	**PSO↓**		
↓ Course Outcomes													1	2	3
RI2302-1.1	3	-	1				-	-			-	2	-	2	2
RI2302-1.2	3	-	1				-	-			-	2	-	2	2
RI2302-1.3	3	-	2				-	-			-	2	-	2	2
RI2302-1.4	3	-	2				-	-			-	2	-	3	3
RI2302-1.5	3	-	3				-	-			-	2	-	2	3

1: Low 2: Medium 3: High

TEXTBOOKS:

1.	Automation, Production Systems and Computer Integrated Manufacturing, Mikell P. Groover,PHI,8th edition, 2008.
2.	Artificial Neural Networks, Yagna Narayana, PHI, 2009
3.	Futuristic Trends in Intelligent Manufacturing: Optimization and Intelligence in Manufacturing (Materials Forming, Machining and Tribology), K. Palanikumar, Elango Natarajan, et al., Springer, 2021

REFERENCE BOOKS:

1.	Intelligent Manufacturing,, Sunil Puranik,, Springer, 2021

E Books / MOOCs/ NPTEL

1.	https://nptel.ac.in/courses/110/106/110106044/
2.	https://www.udemy.com/course/intelligent-manufacturing-system/

Mechatronics

Course Code:	**RI2303-1**	**Course Type**	**PEC**
Teaching Hours/Week (L: T: P: S)	**3:0:0:0**	**Credits**	**03**
Total Teaching Hours	**40**	**CIE + SEE Marks**	**50+50**
Prerequisite	**EC 1001-1, EE 1001-1**		

Teaching Department: Robotics and Artificial Intelligence

Course Objectives:

1.	Understand basic mechatronic systems, mechanical components, actuators, sensors and also with controllers of mechatronic systems, and optical encoders.
2.	Gaining knowledge of pneumatic elements like valves, FRL units and the pneumatic actuators.
3.	To familiarize with the various types mechanical switches, Solid state switches, drives and controls, characteristics and models of various electromechanical actuators.
4.	Provide sound understanding of signal conversion i.e. ADC to DAC and vice versa, amplifiers,
5.	Understand architecture of 8085 microprocessors, micro controller and basic architecture of PLC system

UNIT-I

Introduction	**07 Hours**
Introduction to Mechatronic systems, Measurement systems, control systems, microprocessor based controllers, Mechatronics approach. Examples and discussions on typical mechatronic systems.	
Review of Transducers and Sensors	**04 Hours**
Introduction to Transducers and sensors, their classification, light sensors, proximity sensors and Hall-effect sensor, encoders, selection of sensors.	
Pneumatic Systems	**05 Hours**
Introduction, Basic structure of pneumatic systems, filter, lubricator, regulator, Valves – Classification, Pressure control valve, Flow control valve, Direction control valve. Types of cylinders, air motors, air compressors, Symbols of Pneumatic elements and application circuits. Active learning component on Pneumatics	

UNIT-II

Drives and controls	**04 Hours**
Mechanical system, Anti Friction guide ways, timer belt and pulley, high speed precession bearings	
Electrical Actuation Systems	**04 Hours**
Actuators and actuator system, classification, Mechanical switches, Solenoids, relays, solid-state switches, Motors- DC & AC motors, Stepper motors, servo motor.	
Signal conditioning	**06 Hours**
Introduction to signal conditioning, Operational amplifier, Inverting, Non- inverting, Summing, Integration, Differential amplifier, protection, filtering, wheat stone bridge, Analog –Digital Converter & Digital- Analog Converter, Multiplexers, Data acquisition system.	

UNIT-III

Microprocessors	**05 Hours**

Introduction to microprocessor, 8085 microprocessor architecture and terminology, Microcontrollers. Differences b/w microprocessor & micro controllers. Classification of micro controllers.

Programmable logic controller	**05 Hours**

Introduction to PLC's, basic structure, Principle of operation, Programming and concept of ladder diagram, concept of latching &selection of a PLC. Active learning component on PLC.

Course Outcomes: At the end of the course student will be able to

1.	Summarize significance of mechatronics to attain better performance of electro mechanic systems. Identify key elements of the mechatronic system and represent them as block diagrams. Demonstrate Hall effect, inductive, capacitive and photodiode transducers, which are used in vital mechatronic applications
2.	Describe the pneumatic components such as FRL unit, Valves and pneumatic actuators along with their functions. Design, simulate and develop pneumatic circuits for Industrial applications using these pneumatic components.
3.	Illustrate the operational characteristics of solid state switches, mechanical and electrical actuator systems. Identify suitable drives for mechatronics systems.
4.	Describe the concept of Amplifiers, Filters, Analogue and digital signal, Converters (ADC, DAC) and DAQ for its industrial applications.
5.	Utilize the knowledge of, microprocessor, microcontroller, and PLC. Develop PLC ladder programming for industrial applications.

Course Outcomes Mapping with Program Outcomes & PSO

Program Outcomes→	1	2	3	4	5	6	7	8	9	10	11	12	PSO↓		
↓ Course Outcomes															
RI2303-1.1	3	1	1		1				3	1		2	2		2
RI2303-1.2	3	2	2	2	2				2	1	2	2	2		2
RI2303-1.3	3	2	3	2	3				3	2	2	3	2		2
RI2303-1.4	3	2	2	1	2				2	1	2	2	2		2
RI2303-1.5	3			2	3				2	2	2	3	2		2

1: Low 2: Medium 3: High

TEXTBOOKS:

1.	Mechatronics, W. Bolton, Pearson education, 3rd edition. 2013
2.	Microprocessor Architecture, programming and applications with 8085, R.S. Ganokar, Wiley, Eastern, 1st 1987
3.	Introduction to Mechatronics, K. K.,Appukuttan,, Oxford University press 1st 2007

REFERENCE BOOKS:

1.	Pneumatic systems, S. R Majumdar, Tata Mc.Graw-Hill, Publishing company,ltd, 1st ,1997
2.	A Textbook of Mechatronics, RK Raput, S.Chand Publishing,, 1st 2007
3.	Mechatronics, NitaigourPrem chandMahilik, Tata Mc.Graw-Hill, Publishing company Ltd., 1st 2003

E Books / MOOCs/ NPTEL

1.	https://nptel.ac.in/courses/112/103/112103174/
2.	https://nptel.ac.in/courses/112/107/112107298/

3.	https://nptel.ac.in/courses/112/101/112101304/

Robot Gripper Design

Course Code:	**RI2304-1**	**Course Type**	**PEC**
Teaching Hours/Week (L: T: P: S)	**3:0:0:0**	**Credits**	**03**
Total Teaching Hours	**40**	**CIE + SEE Marks**	**50+50**
Prerequisite	**ME 1003-1, ME 1002-1**		

Teaching Department: Robotics & AI

Course Objectives:

1.	Study the overview about the grippers.
2.	Understand the working principle different types of the mechanical gripper.
3.	Understand the working principle different types of the non-mechanical gripper.
4.	Study different gripper materials.
5.	Understand different hybrid grippers mechanism.

UNIT-I	
Introduction to Prehension Technology: Grippers for Mechanization & Automation, Definitions and conceptual basics, Grasping in natural systems, Historical Overview of Technical Hands.	**07 Hours**
Automatic Prehension: Active Pair Mating Pair Mating, Strategy & Procedures, Prehension Strategy, Gripper Procedure, Conditions & Force, Gripper Flexibility, Gripper Classification, Requirements and Gripper Characteristics & Planning & selection of grippers.	**09 Hours**
UNIT-II	
Impactive Mechanical Grippers: Gripper Drives, Electro-Mechanical Drives, Pneumatic Drives, Electrostrictive & Piezoelectric Actuation, Design of Impactive Grippers, Systematics & Kinematics, Parallel Impactive Grippers, Angular Impactive Grippers, Radial Impactive Grippers (Centring Grippers), Internal Grippers, Gripper with Self-blocking capability, Rotatable Jaw Grippers, Gripper Finger & Jaw Design, Self-Securing Grippers, Securing Through Spring Forces, Securing through object Mass, Three-finger Grippers & Four-finger grippers and Four-point Prehension.	**06 Hours**
Ingressive Grippers: Flexible Materials, Pinch Mechanism, Non-Intrusive Mechanisms	**04 Hours**
UNIT-III	
Astrictive Prehension: Vacuum Suction, Vacuum Production, Vacuum Suckers, Passive Suction Caps, Air Jet Grippers, Magneto adhesion, Permanent Magnet Grippers, Electro-Magnetic Grippers, Hybrid Electro-Magnetic Grippers, Electro-adhesion, Electro-adhesive Prehension of Electrical Conductors, Electro-adhesive Prehension of Electrical Insulators.	**05 Hours**

Contigutive Prehension: Chemo-adhesion, Thermo-adhesion.	**04 Hours**

Course Outcomes: At the end of the course student will be able to

1.	Determine different types of gripper used in robots.
2.	Summarize forces acting on the grippers, requirements & selection criteria of grippers.
3.	Explain working concept of different types of mechanical grippers.
4.	Determine knowledge of different materials used for grippers.
5.	Identify concept of different types of non-mechanical grippers.

Course Outcomes Mapping with Program Outcomes & PSO

Program Outcomes→	1	2	3	4	5	6	7	8	9	10	11	12	**PSO↓**		
↓ Course Outcomes													1	2	3
RI2304-1.1	3	-	3				-	-			-	2	3		3
RI2304-1.2	3	-	3				-	-			-	2	3		3
RI2304-1.3	3	-	3				-	-			-	2	3		3
RI2304-1.4	3	-	3				-	-			-	2	3		3
RI2304-1.5	3	-	3				-	-			-	2	3		3

1: Low 2: Medium 3: High

TEXTBOOKS:

1.	Robot Grippers, Prof. Gareth J. Monkman, Dr. Stefan Hesse Ralf Steinmann, Wiley-VCH Verlag GmbH & Co., 1st Edition 2006.
2.	Robot Grippers, (International Trends in Manufacturing),D.T. Pham, W. B.Heginbotham,IFS,1986.
3.	Make Your First Robot, Kumar Vineesh, Notion Press Inc, Edition: 1, 2017
4.	Topology Design of Robot Mechanisms, Yang Tingli, Springer Verlag, 2018.
5.	Kinematic Analysis of, Robot Manipulators, Carl D. Crane III, Joseph Duffy, Import, 3rd Edition 2008.

E Books / MOOCs/ NPTEL

1.	https://nptel.ac.in/courses/112/107/112107289/

Professional Elective Courses (Signal Processing and Programming Stream)

GROUP-I

Data Visualization

Course Code:	**RI2211-1**	**Course Type**	**PEC**
Teaching Hours/Week (L: T: P: S)	**3:0:0:0**	**Credits**	**03**
Total Teaching Hours	**40**	**CIE + SEE Marks**	**50+50**
Prerequisite	**CS1001-1**		

Teaching Department:

Course Objectives:

1.	Explain the applications of data visualization.
2.	Explore the various advanced visualization tools.
3.	Understand the basics of data visualization tables.
4.	Apply visualization techniques for various data analysis tasks.
5.	Understand the considerations for designing the information dashboard.

UNIT-I

Apply visualization techniques for various data analysis tasks. — **07 Hours**

Acquiring and Visualizing Data, Simultaneous acquisition and visualization, Applications of Data Visualization, Keys factors of Data Visualization (Control of Presentation, Faster and Better JavaScript processing, Rise of HTML5, Lowering the implementation Bar)

Exploring the Visual Data Spectrum — **09 Hours**

charting Primitives (Data Points, Line Charts, Bar Charts, Pie Charts, Area Charts), Exploring advanced Visualizations (Candlestick Charts, Bubble Charts, Surface Charts, Map Charts, Infographics). Making use of HTML5 CANVAS, Integrating SVG

UNIT-II

Basics of Data Visualization — **07 Hours**

Tables Reading Data from Standard text files (.txt, .csv, XML), Displaying JSON content Outputting Basic Table Data (Building a table, Using Semantic Table, Configuring the columns), Assuring Maximum readability (Styling your table, Increasing readability, Adding dynamic Highlighting), Including computations, Using data tables library, relating data table to a chart.

Visualizing data Programmatically — **08 Hours**

Creating HTML5 CANVAS Charts (HTML5 Canvas basics, Linear interpolations, A Simple Column Chart, Animations), Starting with Google charts (Google Charts API Basics, A Basic bar chart, A basic Pie chart, Working with Chart Animations.

UNIT-III

Information Dashboard Design — **09 Hours**

Introduction, Dashboard design issues and assessment of needs, Considerations for designing dashboard-visual perception, Achieving eloquence, Advantages of Graphics _Library of Graphs, Designing Bullet Graphs, Designing Sparklines, Dashboard Display Media, Critical Design Practices, Putting it all together - Unveiling the dashboard.

Course Outcomes: At the end of the course student will be able to

1.	Explain principles of visual perception.
2.	Use advanced visualization tools viz., HTML5 CANVAS, Integrating SVG
3.	Apply basic skills for visual analysis.

4.	Apply visualization techniques and Creating HTML5 CANVAS Charts and Google charts for various data analysis tasks.
5.	Design information dashboard

Course Outcomes Mapping with Program Outcomes & PSO

Program Outcomes→ **↓ Course Outcomes**	1	2	3	4	5	6	7	8	9	10	11	12	**PSO↓** 1	2	3
RI2211-1.1	3	-	1		3		-	-			-	2	-	2	
RI2211-1.2	3	-	1		3		-	-			-	2	-	2	
RI2211-1.3	3	-	3		3		-	-			-	2	-	2	
RI2211-1.4	3	-	3		3		-	-			-	2	-	2	
RI2211-1.5	3	-	1		3		-	-			-	2	-	2	

1: Low 2: Medium 3: High

TEXTBOOKS:

1.	Information Dashboard Design: Displaying Data for At-a-glance Monitoring, Stephen Few, Analytics Press, 2nd , 2013
2.	Beautiful Visualization, Julie Steele, Noah Iliinsky, O'Reilly Media, Inc., 1st Edition, June 2010

E Books / MOOCs/ NPTEL

1.	https://www.coursera.org/specializations/data-visualization
2.	https://www.coursera.org/learn/analytics-tableau
3.	https://www.edx.org/course/data-science-visualization

Introduction to MATLAB Programming

Course Code:	**RI2212-1**	**Course Type**	**PEC**
Teaching Hours/Week (L: T: P: S)	**3:0:0:0**	**Credits**	**03**
Total Teaching Hours	**40**	**CIE + SEE Marks**	**50+50**
Prerequisite	**CS1001-1, IS1001-1**		

Teaching Department: Robotics and Artificial Intelligence

Course Objectives:

1.	Explain the main features of the MATLAB program development environment to enable their usage in the simple engineering problems.
2.	Implement simple mathematical functions/equations in numerical computing environment such as MATLAB
3.	Able to program scripts and functions using the MATLAB development environment.
4.	Create and control simple plot and user-interface graphics objects in MATLAB
5.	Apply numeric techniques and computer simulations to solve engineering-related problems.

UNIT-I

MATLAB Basics	**06 Hours**
The MATLAB environment - Basic computer programming - Variables and constants, operators. Array operations in MATLAB, Loops and Execution Control, MATLAB Files-scripts and functions (m-files), Reading and writing data, file handling - Personalized functions - Toolbox structure, Plotting and Output	
Errors and Approximations	**05 Hours**
Errors in Numerical Computation, Truncation Errors and Taylors Series, Round-Off Errors; and Iterative Methods, Stepwise Methods and Error Propagation.	
Numerical Differentiation and Integration	**04 Hours**
Differentiation in Single Variable, Higher Order Differentiation Formulae, Partial Differentials, Numerical Integration, Multiple Applications of Integration Formulae, In-Built MATLAB Integration Functions	

UNIT-II

Linear Equations	**06 Hours**
Basics of Linear Algebra, Gauss Elimination and Back-Substitution, LU Decomposition and Partial Pivoting, Gauss Siedel Method	
Nonlinear Equations in Single Variable	**05 Hours**
Using MATLAB command fzero, Fixed Point Iteration in Single Variable, Newton-Raphson (single variable), Using MATLAB command fsolve (multi-variable), Newton-Raphson (multi-Variable)	
Regression and Interpolation	**04 Hours**
Introduction, Linear Least Squares Regression, Nonlinear and Functional Regression, Interpolation Functions in MATLAB, Tutorial: How to do linear and nonlinear regression	

UNIT-III

Data analysis in MATLAB	**05 Hours**
Data Representation, Statistical Data Analysis, Data Visualization, Dimensionality Reduction, Data Classification, Data Prediction, Loading and Inspecting Datasets, Detecting Outliers, Histogram plots, Scatter plots, PCA.	
Image Analysis in MATLAB, Signal Analysis in MATLAB	**05 Hours**

Image Representation, Image Resampling, Image Intensity & Color Distributions, Image Filtering, Image Segmentation. Cropping, Color Images, Motion, Convex Hull, Dilation and Erosion. Signals as Time Dependent Data, Signal Interpolation. Signal Frequency Analysis, Sampling and Aliasing.

Course Outcomes: At the end of the course student will be able to

1.	Explain the main features of the MATLAB program development environment to enable their usage in the simple engineering problems.
2.	Implement simple mathematical functions/equations in numerical computing environment such as MATLAB
3.	Able to program scripts and functions using the MATLAB development environment
4.	Create and control simple plot and user-interface graphics objects in MATLAB
5.	Apply numeric techniques and computer simulations to solve engineering-related problems

Course Outcomes Mapping with Program Outcomes & PSO

Program Outcomes→	1	2	3	4	5	6	7	8	9	10	11	12	**PSO↓**		
↓ Course Outcomes													1	2	3
RI2212-1.1	3	2	3	3	3	-	-	-	-	-	-	2	2	-	2
RI2212-1.2	3	2	3	3	3	-	-	-	-	-	-	2	2	-	2
RI2212-1.3	3	2	3	3	3	-	-	-	-	-	-	2	2	-	2
RI2212-1.4	3	2	3	3	3	-	-	-	-	-	-	2	2	-	2
RI2212-1.5	3	2	3	3	3	-	-	-	-	-	-	2	2	-	2

1: Low 2: Medium 3: High

TEXTBOOKS:

1. Mastering MATLAB, Duane C. Hanselman, Bruce L. Littlefield, Pearson1st Edition, 2011

REFERENCE BOOKS:

1. Stephen J. Chapman, Essentials of MATLAB Programming, Published by Cengage Learning, 2nd Edition, 2009
2. MATLAB and its Applications in Engineering, Raj Kumar Bansal, Ashok kumar Goel, Pearson 2016
3. Getting Started with MATLAB A Quick Introduction for Scientists and Engineers, Rudra Pratap Oxford, 7th Edition, 2010

E Books / MOOCs/ NPTEL

1. https://www.coursera.org/learn/matlab
2. https://nptel.ac.in/courses/103/106/103106118/
3. https://ocw.mit.edu/courses/mathematics/18-s997-introduction-to-matlab-programming-fall-2011/
4. https://in.mathworks.com/help/examples.html?s_tid=CRUX_topnav

Mobile Application Development

Course Code:	**RI2213-1**	**Course Type**	**PEC**
Teaching Hours/Week (L: T: P: S)	**3:0:0:0**	**Credits**	**03**
Total Teaching Hours	**40**	**CIE + SEE Marks**	**50+50**
Prerequisite	**IS1001-1**		

Teaching Department: Robotics and Artificial Intelligence

Course Objectives:

1.	Learn to setup Android application development environment
2.	Illustrate user interfaces for interacting with apps and triggering actions
3.	Interpret tasks used in handling multiple activities
4.	Identify options to save persistent application data
5.	Appraise the role of security and performance in Android applications

UNIT-I

Introduction — **16 Hours**

Get started, build your first app, Activities, Testing, debugging and using support libraries User Interaction, Delightful user experience, Testing your UI.

UNIT-II

Building apps — **15 Hours**

Background Tasks, Triggering, scheduling and optimizing background tasks, All about data, Preferences and Settings, Storing data using SQLite, Sharing data with content providers, Loading data using Loaders

UNIT-III

Performance — **09 Hours**

Permissions, Performance and Security, Firebase and AdMob, Publish

Course Outcomes: At the end of the course student will be able to

1.	Create, test and debug Android application by setting up Android development environment
2.	Implement adaptive, responsive user interfaces that work across a wide range of devices.
3.	Infer long running tasks and background work in Android applications
4.	Demonstrate methods in storing, sharing and retrieving data in Android applications
5.	Analyse performance of android applications and understand the role of permissions and security

Course Outcomes Mapping with Program Outcomes & PSO

Program Outcomes→	1	2	3	4	5	6	7	8	9	10	11	12	**PSO↓**		
↓ Course Outcomes													1	2	3
RI2213-1.1	3	-	-	1	2	1	-	-	-	-	-	1	-	3	3
RI2213-1.2	3	-	-	1	2	1	-	-	-	-	-	1	-	3	3
RI2213-1.3	3	-	-	2	1	3	-	-	-	-	-	1	-	3	3
RI2213-1.4	3	-	-	2	1	2	-	-	-	-	-	1	-	3	3
RI2213-1.5	3	-	-	2	1	2	-	-	-	-	-	1	-	3	3

1: Low 2: Medium 3: High

TEXTBOOKS:

1.	Android Developer Fundamentals Course –Google Developer, 2017

2.	Android Wireless Application Development, Lauren Darcey and Shane, Pearson Education, 2nd Edn. 2011
REFERENCE BOOKS:	
1.	Professional Android 2 Application Development, Reto Meier, Wiley, 2010
2.	Android Programming – Pushing the Limits, Erik Hellman, Wiley, 2014
3.	Headfirst Android Development, Dawn Griffiths and David, O'Reilly SPD Publishers, 1st Edn. 2015
4.	Beginning Android Programming with Android, J F DiMarzio, Wiley, 4th Edn. 2016
E Books / MOOCs/ NPTEL	
1.	https://nptel.ac.in/courses/106/106/106106156/
2.	https://nptel.ac.in/courses/106/106/106106147/
3.	https://www.udemy.com/course/introduction-to-mobile-application-development/
4.	https://www.udemy.com/course/android-app-development-course/

Virtual Instrumentation

Course Code:	**RI2214-1**	**Course Type**	**PEC**
Teaching Hours/Week (L: T: P: S)	**3:0:0:0**	**Credits**	**03**
Total Teaching Hours	**40**	**CIE + SEE Marks**	**50+50**
Prerequisite	**EC 1001-1**		

Teaching Department: Robotics and Artificial Intelligence

Course Objectives:

1.	Describe virtual instrumentation concepts.
2.	Describe data acquisition methodologies
3.	Describe PC Buses used in virtual instrumentation systems.
4.	Solve simple VI design problems using the tools of VI software.
5.	Apply the concept of VI for data acquisition and control.

UNIT-I

Virtual Instrumentation	**07 Hours**

Definition and Flexibility - Block diagram and Architecture for Virtual Instruments versus Traditional Instruments Instrumentation -VI Programming techniques - VI, sub VI, Loop and Charts, Arrays, Clusters and Graphs, Case and Sequence Structures, Formula nodes, String and File Input / Output.

A/D and D/A converters	**09 Hours**

Plug-in Analog Input / Output cards – Digital Input and Output Cards, Organization of the DAQ VI system – Opto-isolation – Performing analog input and analog output – Scanning multiple analog channels – Issues involved in selection of Data acquisition cards – Data acquisition modules with serial communication – Design of digital voltmeter with transducer input –Timers and Counters.

UNIT-II

Introduction to PC Buses – Local buses	**08 Hours**

ISA, PCI, RS232, RS422 and RS485 – Interface Buses:- USB, PCMCIA, VXI, SCXI and PXI – Instrumentation Buses :- Modbus and GPIB – Networked busses – ISO/OSI Reference model, Ethernet and TCP/ IP Protocols.

Designs using VI Software	**06 Hours**

ON/OFF controller – Proportional controller – Modeling and basic control of level and reactor processes – Case studies on development of HMI, SCADA in VI.

UNIT-III

	10 Hours

PC architecture, current trends, operating system requirements, PC based instrumentation, analog and digital interfaces, PXI and SCXI main frame - modular instruments – Transducers – power, speed and timing considerations.

Course Outcomes: At the end of the course student will be able to

1.	Explain virtual instrumentation and programming concepts.
2.	Explain data acquisition methodologies for Virtual Instrumentation
3.	Explain PC Buses used in virtual instrumentation systems.
4.	Solve simple VI design problems using the tools of VI software.

5.	Explain the implementation methods for instrumentation and the basic concepts of interfacing of VI.

Course Outcomes Mapping with Program Outcomes & PSO

Program Outcomes→ **↓ Course Outcomes**	1	2	3	4	5	6	7	8	9	10	11	12	PSO↓		
RI2214-1.1	2	2	2	2	3	-	-	-	-	-	-	3	3	2	3
RI2214-1.2	2	2	2	2	3	-	-	-	-	-	-	3	3	2	3
RI2214-1.3	2	2	2	2	3	-	-	-	-	-	-	3	3	2	3
RI2214-1.4	2	2	2	2	3	-	-	-	-	-	-	3	3	2	3
RI2214-1.5	2	2	2	2	3	-	-	-	-	-	-	3	3	2	3

1: Low 2: Medium 3: High

TEXTBOOKS:

1.	LabVIEW Graphical Programming, Gary W. Johnson, Richard Jennings, McGraw-Hill Professional Publishing, 3rd edition, 2001
2.	Lab view for Everyonell, Lisa K Wells, Prentice Hall of India. 3rd edition, 2006

REFERENCE BOOKS:

1.	Sensor, transducers and Lab view, Barry Paton, Prentice Hall of India, 2000.
2.	Computer buses, Buchanan, W, CRC Press 2000

E Books / MOOCs/ NPTEL

1.	https://www.ni.com/ (website)
2.	https://www.ni.com/en-in/innovations/white-papers/06/virtual-instrumentation.html

GROUP-II

Augmented Reality and Virtual Reality			
Course Code:	**RI2311-1**	**Course Type**	**PEC**
Teaching Hours/Week (L: T: P: S)	**3:0:0:0**	**Credits**	**03**
Total Teaching Hours	**40**	**CIE + SEE Marks**	**50+50**
Prerequisite	**ME 1002-1**		

Teaching Department:

Course Objectives:

1.	Explain the strategic role of AR
2.	Discuss the Interactive Techniques in Virtual Reality
3.	Apply the concept of Visual Computation in Virtual Reality
4.	Discuss the features and methods of Augmented and Mixed Reality
5.	Explain the Multiple Models of Input and Output Interface in Virtual Reality.

UNIT-I

Introduction to Virtual Reality:	**07 Hours**

Fundamental Concept and Components of Virtual Reality. Primary Features and Present Development on Virtual Reality. Computer graphics, Real time computer graphics, Flight Simulation, Virtual environment requirement, benefits of virtual reality, Historical development of VR, Scientific Landmark 3D Computer Graphics: Introduction, The Virtual world space, positioning the virtual observer, the perspective projection, human vision, stereo perspective projection, 3D clipping, Colour theory, Simple 3D modelling, Illumination models, Reflection models, Shading algorithms, Radiosity, Hidden Surface Removal, Realism Stereographic image.

Interactive Techniques in Virtual Reality:	**09 Hours**

Introduction, From 2D to 3D, 3D space curves, 3D boundary representation Geometrical Transformations: Introduction, Frames of reference, Modeling transformations, Instances, Picking, Flying, Scaling the VE, Collision detection Generic VR system: Introduction, Virtual environment, Computer environment, VR technology, Model of interaction, VR Systems.

UNIT-II

Visual Computation in Virtual Reality:	**06 Hours**

Animating the Virtual Environment: Introduction, The dynamics of numbers, Linear and Nonlinear interpolation, the animation of objects, linear and non-linear translation, shape & object inbetweening, free from deformation, particle system. Physical Simulation: Introduction, Objects falling in a
gravitational field, Rotating wheels, Elastic collisions, projectiles, simple pendulum, springs, Flight dynamics of an aircraft.

Animating the Virtual Environment:	**08 Hours**

The dynamics of numbers, Linear and Nonlinear interpolation, the animation of objects, linear and non-linear translation, shape & object inbetweening, free from deformation, particle system. Physical Simulation: Introduction, Objects falling in a
gravitational field, Rotating wheels, Elastic collisions, projectiles, simple pendulum, springs, Flight dynamics of an aircraft.

Augmented and Mixed Reality	**05 Hours**

Taxonomy, technology and features of augmented reality, difference between AR and VR, Challenges with AR, AR systems and functionality, Augmented reality methods, visualization techniques for augmented reality, wireless displays in educational augmented reality applications, mobile projection interfaces, marker-less tracking for augmented reality, enhancing interactivity in AR environments, evaluating AR systems.

UNIT-III

Multiple Models of Input and Output Interface in Virtual Reality: **05 Hours**

Human factors: Introduction, the eye, the ear, the somatic senses. VR Hardware: Introduction, sensor hardware, Head-coupled displays, Acoustic hardware, Integrated VR systems. VR Software: Introduction, Modeling virtual world, Physical simulation, VR toolkits, Introduction to VRML, Input -Tracker, Sensor, Digital Glove, Movement Capture, Video-based Input, 3D Menus & 3DScanner etc. Output -- Visual /Auditory / Haptic Devices.
VR Technology in Film & TV Production. VR Technology in Physical Exercises and Games. Demonstration of Digital Entertainment by VR.

Course Outcomes: At the end of the course student will be able to

1.	Explain the strategic role of AR
2.	Discuss the Interactive Techniques in Virtual Reality
3.	Apply the concept of Visual Computation in Virtual Reality
4.	Discuss the features and methods of Augmented and Mixed Reality
5.	Explain the Multiple Models of Input and Output Interface in Virtual Reality.

Course Outcomes Mapping with Program Outcomes & PSO

Program Outcomes→	1	2	3	4	5	6	7	8	9	10	11	12	**PSO↓**		
↓ Course Outcomes													1	2	3
RI2311-1.1	3	-	-		2		-	-			-	2	-	3	
RI2311-1.2	3	-	-		2		-	-			-	2	-	3	
RI2311-1.3	3	-	-		3		-	-			-	2	-	3	
RI2311-1.4	3	-	-		3		-	-			-	2	-	3	
RI2311-1.5	3	-	-		3		-	-			-	2	-	3	

1: Low 2: Medium 3: High

TEXTBOOKS:

1. Virtual Reality Technology, Burdea, G. C. and P. Coffet., Wiley-IEEE Press, Second Edition, 2003/2006.

2. Understanding Augmented Reality, Concepts and Applications, Alan B. Craig, Morgan Kaufmann,, 2013.

3. Developing Virtual Reality Applications, Foundations of Effective Design, Alan Craig, William Sherman and Jeffrey Will, Morgan Kaufmann, 2009

REFERENCE BOOKS:

1. Virtual Reality Systems, Pearson Education, John Vince, 2007

2. Augmented and Virtual Reality, Anand R, Khanna Publishing House, Delhi

3. Visualizations of Virtual, Adams, Tata McGraw Hill, 2000.

E Books / MOOCs/ NPTEL

1. https://nptel.ac.in/courses/121/106/121106013/

2. https://www.udemy.com/course/augment-reality-merge-cube-ar-introduction-to-augment-reality-ar/

3. https://www.udemy.com/course/businesses-in-augmented-reality-virtual-reality/

Computer Vision

Course Code:	**RI2312-1**	**Course Type**	**PEC**
Teaching Hours/Week (L: T: P: S)	**3:0:0:0**	**Credits**	**03**
Total Teaching Hours	**40**	**CIE + SEE Marks**	**50+50**
Prerequisite	**CS1001-1**		

Teaching Department: Robotics and Artificial Intelligence

Course Objectives:

1.	Understand digital image formation and process image using various transformation filtering, enhancement and histogram processing.
2.	Understand depth information and tracking object through multi-camera views.
3.	Understand feature extraction and image segmentation techniques
4.	Know the clustering and classification techniques to analyse patterns
5.	Tracking of an object through image sequence using motion analysis and estimating the shape from texture, color, motion and edges

UNIT-I

Digital Image Formation and low-level processing	**07 Hours**

Overview and State-of-the-art, Fundamentals of Image Formation, Transformation: Orthogonal, Euclidean, Affine, Projective, etc; Fourier Transform, Convolution and Filtering, Restoration.

Depth estimation and Multi-camera views	**09 Hours**

Perspective, Binocular Stereopsis: Camera and Epipolar Geometry; Homography, Rectification, DLT, RANSAC, 3-D reconstruction framework; Auto-calibration.

UNIT-II

Feature Extraction	**08 Hours**

Edges - Canny, LOG, DOG; Line detectors (Hough Transform), Corners - Harris and Hessian Affine, Orientation Histogram, SIFT, SURF, HOG, GLOH, Scale-Space Analysis- Image Pyramids and Gaussian derivative filters, Gabor Filters and DWT.

Pattern Analysis: Clustering	**06 Hours**

K-Means, K-Medoids, Mixture of Gaussians, Classification: Discriminant Function, Supervised, Un-supervised, Semi-supervised; Classifiers: Bayes, KNN, ANN models; Dimensionality Reduction: PCA, LDA, ICA; Non-parametric methods.

UNIT-III

Motion Analysis	**05 Hours**

Background Subtraction and Modeling, Optical Flow, KLT, Spatio-Temporal Analysis, Dynamic Stereo; Motion parameter estimation.

Shape from X	**05 Hours**

Light at Surfaces; Phong Model; Reflectance Map; Albedo estimation; Photometric Stereo; Use of Surface Smoothness Constraint; Shape from Texture, color, motion and edges.

Course Outcomes: At the end of the course student will be able to

1.	Create image, apply various transformations and enhancement of image.
2.	Make use of geometric camera models and multiple view geometry.
3.	Apply various filtering techniques for feature extraction of image.
4.	Apply algorithms for image segmentation and pattern recognition.

5.	Apply different methods for motion analysis and shape estimation.

Course Outcomes Mapping with Program Outcomes & PSO

Program Outcomes→	1	2	3	4	5	6	7	8	9	10	11	12	PSO↓		
↓ Course Outcomes															
RI2312-1.1	3	3	3	2	3	-	-	-	-	-	-	3	2	3	2
RI2312-1.2	3	3	3	2	3	-	-	-	-	-	-	3	2	3	2
RI2312-1.3	3	3	3	2	3	-	-	-	-	-	-	3	2	3	2
RI2312-1.4	3	3	3	2	3	-	-	-	-	-	-	3	2	3	2
RI2312-1.5	3	3	3	2	3	-	-	-	-	-	-	3	2	3	2

1: Low 2: Medium 3: High

TEXTBOOKS:

1.	Computer Vision: Algorithms and Applications, Richard Szeliski, Microsoft Research, Electronic draft (2010).
2.	Computer Vision: A Modern Approach, David A. Forsyth & Jean Ponce, Prentice Hall; 2 edition (2011)
3.	Multiple View Geometry in Computer Vision, Hartley & Zisserman, Cambridge University Press; 2 edition (2004)

REFERENCE BOOKS:

1.	Machine vision, Jain, Ramesh and Rangachar Kasturi and Brian G. Schunck; McGraw-Hill, Edition-1995.
2.	Introductory computer vision and image processing, Low, Adrian; McGraw-Hill, Edition-1991.
3.	Digital image processing, Gonzalez, Rafael C. and Richard E. Woods; Addison-Wesley, Edition: 3rd, Year:1998.

E Books / MOOCs/ NPTEL

1.	https://nptel.ac.in/courses/106/105/106105216/
2.	http://www.cse.iitm.ac.in/~vplab/computer_vision.html
3.	https://cloud.google.com/vision

PLC and SCADA

Course Code:	**RI2313-1**	**Course Type**	**PEC**
Teaching Hours/Week (L: T: P: S)	**3:0:0:0**	**Credits**	**03**
Total Teaching Hours	**40**	**CIE + SEE Marks**	**50+50**
Prerequisite	**EE 1001-1, EC 1001-1**		

Teaching Department: Robotics and Artificial Intelligence

Course Objectives:

1.	Gain knowledge in the concepts of developing basic skills necessary for PLC & SCADA
2.	Understand the basic programming concepts and various Operation using RELAY LOGIC devices used in PLC and SCADA
3.	Diagnose the problem related types of I/O module, Data Acquisition System and Communication Networks (Bus Systems) using Standard Protocol.
4.	Understand the concepts of SCADA fundamentals.
5.	Understand the human machine interfacing component for control application.

UNIT-I

Programmable Logic Controllers	**07 Hours**

Introduction, Parts of a PLC, Principles of Operation, Modifying the Operation, PLCs versus Computers, PLC Size and Application. PLC Hardware Components: The I/O Section, Discrete I/O Modules, Analog I/O Modules, Special I/O Modules, I/O Specifications, The Central Processing Unit (CPU), Memory Design, Memory Types, Programming Terminal Devices, Recording and Retrieving Data, Human Machine Interfaces (HMIs).

Basics of PLC Programming	**09 Hours**

Processor Memory Organization, Program Scan, PLC Programming Languages, Relay- Type Instructions, Instruction Addressing, Branch Instructions, Internal Relay Instructions, Programming Examine If Closed and Examine If Open Instructions, Entering the Ladder Diagram, Modes of operation.

UNIT-II

Developing Fundamental PLC Wiring Diagrams and Ladder Logic Programs	**07 Hours**

Electromagnetic Control Relays, Contactors, Motor Starters, Manually Operated Switches, Mechanically Operated Switches, Sensors, Output Control Devices, Seal-in Circuits, Latching Relays, Converting Relay Schematics into PLC Ladder Programs, Writing a Ladder Logic Program Directly from a Narrative Description. Programming Timers: Mechanical Timing Relays, Timer Instructions, On-Delay Timer Instruction, Off-Delay Timer Instruction, Retentive Timer, Cascading Timers.

SCADA Fundamentals	**07 Hours**

Introduction, Open system: Need and advantages, Building blocks of SCADA systems, Remote terminal unit (RTU): Evolution of RTUs, Components of RTU, Communication subsystem, Logic subsystem, Termination subsystem, Testing and human-machine interface (HMI) subsystem, Power supplies, Advanced RTU functionalities, Intelligent electronic devices (IEDs), Data concentrators and merging units, SCADA communication systems.

UNIT-III

Master Station	**05 Hours**

Master station software components, Master station hardware components, Server systems in the master station, small, medium, and large master stations, Global positioning systems (GPS), Master station performance

Human-Machine Interface (HMI)	**05 Hours**
HMI components, HMI software functionalities, Situational awareness, Intelligent alarm filtering: Need and technique, Alarm suppression techniques, Operator needs and requirements, SCADA Systems: Building the SCADA systems, legacy, hybrid, and new systems, Classification of SCADA systems, SCADA implementation: A laboratory model: The SCADA laboratory, System hardware, System software, SCADA lab field design.	

Course Outcomes: At the end of the course student will be able to

1.	Explain the principles of operation, hardware components and applications of PLC
2.	Develop Fundamental PLC Wiring Diagrams and Ladder Logic Programs
3.	Explain the building blocks and fundamentals of SCADA system
4.	Explain the master station software and hardware components and server system
5.	Design Human-Machine Interface (HMI) for a control application

Course Outcomes Mapping with Program Outcomes & PSO

Program Outcomes→	1	2	3	4	5	6	7	8	9	10	11	12	PSO↓		
↓ Course Outcomes															
RI2313-1.1	2	2	2	2	2	-	-	-	-	-	-	2	3	2	3
RI2313-1.2	2	2	2	2	2	-	-	-	-	-	-	2	3	2	3
RI2313-1.3	2	2	2	2	2	-	-	-	-	-	-	2	3	2	3
RI2313-1.4	2	2	2	2	2	-	-	-	-	-	-	2	3	2	3
RI2313-1.5	2	2	2	2	2	-	-	-	-	-	-	2	3	2	3

1: Low 2: Medium 3: High

TEXTBOOKS:

1.	"Programmable Logic Controllers And Industrial Automation An Introduction" by Madhuchhanda Mitra, Penram International Publishing, 2008
2.	Ronald L Krutz, "Securing SCADA System", Wiley Publication, 2005
3.	Gary Dunning," Introduction to Programmable Logic Controllers", Thomson, 2nd Edition.

REFERENCE BOOKS:

1.	John W Webb, Ronald A Reis,"Programmable Logic Controllers: Principles and Application", PHI Learning, Newdelhi, 5 th Edition.
2.	Stuart A Boyer, "SCADA Supervisory Control and Data Acqusition", ISA, 4 th Revised edition
3.	SCADA Supervisory Control and Data Acquisition, Stuart A Boyer, ISA, 4th Revised edition 1993

E Books / MOOCs/ NPTEL

1.	https://nptel.ac.in/courses/108/105/108105088/
2.	Virtual Lab link- https://plc-coep.vlabs.ac.in/
3.	https://new.abb.com/plc
4.	https://new.siemens.com/global/en/products/automation/industry-software/automation- software/scada.html

SIGNAL PROCESSING

Course Code:	**RI2314-1**	**Course Type**	**PEC**
Teaching Hours/Week (L: T: P: S)	**3:0:0:0**	**Credits**	**03**
Total Teaching Hours	**40**	**CIE + SEE Marks**	**50+50**
Prerequisite	**EE 1001-1, EC 1001-1**		

Teaching Department: Robotics and Artificial Intelligence

Course Objectives:

1.	Understand the concept of Frequency Domain Sampling, Computation of DFT and properties of DFT
2.	Understand Linear Filtering methods using Overlap Add and Overlap Save Algorithms.
3.	Understand the Fast Fourier Transform using Radix 2 DITFFT and DIFFFT Algorithms.
4.	Design and Analyze the characteristics of Analog filters using Butterworth & Chebyshev approximation techniques
5.	Understand architecture of DSP Processors and Filter Implementations using Fixed Point DSP processors.

UNIT-I

Discrete Fourier Transform	**08 Hours**
Discrete Fourier Transform (DFT), DFT as a linear Transformation, Properties of DFT (derivation not included);Overlap-save and Overlap-add method;	
Fast Fourier Transform	**08 Hours**
Decimation in Time FFT (DITFFT) algorithm and In-place computations, Decimation in Frequency FFT (DIFFFT) algorithm. Inverse Fast Fourier Transforms.	

UNIT-II

Design of Infinite Impulse Response (IIR) Digital Filters	**08 Hours**
IIR Butterworth and Chebyshev Filter Design by Impulse Invariance and Bilinear Transformation. IIR Filter structures (Direct Form I & Direct Form II).	
Design of Finite Impulse Response (FIR) Filters	**08 Hours**
Design of FIR filters using windows, Design of FIR filters using Frequency Sampling method, FIR Filter Structures (Linear phase & Lattice structure).	

UNIT-III

Digital Signal Processors	**08 Hours**
DSP Architecture, DSP Hardware Units, Fixed point format, Floating point Format, IEEE Floating point formats, Fixed point digital signal processors, Floating point processors, FIR and IIR filter implementations in Fixed point systems	

Course Outcomes: At the end of the course student will be able to

1.	Develop representations for signal analysis and synthesis using DFT and its properties.
2.	Build and apply algorithms using Overlap Add Method and Overlap Save Method for sequences of length not more than 20 and faster algorithms Radix 2 DITFFT and Radix 2 DIFFFT to compute DFT.

3.	Make use of Butterworth & Chebyshev approximations to design and implement analog and digital IIR Filters.
4.	Design & implement FIR Filters using windowing and Frequency sampling. approaches.
5.	Identify architectural features of Fixed-point DSP processors and plan the implementation of Filters.

Course Outcomes Mapping with Program Outcomes & PSO

Program Outcomes→	1	2	3	4	5	6	7	8	9	10	11	12	PSO↓		
↓ Course Outcomes													01	02	03
RI2314-1.1	3	-	-	-	-	-	-	-	-	-	-	-	3	-	-
RI2314-1.2	3	-	-	-	-	-	-	-	-	-	-	-	3	-	-
RI2314-1.3	3	-	1	-	1	-	-	-	-	-	-	-	3	2	-
RI2314-1.4	3	-	1	-	1	-	-	-	-	-	-	-	3	2	-
RI2314-1.5	3	-	-	-	-	-	-	-	-	-	-	-	3	2	-

1: Low 2: Medium 3: High

TEXTBOOKS:

1.	Proakis, Manolakis, "Digital Signal Processing – Principles Algorithms & Applications", PHI, 4thEdition, New Delhi, 2007.
2.	Li Tan, "Digital Signal processing – Fundamentals and Applications", Academic Press, 2008.
3.	Avtar Singh, S Srinivasan, "Digital Signal Processing", Thomson Publishing, 2004.

REFERENCE BOOKS:

1.	Oppenheim & Schaffer, "Discrete Time Signal Processing", PHI, 2003
2.	S. K. Mitra, "Digital Signal Processing", Tata McGraw Hill, 2nd Edition, 2004

E Books / MOOCs/ NPTEL

1.	https://nptel.ac.in/courses/117102060

Professional Elective Courses (Artificial Intelligence Stream)

GROUP-I

Cloud Computing

Course Code:	**RI2221-1**	**Course Type**	**PEC**
Teaching Hours/Week (L: T: P: S)	**3:0:0:0**	**Credits**	**03**
Total Teaching Hours	**40**	**CIE + SEE Marks**	**50+50**
Prerequisite	**IS1001-1**		

Teaching Department:

Course Objectives:

1.	Explain the various elements of distributed computing.
2.	Explain the types of cloud and its challenges.
3.	Explain the characteristics of virtualized environment and understand the technologies used.
4.	Understand the security concerns in cloud computing.

UNIT-I

Introduction to Cloud Computing — **07 Hours**

Eras of computing, Parallel vs. Distributed Computing, Elements of Parallel Computing- (What is parallel computing, hardware architecture for Parallel processing, approaches to parallel programming, levels of parallelism, Laws of caution). Elements of Distributed Computing- (General concepts and definitions, components of a distributed system, Architectural styles for distributed computing, models for inter-process communication, Technologies for distributed computing-Remote procedure call, Service oriented computing).
Classic data center, its elements, challenges and benefits. Data center management Steps in transitioning to cloud- consolidation, automation, IT as a service.

Cloud computing Architecture — **07 Hours**

Introduction, Cloud reference models- (Architecture, Infrastructure/Hardware as a service, Platform as a service, Software as a service), Types of cloud – (Public Clouds, Private Clouds, Hybrid Clouds, Community Clouds), Economics of cloud, Open challenges.

UNIT-II

Virtualization — **8 Hours**

Introduction, characteristics of virtualized environments, taxonomy of virtualization technique- (execution of virtualization, other types of virtualization-Compute, Storage, Network, Desktop, Application). Virtualization and cloud computing, Pros and Cons of virtualization,

Technology examples — **7 Hours**

XEN, VMware, Microsoft Hyper-V.
Security Concerns, Risk Issues:- Cloud Computing- Security Concerns. A Closer Examination: Virtualization, A Closer Examination: Provisioning.
Securing the Cloud: Key Strategies and Best Practices: - Overall Strategy: Effectively Managing Risk- Risk Management: Stages and Activities. Overview of Security Controls, Cloud Security Controls Must Meet Your Needs, NIST Definitions for Security Controls, Unclassified Models, Classified Model The Cloud Security Alliance Approach. The Limits of Security Controls - Security Exposure Will Vary over Time, Exploits Don't Play Fair. Best Practices: Best Practices for Cloud Computing- First Principals, Best Practices across the Cloud Community. Other Best Practices for Cloud Computing-
Cloud Service Consumers, Cloud Service Providers. Security Monitoring.

UNIT-III

Cloud Computing Security	10 Hours

The Purpose of Security Monitoring, Transforming an Event Stream, The Need for C.I.A. in Security Monitoring, the Opportunity for MaaS.
Case studies: Public cloud- AWS, Windows Azure, Google App Engine. Private Cloud- Open stack, Eucalyptus

Course Outcomes: At the end of the course student will be able to

1.	Describe the concept of cloud computing, business need and networking methods.
2.	Explain the infrastructure management for cloud environment.
3.	Apply the concepts of Virtualization at all levels using technology XEN, Vmware, Microsoft Hyper-v.
4.	Explain the security concepts in cloud computing and securing the cloud.
5.	Apply the concepts of Security Monitoring, Transforming an Event Stream using case studies of public cloud such as AWS, Google App Engine and private cloud such as Open Stack.

Course Outcomes Mapping with Program Outcomes & PSO

Program Outcomes→	1	2	3	4	5	6	7	8	9	10	11	12	**PSO↓**		
↓ Course Outcomes													1	2	3
RI2221-1.1	3	2	-	-	-	-	-	-			-	2	-	2	-
RI2221-1.2	3	3	-	-	-	-	-	-			-	2	-	2	-
RI2221-1.3	3	3	-	-	-	-	-	-			-	2	-	2	-
RI2221-1.4	3	3	-	-	-	-	-	-			-	2	-	2	-
RI2221-1.5	3	3	-	-	-	-	-	-			-	2	-	2	-

1: Low 2: Medium 3: High

TEXTBOOKS:

1.	Mastering Cloud Computing Fundamentals and Applications Programming, Buyya, Rajkumar, Christian Vecchiola and Thamarai Selvi, McGraw Hill, 2013.
2.	Information Storage and, Management, G,, Somasundarm and Alok Srivatsa, Wiley Publishing Inc., 2009
3.	Moving to the Cloud - Developing Apps in the World of Cloud Computing, Sitaram, Dinakar and Geetha Manjunath, Elsevier, 2012

REFERENCE BOOKS:

1.	Cloud Computing Bible, Sosinsky, Barrie, Wiley India Pvt. Ltd., 2013
2.	Securing the Cloud - Cloud Computer Security Techniques and Tactics, Winkler, Vic(J.R.), Elsevier Inc., 2012
3.	Cloud computing for dummies, Hurwitz, Judith, Wiley India Pvt Ltd, 2011
4.	Cloud Computing, A Practical Approach, Velte, Toby, Anthony Velte and R. Elsenpete, Tata McGraw-Hill, 2010

E Books / MOOCs/ NPTEL

1.	https://nptel.ac.in/courses/106/105/106105167/
2.	https://nptel.ac.in/courses/106/105/106105223/
3.	https://www.udemy.com/course/introduction-to-cloud-computing/
4.	https://www.udemy.com/course/intro-to-cloud-computing/

Design and Analysis of Algorithms

Course Code:	**RI2222-1**	**Course Type**	**PEC**
Teaching Hours/Week (L: T: P: S)	**3:0:0:0**	**Credits**	**03**
Total Teaching Hours	**40**	**CIE + SEE Marks**	**50+50**
Prerequisite	**CS1001-1**		

Teaching Department: Robotics and Artificial Intelligence

Course Objectives:

1.	Understand the non-recursive or recursive algorithm and to represent in terms of standard Asymptotic notations.
2.	Understand the Brute Force or Divide and Conquer algorithm design techniques
3.	Understand the Decrease and Conquer and Transform and Conquer algorithm design techniques to a given real time problem.
4.	Understand the Time and Space Trade off sin designing algorithms and also to apply dynamic programming to a given real time problem.
5.	Understand the Dynamic programming using Warshall's and Floyd's Algorithms. Apply the dynamic programming by using various memory functions to a given real time problem.

UNIT-I

Introduction	**06 Hours**
What is an Algorithm? Fundamentals of Algorithmic, Problem Solving. Important Problem Types, Fundamental Data Structures.	
Fundamentals of the algorithm's efficiency	**05 Hours**
Analysis Framework, Asymptotic Notations and Basic Efficiency Classes, Mathematical Analysis of Non-recursive and Recursive Algorithms – Fibonacci Numbers and Tower of Hanoi	
Brute force	**04 Hours**
Selection Sort and Bubble Sort, Sequential Search and Brute-Force String Matching, Exhaustive Search.	

UNIT-II

Divide and conquer	**06 Hours**
Merge sort, Quick sort, Binary Search, Binary tree traversals and related properties, Multiplication of large integers and Strassen's Matrix Multiplication.	
Decrease & conquer	**05 Hours**
Insertion Sort, Depth First Search, Breadth First Search, Topological Sorting, Algorithms for Generating Combinatorial Objects.	
Transform and conquer	**04 Hours**
Pre-sorting, Balanced Search Trees, Heaps and Heap sort, Problem Reduction	

UNIT-III

Time and space trade-offs	**05 Hours**
Sorting by Counting, Input Enhancement in String Matching, Hashing.	
Dynamic programming	**05 Hours**
Computing a Binomial Coefficient, Warshall's and Floyd's Algorithms, The Knapsack Problem and memory functions.	

Course Outcomes: At the end of the course student will be able to

1.	Analyze non-recursive or recursive algorithm and to represent in terms of standard Asymptotic notations

2.	Apply Brute Force or Divide and Conquer algorithm design techniques to a given real time problem.
3.	Apply the Decrease and Conquer and Transform and Conquer algorithm design techniques to a given real time problem.
4.	Analyze Time and Space Trade off sin designing algorithms and also to apply dynamic programming to a given real time problem.
5.	Apply Greedy, Backtracking and Branch and Bound algorithm design techniques to real time problems

Course Outcomes Mapping with Program Outcomes & PSO

Program Outcomes→	1	2	3	4	5	6	7	8	9	10	11	12	**PSO↓**		
↓ Course Outcomes													1	2	3
RI2222-1.1	3	3	2	2	2	-	-	-	-	-	-	2	2	-	2
RI2222-1.2	3	3	2	2	2	-	-	-	-	-	-	2	2	-	2
RI2222-1.3	3	3	2	2	2	-	-	-	-	-	-	2	2	-	2
RI2222-1.4	3	3	2	2	2	-	-	-	-	-	-	2	2	-	2
RI2222-1.5	3	3	2	2	2	-	-	-	-	-	-	2	2	-	2

1: Low 2: Medium 3: High

TEXTBOOKS:

1.	Anany Levitin, “Introduction to the Design & Analysis of Algorithms”, 2nd Edition, Pearson Education, 2007.

REFERENCE BOOKS:

1.	Thomas H. Cormen, Charles E. Leiserson, Ronal L. Rivest, Clifford Stein, “Introduction to Algorithms”, 2nd Edition, PHI,2006.
2.	Horowitz E., Sahni S., Rajasekaran S, “Computer Algorithms”, Galgotia Publications, 2001.
3.	R.C.T. Lee, S.S. Tseng, R.C. Chang & Y.T.T sai, “Introduction to the Design and Analysis of Algorithms a Strategic Approach”, Tata McGraw Hill,2005.

E Books / MOOCs/ NPTEL

1.	https://onlinecourses.nptel.ac.in/noc22_cs27/preview
2.	https://www.coursera.org/lecture/algorithms-part1/analysis-of-algorithms introduction-xaxyP
3.	Virtual Lab link- https://cs413daa.wixsite.com/algorithms/virtual-lab
4.	https://www.aziksa.com/algorithms-design-analysis

NPTEL

1.	https://nptel.ac.in/courses/106106131

Machine Learning with Python

Course Code:	**RI2223-1**	**Course Type**	**PEC**
Teaching Hours/Week (L: T: P: S)	**3:0:0:0**	**Credits**	**03**
Total Teaching Hours	**40**	**CIE + SEE Marks**	**50+50**
Prerequisite	**CS1001-1**		

Teaching Department: Robotics and Artificial Intelligence

Course Objectives:

1.	Understand the fundamentals of Machine Learning, data types, types of machine learning
2.	Understand the application of linear regression and logistic regression for real world problems
3.	Understanding and implementation of algorithms for supervised learning
4.	Understand the application of unsupervised learning algorithms with generated learning models and understand the combining Learners
5.	Make use of Data sets in implementing the machine learning algorithms and implement the machine learning concepts and algorithms in any suitable language of choice

UNIT-I

Foundations of Machine Learning	**09 Hours**

What is machine learning? Applications of Machine learning, Understand Data, Types of machine learning: Supervised, Unsupervised, Reinforcement Learning, Theory of learning: feasibility of learning, error and noise, training versus testing, theory of generalization, bias and variance, learning curve.

Supervised Learning-I	**07 Hours**

Linear Regression: Introduction, univariate linear regression, multivariate linear regression, regularized regression

UNIT-II

Supervised Learning – II	**15 Hours**

Logistic regression: classification, Artificial Neural Networks, Support Vector Machines.
Classification: Introduction, Decision Trees, Linear Discriminant Analysis, K-nearest neighbor model, Bayesian Learning, Introduction to Hidden Markov Models and deep learning

UNIT-III

Unsupervised Learning	**05 Hours**

Clustering: Introduction, K-means, Hierarchical clustering Evaluation Measures and Combining Learners Evaluation Measures: Cross-validation and Re-sampling, Measuring Error, Hypothesis Testing,

Combining Learners	**05 Hours**

Voting, Bagging, Boosting

Course Outcomes: At the end of the course student will be able to

1.	Develop an appreciation for what is involved in learning models from data.
2.	Demonstrate the application of linear regression and logistic regression for real world problems
3.	Design and implement algorithms for supervised learning
4.	Construct basic unsupervised learning algorithms and evaluate the generated learning models

5.	Identify and apply Machine Learning algorithms to solve real world problems

Course Outcomes Mapping with Program Outcomes & PSO

Program Outcomes→	1	2	3	4	5	6	7	8	9	10	11	12	**PSO↓**		
↓ Course Outcomes													1	2	3
RI2223-1.1	3	3	2	2	2	-	-	-	-	-	-	2	2	-	2
RI2223-1.2	3	3	2	2	2	-	-	-	-	-	-	2	2	-	2
RI2223-1.3	3	3	2	2	2	-	-	-	-	-	-	2	2	-	2
RI2223-1.4	3	3	2	2	2	-	-	-	-	-	-	2	2	-	2
RI2223-1.5	3	3	2	2	2	-	-	-	-	-	-	2	2	-	2

1: Low 2: Medium 3: High

TEXTBOOKS:

1.	C. M. Bishop, Pattern Recognition and Machine Learning, Springer, 2006
2.	Ethem Alpaydin, Introduction to Machine Learning, Second Edition, 2004

REFERENCE BOOKS:

1.	T. M. Mitchell, “Machine Learning”, McGraw Hill, 1997.
2.	R. O. Duda, P. E. Hart and D. G. Stork Pattern Classification, Wiley Publications, 2001
3.	T. Hastie, R. Tibshirani, J. Friedman. The Elements of Statistical Learning, 2e, 2008.
4.	P. Flach, “Machine Learning: The art and science of algorithms that make sense of data”, Cambridge University Press, 2012.
5.	K. P. Murphy, “Machine Learning: A probabilistic perspective”, MIT Press, 2012.
6.	M. Mohri, A. Rostamizadeh, and A. Talwalkar, “Foundations of Machine Learning”, MIT Press, 2012.
7.	S. Russel and P. Norvig, “Artificial Intelligence: A Modern Approach”, Third Edition, Prentice Hall, 2009.

E Books / MOOCs/ NPTEL

1.	https://onlinecourses.nptel.ac.in/noc22_cs27/preview
2.	https://www.coursera.org/lecture/algorithms-part1/analysis-of-algorithms-introduction-xaxyP
3.	Virtual Lab link- https://cs413daa.wixsite.com/algorithms/virtual-lab
4.	https://www.aziksa.com/algorithms-design-analysis

Managing Information System

Course Code:	**RI2224-1**	**Course Type**	**PEC**
Teaching Hours/Week (L: T: P: S)	**3:0:0:0**	**Credits**	**03**
Total Teaching Hours	**40**	**CIE + SEE Marks**	**50+50**
Prerequisite	**CS1001-1, IS1001-1**		

Teaching Department: Robotics and Artificial Intelligence

Course Objectives:

1.	To describe the role of information technology and decision support systems in business and record the current issues with those of the firm to solve business problems.
2.	To introduce the fundamental principles of computer-based information systems analysis and design and develop an understanding of the principles and techniques used.
3.	To provide the theoretical models used in database management systems to answer business questions
4.	To enable students, understand the various knowledge representation methods and different expert system structures as strategic weapons to counter the threats to business and make business more competitive.
5.	To enable the students to use information to assess the impact of the Internet and Internet technology on electronic commerce and electronic business and understand the specific threats and vulnerabilities of computer systems.

UNIT-I

Introduction	**07 Hours**
Data, Information, Intelligence, Information Technology, Information System, evolution, types based on functions and hierarchy, System development methodologies, Functional Information Systems, DSS, EIS, KMS, GIS, International Information System.	
System Analysis and Design	**09 Hours**
Case tools - System flow chart, Decision table, Data flow Diagram (DFD), Entity Relationship (ER), Object Oriented Analysis and Design (OOAD), UML diagram.	

UNIT-II

Database Management Systems	**07 Hours**
DBMS HDBMS, NDBMS, RDBMS, OODBMS, Query Processing, SQL, Concurrency Management, Data warehousing and Data Mart.	
Security, Control and Reporting	**07 Hours**
Security, Testing, Error detection, Controls, IS Vulnerability, Disaster Management, Computer Crimes, Securing the Web, Intranets and Wireless Networks, Software Audit, Ethics in IT, User Interface and reporting	

UNIT-III

New IT Initiatives	**10 Hours**
Role of information management in ERP, e- business, e-governance, Data Mining, Business Intelligence, Pervasive Computing, Cloud computing, CMM	

Course Outcomes: At the end of the course student will be able to

1.	Relate the basic concepts and technologies used in the field of management information systems.
2.	Compare the processes of developing and implementing information systems.
3.	Apply the understanding of how various information system like DBMS work together to accomplish the information objectives of an organization.
4.	Outline the role of the ethical, social and security issues of information system.
5.	Translate the role of information systems in organization, the strategic management process, with the implementation for the management.

Course Outcomes Mapping with Program Outcomes & PSO

Program Outcomes→	1	2	3	4	5	6	7	8	9	10	11	12	PSO↓		
↓ Course Outcomes															
RI2224-1.1	3	2	1	-	-	-	-	-	-	-	-	1	-	-	3
RI2224-1.2	3	2	1	-	-	-	-	-	-	-	-	1	-	-	3
RI2224-1.3	3	2	1	-	-	-	-	-	-	-	-	1	-	-	3
RI2224-1.4	3	2	1	-	-	-	-	-	-	-	-	1	-	-	3
RI2224-1.5	3	2	1	-	-	-	-	-	-	-	-	1	-	-	3

1: Low 2: Medium 3: High

TEXTBOOKS:

1.	Robert Schultheis and Mary Summer, Management Information Systems – The Managers View, Tata McGraw Hill, 2008
2.	Kenneth C. Laudon and Jane Price Laudon, Management Information Systems – Managing the digital firm, PHI Learning / Pearson Education, PHI, Asia, 2012
3.	

REFERENCE BOOKS:

1.	Gordon Davis, Management Information System: Conceptual Foundations, Structure and Development, Tata McGraw Hill, 21st Reprint 2008
2.	Haag, Cummings and Mc Cubbrey, Management Information Systems for the Information Age, McGraw Hill, 2005, 9th edition, 2013
3.	Raymond McLeod and Jr. George P. Schell, Management Information Systems, Pearson Education, 2007
4.	James O Brien, Management Information Systems – Managing Information Technology in the E- business enterprise, Tata McGraw Hill, 2004
5.	Raplh Stair and George Reynolds, Information Systems, Cengage Learning, 10th Edition, 2012
6.	Frederick, Gallegor, Sandra, Senft, Daniel P. Manson and Carol Gonzales, Information Technology Control and Audit, Auerbach Publications, 4th Edition, 2013

GROUP-II

Autonomous Vehicles

Course Code:	**RI2321-1**	**Course Type**	**PEC**
Teaching Hours/Week (L: T: P: S)	**3:0:0:0**	**Credits**	**03**
Total Teaching Hours	**40**	**CIE + SEE Marks**	**50+50**
Prerequisite	**ME 1003-1, IS 1001-1, EC 1001-1**		

Teaching Department: Robotics and Artificial Intelligence

Course Objectives:

1.	Introduce the fundamental aspects of Autonomous Vehicles.
2.	Gain Knowledge about the Sensing Technology and Algorithms applied in Autonomous vehicles.
3.	Understand the fundamentals of car technology.
4.	Understand the Connectivity Aspects and the issues involved in driverless cars.
5.	Understand the aspects related to Computer Vision and Deep Learning for Autonomous Vehicles

UNIT-I

Introduction	**07 Hours**
Evolution of Automotive Electronics -Basic Control System Theory applied to Automobiles-Overview of the Operation of ECUs -Infotainment, Body, Chassis, and Powertrain Electronics-Advanced Driver Assistance Systems-Autonomous Vehicles.	
Sensor Technology for Autonomous Vehicles	**09 Hours**
Basics of Radar Technology and Systems -Ultrasonic Sonar Systems-LIDAR Sensor Technology and Systems -Camera Technology -Night Vision Technology -Use of Sensor Data Fusion-Kalman Filters.	

UNIT-II

Connected Car Technology	**07 Hours**
Connectivity Fundamentals -DSRC (Direct Short-Range Communication) -Vehicle-to- Vehicle Technology and Applications -Vehicle-to-Roadside and Vehicle-to-Infrastructure Applications -Security Issues.	
Autonomous Vehicle Technology	**07 Hours**
Driverless Car Technology-Different Levels of Automation -Localization -Path Planning. Controllers to Actuate a Vehicle -PID Controllers -Model Predictive Controllers, ROS Framework.	

UNIT-III

Computer Vision and Deep Learning for Autonomous Vehicles	**05 Hours**
Computer Vision Fundamentals -Advanced Computer Vision -Neural Networks for Image Processing	
Autonomous Vehicles' Biggest Challenges	**05 Hours**
Technical Issues, Security Issues, Moral and Legal Issues.	

Course Outcomes: At the end of the course student will be able to

1.	Explain the evolution of Automotive Electronics and the operation of ECUs.
2.	Compare the different type of sensing mechanisms involved in Autonomous Vehicles.
3.	Summarize the aspects of connectivity fundamentals existing in a driverless car.

4.	Identify the different levels of automation involved in an Autonomous Vehicle.
5.	Discuss about the use of computer vision in vehicles along with its challenges.

Course Outcomes Mapping with Program Outcomes & PSO

Program Outcomes→	1	2	3	4	5	6	7	8	9	10	11	12	PSO↓		
↓ Course Outcomes															
RI2321-1.1	2	2	2	2	3	-	-	-	-	-	-	3	2	2	2
RI2321-1.2	2	2	2	2	3	-	-	-	-	-	-	3	2	2	2
RI2321-1.3	2	2	2	2	3	-	-	-	-	-	-	3	2	2	2
RI2321-1.4	2	2	2	2	3	-	-	-	-	-	-	3	2	2	2
RI2321-1.5	2	2	2	2	3	-	-	-	-	-	-	3	2	2	2

1: Low 2: Medium 3: High

TEXTBOOKS:

1.	Autonomous Intelligent Vehicles: Theory, Algorithms and Implementation, Hong Cheng Springer, 2011
2.	Understanding Automotive Electronics, Williams. B. Ribbens, Elsevier Inc 7th Edn. 2012
3.	Creating Autonomous Vehicle Systems, Shaoshan Liu, Liyun Li, Morgan and Claypool Publishers

REFERENCE BOOKS:

1.	Autonomous Driving: Technical, Legal and Social Aspects , Marcus Maurer, J. Christian Gerde, Springer, 2016
2.	Autonomous Vehicles for Safer Driving, Ronald. K. Jurgen, SAE International, 2013
3.	Autonomous Vehicle Technology: A Guide for Policymakers, James Anderson, KalraNidhi, Karlyn Stanly, Rand Co, 2014

E Books / MOOCs/ NPTEL

1.	https://www.coursera.org/specializations/self-driving-cars
2.	https://www.udacity.com/course/self-driving-car-fundamentals-featuring-apollo--ud0419
3.	https://waymo.com/

Basics of Natural Language Processing

Course Code:	**RI2322-1**	**Course Type**	**PEC**
Teaching Hours/Week (L: T: P: S)	**3:0:0:0**	**Credits**	**03**
Total Teaching Hours	**40**	**CIE + SEE Marks**	**50+50**
Prerequisite	**CS1001-1**		

Teaching Department: Robotics and Artificial Intelligence

Course Objectives:

1.	To learn the fundamentals of natural language processing
2.	To understand the use of CFG and PCFG in NLP
3.	To understand the role of semantics of sentences and pragmatics
4.	To apply the NLP techniques to IR applications

UNIT-I

Introduction to NLP and Overview and language modelling:	**07 Hours**

Overview: Origins and challenges of NLP Language and Grammar-Processing Indian Languages- NLP Applications Information Retrieval. Language Modeling: Various Grammar-based Language

Models-Statistical Language Model:	**09 Hours**

Word Level Analysis Unsmoothed N-grams, Evaluating N-grams, Smoothing, Interpolation and Backoff – Word Classes, Part-of-Speech Tagging, Rule-based, Stochastic and Transformation-based tagging, Issues in PoS tagging – Hidden Markov and Maximum Entropy models.

UNIT-II

Programming Parsing	**08 Hours**

Programming parsing – Shallow parsing – Probabilistic CFG, Probabilistic CYK, Probabilistic Lexicalized CFGs – Feature structures, Unification of feature structures;
Mining Diagnostic Text Reports by Learning to Annotate Knowledge Roles:
Introduction, Domain Knowledge and Knowledge Roles, Frame Semantics and Semantic Role Labelling, Learning to Annotate Cases with Knowledge Roles and Evaluations.

Discourse Analysis and Lexical Resources	**08 Hours**

Discourse segmentation, Coherence – Reference Phenomena, Anaphora Resolution using Hobbs and Cantering Algorithm – Co-reference Resolution – Resources;
Extracting Relations from Text: From Word Sequences to Dependency Paths: Introduction, Subsequence Kernels for Relation Extraction, A Dependency-Path Kernel for Relation Extraction and Experimental Evaluation.

UNIT-III

Evaluating Self-Explanations in iSTART	**08 Hours**

Word Matching, Latent Semantic Analysis, and Topic Models:
Introduction, iSTART: Feedback Systems, iSTART: Evaluation of Feedback Systems,
Textual Signatures: Identifying Text-Types Using Latent Semantic Analysis to Measure the Cohesion of Text Structures:
Introduction, Cohesion, Coh-Metrix, Approaches to Analysing Texts, Latent Semantic Analysis, Predictions, Results of Experiments.
Automatic Document Separation: A Combination of Probabilistic Classification and Finite-State Sequence Modeling:
Introduction, Related Work, Data Preparation, Document Separation as a Sequence Mapping Problem, Results.

Evolving Explanatory Novel Patterns for Semantically-Based Text Mining: Related Work, A Semantically Guided Model for Effective Text Mining.

Course Outcomes: At the end of the course student will be able to

1.	Tag a given text with basic Language features
2.	design an innovative application using NLP components
3.	implement a rule based system to tackle morphology/syntax of a language
4.	design a tag set to be used for statistical processing for real-time applications
5.	compare and contrast the use of different statistical approaches for different types of NLP applications

Course Outcomes Mapping with Program Outcomes & PSO

Program Outcomes→	1	2	3	4	5	6	7	8	9	10	11	12	**PSO↓**		
↓ Course Outcomes													1	2	3
RI2322-1.1	2	1	-	-	-	-	-	-	-	-	-	2	-	2	2
RI2322-1.2	2	2	-	-	-	-	-	-	-	-	-	1	-	2	2
RI2322-1.3	2	3	-	-	-	-	-	-	-	-	-	2	-	2	2
RI2322-1.4	1	1	-	-	-	-	-	-	-	-	-	1	-	2	2
RI2322-1.5	2	2	-	-	-	-	-	-	-	-	-	1	-	2	2

1: Low 2: Medium 3: High

TEXTBOOKS:

1. Speech and Language Processing: An Introduction to Natural Language Processing, Computational Linguistics and Speech Daniel Jurafsky, James H. Martin, Pearson Publication, 2nd Edition., 2014.

2. Natural Language Processing and Text Mining, Anne Kao and Stephen R. Poteet (Eds), Springer-Verlag London Limited, 1st Edition.,2007

3. Handbook of Natural Language Processing, Breck Baldwin, Chapman and Hall/CRC Press, 2nd Edition., 2010

REFERENCE BOOKS:

1. Natural Language Processing and Information Retrieval, Tanveer Siddiqui, U.S Tiwary, Oxford University Press, 2nd Edition., 2008

2. Natural Language Understanding, James Allen, Benjamin/Cummings publishing company, 2nd edition.,1995.

E Books / MOOCs/ NPTEL

1. https://nptel.ac.in/courses/106/105/106105158/

2. https://www.udemy.com/course/nlp-natural-language-processing-with-python/

3. https://www.udemy.com/course/data-science-natural-language-processing-in-python/

4. https://www.udemy.com/course/natural-language-processing/

NPTEL

1. https://onlinecourses.nptel.ac.in/noc19_cs56/preview

Business Analytics

Course Code:	**RI2323-1**	**Course Type**	**PEC**
Teaching Hours/Week (L: T: P: S)	**3:0:0:0**	**Credits**	**03**
Total Teaching Hours	**40**	**CIE + SEE Marks**	**50+50**
Prerequisite	**MA 1001-1, MA 1003-1**		

Teaching Department: Robotics and Artificial Intelligence

Course Objectives:

1.	To gain an understanding of how managers use business analytics
2.	to formulate and solve business problems and to support managerial decision making.
3.	To become familiar with the processes needed to develop, report, and analyse business data.
4.	To learn how to use and apply Excel and Excel add-ins to solve business problems.

UNIT-I

Descriptive Statistics	**07 Hours**

Meaning, Scope, types, functions and limitations of statistics, Measures of Central tendency – Mean,Median, Mode, Quartiles, Measures of Dispersion – Range, Inter quartile range, Mean deviation, Standard deviation, Variance, Coefficient of Variation, Skew-ness and Kurtosis.

Time Series & Index Number	**09 Hours**

Time series analysis: Concept, Additive and Multiplicative models, Components of time series, Trend analysis: Least Square method - Linear and Non- Linear equations, Applications in business decision-making.

UNIT-II

Correlation & Regression Analysis	**16 Hours**

Correlation Analysis: Rank Method & Karl Pearson's Coefficient of Correlation and Properties of Correlation. Regression Analysis: Fitting of a Regression Line and Interpretation of Results, Properties of Regression Coefficients and Relationship between Regression and Correlation.

UNIT-III

Hypothesis Testing& Business Analytics	**08 Hours**

Hypothesis Testing: Null and Alternative Hypotheses; Type I and Type II errors; Testing of Hypothesis: Large Sample Tests, Small Sample test, (t, F, Z Test and Chi Square Test) Concept of Business Analytics- Meaning types and application of Business Analytics, Use of Spread Sheet to analyse data- Descriptive analytics and Predictive analytics.

Course Outcomes: At the end of the course student will be able to

1.	Explain the different basic concept / fundamentals of business statistics.
2.	Explain the importance of measures of Descriptive statistics which includes measures of central tendency, Measures of Dispersion, Time Series Analysis, Index Number, Correlation and Regression analysis and their implication on Business performance.
3.	Explain the concept of Probability and its usage in various business applications.
4.	Explain the Hypothesis Testing concepts and use inferential statistics- t, F, Z Test and Chi Square Test

5.	Explain the practical application of Descriptive and Inferential Statistics concepts and their uses for Business Analytics.

Course Outcomes Mapping with Program Outcomes & PSO

Program Outcomes→	1	2	3	4	5	6	7	8	9	10	11	12	**PSO↓**		
↓ Course Outcomes													1	2	3
RI2323-1.1	3	3	-				-	-			2	1	-		
RI2323-1.2	3	3	-				-	-			2	1	-		
RI2323-1.3	3	3	-				-	-			2	1	-		
RI2323-1.4	3	3	-				-	-			2	1	-		
RI2323-1.5	3	3	-				-	-			2	1	-		

1: Low 2: Medium 3: High

TEXTBOOKS:

1.	Business Statistics, G C Beri, TATA McGrawHill, 3rd
2.	Statistics for Managers, Chandrasekara n & PHI Learning, 1st edition.,2016
3.	Staistical techniques in business and economics, Lind, Marchal,, Wathen, McGraw Hill, 18th ed., Jan 2020

REFERENCE BOOKS:

1.	Statistics for Business and Economics, Newbold, Carlson,Pearson, 6th ed.,2013

E Books / MOOCs/ NPTEL

1.	https://nptel.ac.in/courses/110/105/110105089/
2.	https://www.udemy.com/course/applied-business-analytics/
3.	https://www.coursera.org/specializations/business-analytics

University Core Courses (UCC)

INTERNSHIP-I

Course Code	**UC1001-2**	**CIE Marks**	**100**
Teaching Hours/Week (L: T: P: S)	**-**	**SEE Marks**	-
Total Hours of Pedagogy	80-90 Hours (During I/II semesters)	**Total Marks**	**100** (Evaluation in I/II/III Semester and grades earned shall be included in IV Semester grade card)
Credits	**2**	**Exam Hours**	**--**

Course objective

1. This course is meant to provide students an opportunity to be involved in Inter/ Intra Institutional Activities viz; Training with higher Institutions; Soft skill training organized by Training and Placement Cell of the institution; contribution at incubation/ innovation /entrepreneurship cell of the institution; participation in conferences/ workshops/ competitions etc.; Learning at Departmental Lab/ Tinkering Lab/ Institutional workshop; Working for consultancy/ research projects within the institution and Participation in all the activities of Institute's Innovation Council.

Activities: Refer Appendix B - 3.4 for details

Course outcomes

1. Experience the working in Inter / Institutional activities
2. Work in teams and communicate efficiently both written and oral.
3. Develop the ability to do work in different activities, which will provide the necessary understanding and contribute to the same and provide a foundation to undergo higher level training in subsequent internships.

Course Outcomes Mapping with Program Outcomes & PSO

Program Outcomes→	1	2	3	4	5	6	7	8	9	10	11	12	**PSO↓**		
↓ Course Outcomes													1	2	3
UC2001-1.1	3	1	-	-	1	-	-	-	2	3	1	-	-	-	-
UC2001-1.2	3	1	-	-	1	-	-	-	2	3	1	-	-	-	-
UC2001-1.3	3	1	-	-	1	-	-	-	2	3	1	-	-	-	-
1: Low 2: Medium 3: High															

INTERNSHIP-II

Course Code:	**UC2001-2**	**Course Type:**	**UCC**
Teaching Hours/Week (L: T: P: S):	**-**	**Credits:**	**08**
Total Teaching Hours:	**-**	**CIE + SEE Marks:**	**50+50**

Course Objectives:

1.	This course is meant to provide students an avenue to understand the work environment, ethics and practices in an industry/organization and take up assignments/jobs in the future.

Course Outcomes: At the end of the course student will be able to

1.	Analyse and develop technical solutions for a specific problem that is assigned to them.
2.	Communicate ideas that are developed through brainstorming, presentation and prepare a report.
3.	Understand and inculcate industry practices in their professional career.

Course Outcomes Mapping with Program Outcomes & PSO

Program Outcomes→	**1**	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**	**11**	**12**	**PSO↓**		
↓ Course Outcomes													**1**	**2**	**3**
UC2001-1.1	3	2	-	-	1	1	-	-	2	3	1	-	1	1	1
UC2001-1.2	3	2	-	-	1	1	-	-	2	3	1	-	1	1	1
UC2001-1.3	3	2	-	-	1	1	-	-	2	3	1	-	1	1	1

1: Low 2: Medium 3: High

NITTE (Deemed to be University)

MAJOR PROJECT

Course Code:	**UC2002-2 & UC3001-2**	**Course Type:**	**UCC**
Teaching Hours/Week (L: T: P: S):	**24**	**Credits:**	**2+8**
Total Teaching Hours:	**-**	**CIE + SEE Marks:**	**(100+0) + 100+100**

Course Objectives:

1.	To perform effective literature survey, identification of research problem / project idea.
2.	To develop skills of planning to execute the project
3.	To assess the needs and necessity of a project.
4.	To learn time management and documentation.
5.	To expose the students to research aspects like literature review, executing experiments and analysis of results.
6.	To expose the students to research aspects like literature review, executing experiments and analysis of results.

A group of students (not more than 4) is assigned to a guide/project supervisor. The students must do a thorough literature review and come out with a project plan. They are expected submit a project proposal (not more than 10 pages) including project idea, protocols, designs (if any), expected outcome, major requirements, and approximate budget. They shall present the same in a proposal seminar in front of the panel of internal examiners (involving guide) and shall get their proposal approved. The presentation must involve projected timeline of the project execution.

Assessment Details (both CIE and SEE)

CIE procedure: Shall involve project proposal, proposal seminar, continuous evaluation of the project progress by Guide and HOD. Monthly progress is evaluated.

Semester End Examination:

SEE procedure:

i)Single discipline: Contribution to the project and the performance of each group member shall be assessed individually in semester end examination (SEE) conducted at the department.

ii) Interdisciplinary: Contribution to the project and the performance of each group member shall be assessed individually in semester end examination (SEE) conducted separately at the departments to which the student/s belong to.

SCHEME OF EVALUATION:

Project demonstration, Viva voce

Total marks: 100 Marks

The distribution of marks shall be proportioned based on the type of the project and it is based on fulfilling the following requisites.

The evaluation of students is proposed to be done by internal faculty with active involvement of industrial personnel. The evaluation may be based on following criteria:

- Punctuality and Attendance ¨ Interpersonal relations
- Sense of Responsibility

- Clarity of concepts, principles and procedures
- Self-expression/communication skills
- Report Writing Skills
- Creativity/conceiving new and unusual ideas
- Problem-solving skills

At the end of the project work course students are required to submit a working model of the equipment they have designed and developed or if it is a theoretical or experimental work, they are expected to study a detailed analysis and findings from their work.

Course Outcomes: At the end of the course student will be able to

1.	Use various methods or sources for finding literature and analyze data for relevance and appropriateness to the research project undertaken.
2.	Identify and propose suitable methods of analysis and/or design or develop appropriate experiments to address the specific research objectives.
3.	Apply suitable standardized method/s for experimental design.
4.	Analyze and interpret the research findings and compare with reported results to arrive at suitable conclusions.
5.	Adopt appropriate documentation protocol to organize research findings, learn good laboratory practices and work in a team.

Course Outcomes Mapping with Program Outcomes & PSO

Program Outcomes→	**1**	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**	**11**	**12**	**PSO↓**		
↓ Course Outcomes													**1**	**2**	**3**
UC2002-1/UC3001-1.1	-	1	-	-	2	2	3	1	-	-	-	1	1	2	2
UC2002-1/UC3001-1.2	-	1	2	1	1	-	1	2	1	-	1	1	1	2	2
UC2002-1/UC3001-1.3	-	1	2	2	1	-	1	1	1	1	1	1	1	2	2
UC2002-1/UC3001-1.4	1	3	2	2	1	2	2	3	3	3	3	2	1	2	2
UC2002-1/UC3001-1.5	-	1	1	-	1	2	2	3	3	3	3	1	1	2	2

1: Low 2: Medium 3: High

Open Elective Course [OEC]

Autonomous Mobile Robots

Course Code:	**RI2501-1**	**Course Type**	**OEC**
Teaching Hours/Week (L: T: P: S)	**3:0:0:0**	**Credits**	**03**
Total Teaching Hours	**40**	**CIE + SEE Marks**	**50+50**
Prerequisite	**EC 1001-1, ME 1003-1**		

Teaching Department: Robotics and Artificial Intelligence

Course Objectives:

1.	**Explain** different types of locomotion in mobile robots to obtain a required task.
2.	**Understand** the different types of kinematics and dynamics involved in a mobile robot.
3.	**Study** the different types of sensors used in an autonomous mobile robot.
4.	**Understand** the different types of algorithms to identify the position of the mobile robot.
5.	**Understand** the various algorithms for planning and navigation of the mobile robot.

UNIT-I

Robot locomotion:	**07 Hours**
Types of locomotion, hopping robots, legged robots, wheeled robots, stability, maneuverability, and controllability.	
Mobile robot kinematics and dynamics:	**09 Hours**
Forward and inverse kinematics, holonomic and nonholonomic constraints, kinematic models of simple car and legged robots, dynamics simulation of mobile robots.	

UNIT-II

Perception:	**07 Hours**
Proprioceptive/Exteroceptive and passive/active sensors, performance measures of sensors, sensors for mobile robots like global positioning system (GPS), Doppler effect-based sensors, vision-based sensors, uncertainty in sensing, filtering.	
Localization:	**07 Hours**
Odometric position estimation, belief representation, probabilistic mapping, Markov localization, Bayesian localization, Kalman localization, and positioning beacon systems.	

UNIT-III

Introduction to planning and navigation:	**10 Hours**
Path planning algorithms based on A-star, Dijkstra, Voronoi diagrams, probabilistic roadmaps (PRM), rapidly exploring random trees (RRT), Markov Decision Processes (MDP), stochastic dynamic programming (SDP).	

Course Outcomes: At the end of the course student will be able to

1.	**Explain** different types of locomotion in mobile robots to obtain a required task.
2.	**Identify** the different types of kinematics and dynamics involved in a mobile robot.
3.	**Apply** the different types of sensors used in an autonomous mobile robot.
4.	**Apply** the different types of algorithms to identify the position of the mobile robot.
5.	**Apply** the various algorithms for planning and navigation of the mobile robot to reach the destination.

Course Outcomes Mapping with Program Outcomes & PSO

Program Outcomes→ ↓ Course Outcomes	1	2	3	4	5	6	7	8	9	10	11	12	PSO↓		
RI2501-1.1	3	3	3	3	2	1	-	-	-	-	-	3	3	2	3
RI2501-1.2	3	3	3	3	2	1	-	-	-	-	-	3	3	2	3
RI2501-1.3	3	3	3	3	2	1	-	-	-	-	-	3	3	2	3
RI2501-1.4	3	3	3	3	2	1	-	-	-	-	-	3	3	2	3
RI2501-1.5	3	3	3	3	2	1	-	-	-	-	-	3	3	2	3

1: Low 2: Medium 3: High

TEXTBOOKS:

1. R. Siegwart, I. R. Nourbakhsh, "Introduction to Autonomous Mobile Robots", The MIT Press, 2011.
2. Peter Corke, Robotics, Vision and Control: Fundamental Algorithms in MATLAB, Springer Tracts in Advanced Robotics, 2011.
3. S. M. LaValle, "Planning Algorithms", Cambridge University Press, 2006. (Available online http://planning.cs.uiuc.edu/)

REFERENCE BOOKS:

1. Thrun, S., Burgard, W., and Fox, D., Probabilistic Robotics. MIT Press, Cambridge, MA, 2005.
2. Melgar, E. R., Diez, C. C., Arduino, and Kinect Projects: Design, Build, Blow Their Minds, 2012.
3. H. Choset, K. M. Lynch, S. Hutchinson, G. Kantor, W. Burgard, L. E. Kavraki, and S. Thrun, Principles of Robot Motion: Theory, Algorithms, and Implementations, PHI Ltd., 2005.

E Books / MOOCs/ NPTEL

1. https://archive.nptel.ac.in/courses/112/106/112106298/
2. https://www.edx.org/course/autonomous-mobile-robots

Medical Robotics

Course Code:	**RI2502-1**	**Course Type**	**PEC**
Teaching Hours/Week (L: T: P: S)	**3:0:0:0**	**Credits**	**03**
Total Teaching Hours	**40**	**CIE + SEE Marks**	**50+50**
Prerequisite	**PH 1001-1, IS 1001-1, CY 1001-1**		

Teaching Department: Robotics and Artificial Intelligence

Course Objectives:

1.	Understand the types of medical robots used in the field of healthcare.
2.	Explain the various localization and tracking sensors
3.	Understand the applications of surgical robots with the help of few case studies
4.	Understand Rehabilitation of limbs and brain machine interface with the help of few case studies
5.	Understand the design methodology of medical robots.

UNIT-I

Introduction	**07 Hours**
Types of medical robots - Navigation - Motion Replication - Imaging - Rehabilitation and Prosthetics - State of art of robotics in the field of healthcare. Localization And Tracking	
Position sensors requirements	**09 Hours**
Tracking - Mechanical linkages - Optical - Sound-based - Electromagnetic -Impedance-based - In-bore MRI tracking - Video matching - Fiber optic tracking	

UNIT-II

Control Modes Radiosurgery	**07 Hours**
Orthopedic Surgery - Urologic Surgery and Robotic Imaging - Cardiac Surgery – Neurosurgery – case studies.	
Rehabilitation	**07 Hours**
Rehabilitation for Limbs - Brain-Machine Interfaces - Steerable Needles – case studies.	

UNIT-III

Design of Medical Robots	**10 Hours**
Characterization of gestures to the design of robots- Design methodologies- Technological choices - Security	

Course Outcomes: At the end of the course student will be able to

1.	Describe the types of medical robots and the concepts of navigation and motion replication.
2.	Describe about the sensors used for localization and tracking
3.	Explain the applications of surgical robots
4.	Explain the concepts in Rehabilitation of limbs and brain machine interface
5.	Classify the types of assistive robots and analyze the design characteristics, methodology and technological choices for medical robots.

Course Outcomes Mapping with Program Outcomes & PSO

Program Outcomes→	1	2	3	4	5	6	7	8	9	10	11	12	PSO↓		
↓ Course Outcomes															

RI2502-1.1	3	-	1	-	-	-	-	-			-	1	3		3
RI2502-1.2	3	-	1	-	-	-	-	-			-	1	3		3
RI2502-1.3	3	-	1	-	-	-	-	-			-	1	3		3
RI2502-1.4	3	-	1	-	-	-	-	-			-	1	3		3
RI2502-1.5	3	-	3	-	-	-	-	-			-	1	3		3

1: Low 2: Medium 3: High

TEXTBOOKS:	
1.	Robot Modeling and Control, Mark W. Spong, Seth Hutchinson, and M. Vidyasagar, Wiley Publishers, 2006
2.	Medical robotics- Minimally, Invasive surgery, Paula Gomes, Woodhead, 2012
3.	Medical Robotics, Achim Schweikard, Floris Ernst, Springer, 2015
REFERENCE BOOKS:	
1.	Medical Robotics, Jocelyne Troccaz, Wiley-ISTE, 2012
2.	Medical Robotics, Vanja Bonzovic, I-tech Education publishing Austria, 2008
3.	Medical Robotics, Daniel Faust, Rosen Publishers, 2016
4.	Medical Robotics, Jocelyne Troccaz, Wiley,2013
E Books / MOOCs/ NPTEL	
1.	https://www.futurelearn.com/courses/medtech-ai-and-medical-robots
2.	https://web.stanford.edu/class/me328/

PLC Control of Hydraulic and Pneumatic Circuits

Course Code:	**RI2503-1**	**Course Type**	**OEC**
Teaching Hours/Week (L: T: P: S)	**3:0:0:0**	**Credits**	**03**
Total Teaching Hours	**40**	**CIE + SEE Marks**	**50+50**
Prerequisite	**EE 1001-1**		

Teaching Department: Robotics and Artificial Intelligence

Course Objectives:

1.	To understand the fundamentals of fluid power transmission systems
2.	To design various hydraulic system components.
3.	To design various pneumatic system components.
4.	Learn various types of hydraulic and pneumatic power circuits.
5.	Learn various types of applications in fluid power circuits.

UNIT-I

Fluid power systems and fundamentals	**06 Hours**

Introduction to fluid power, Advantages of fluid power, Application of fluid power system. Types of fluid power systems, General types of fluids - Properties of hydraulic fluids -Fluid power symbols. Basics of Hydraulics-Applications of Pascal's

Hydraulic system components	**05 Hours**

Sources of Hydraulic Power: Pumping theory - Pump classification - construction and working of pumps - Variable displacement pumps, pump performance. Actuators: Linear hydraulic actuators-Single acting and double acting cylinders, Rotary actuators - Fluid motors.

Control Components	**04 Hours**

Direction control valve - Valve terminology - Various center positions. Shuttle valve - check valve - pressure control valve - pressure reducing valve, sequence valve. Flow control valves - Fixed and adjustable Safety valves.

UNIT-II

Pneumatic system components	**07 Hours**

Pneumatic Components: Properties of air. Compressors. FRL Unit -Air control valves, Quick exhaust valves and pneumatic actuators- cylinders, air motors. Basics of low-cost automation

Fluidics & Pneumatic circuit design	**08 Hours**

Fluidics - Introduction to fluidic devices, simple circuits Introduction to Electrohydraulic Pneumatic logic circuits, PLC applications in fluid power control, Sequential circuit design for simple applications using classic, cascade, step counter, logic with Karnaugh- Veitch Mapping and combinational circuit design methods.

UNIT-III

Fluid power circuits	**10 Hours**

Speed control circuits, synchronizing circuit, Pneumo hydraulic circuit, Accumulators and Intensifiers-Accumulator circuits, Intensifier circuits. Servo systems - Hydro Mechanical servo systems, Electrohydraulic servo systems and proportional valves. Deceleration circuit, hydrostatics transmission circuits, control circuits for reciprocating drives in machine tools, Material handling equipment. Fluid power circuits; failure and troubleshooting. Robot Applications- medical, mining, space, defense, security, domestic, entertainment, Industrial Applications- Material handling, welding, Spray painting, Machining.

Course Outcomes: At the end of the course student will be able to

1.	Compare the basics of hydraulics to the performance of fluid power systems

2.	Explain the working principle of hydraulic systems including pumps and control components.
3.	Explain the working principle of pneumatic systems and their components.
4.	Design various types of hydraulic and pneumatic power circuits
5.	Design various types of applications in fluid power circuits.

Course Outcomes Mapping with Program Outcomes & PSO

Program Outcomes→	1	2	3	4	5	6	7	8	9	10	11	12	**PSO↓**		
↓ Course Outcomes													1	2	3
RI2503-1.1	3	2	3	2	3	-	-	-	-	-	-	3	3	2	3
RI2503-1.2	3	2	3	2	3	-	-	-	-	-	-	3	3	2	3
RI2503-1.3	3	2	3	2	3	-	-	-	-	-	-	3	3	2	3
RI2503-1.4	3	2	3	2	3	-	-	-	-	-	-	3	3	2	3
RI2503-1.5	3	2	3	2	3	-	-	-	-	-	-	3	3	2	3

1: Low 2: Medium 3: High

TEXTBOOKS:

1.	Majumdar S.R., "Pneumatic systems - Principles and maintenance", Tata McGraw Hill, 2008
2.	Anthony Esposito, "Fluid Power with Applications", Pearson Education 2009.

REFERENCE BOOKS:

1.	Majumdar S.R., "Oil Hydraulics", Tata McGraw-Hill, 2000.
2.	Harry L. Stevart D. B, "Practical guide to fluid power", Taraoeala sons and Port Ltd.Broadey, 2010
3.	Michael J, Prinches and Ashby J. G, "Power Hydraulics", Prentice Hall, 2011.
4.	Dudelyt, A. Pease and John T. Pippenger, "Basic Fluid Power", Prentice Hall, 2011.

E Books / MOOCs/ NPTEL

1.	https://nptel.ac.in/courses/108/105/108105088/
2.	https://plc-coep.vlabs.ac.in/List%20of%20experiments.html?domain=Electrical%20Engineering
3.	http://vlabs.iitb.ac.in/vlabs-dev/vlab_bootcamp/bootcamp/COEP_KNOWLEDGE_SEEKERS/labs/exp1/theory.html

Humanities & Management Courses

ENHANCING SELF-COMPETENCE

Course Code:	**HU2001-1**	**Course Type**	**HSMC**
Teaching Hours/Week (L: T: P: S)	**2:0:0:0**	**Credits**	**02**
Total Teaching Hours	**26+0+0+0**	**CIE + SEE Marks**	**50+50**

Teaching Department: Humanities

Course Objectives:

1.	Introspect and learn about oneself.
2.	Develop professional writing skills.
3.	Acquaint with the various social behaviour and etiquette.
4.	Apply the techniques of fundamental communication skills.
5.	Develop necessary techniques for formal presentations.

UNIT-I

Personality Traits — **09 Hours**

Types & Kinds of personality, Ways to Identify Self (SWOT Analysis, Johari Window), Concepts of Self-Management and Self-Motivation

Effective Communication Skills

One-way and Two-way Communication, Interpersonal & Social Skills

UNIT-II

Social Behaviour and Cultural Etiquette — **09 Hours**

Time Management, Personal Grooming, Making Small Talk, Customs & Manners

Professional Presentation Techniques

Formal Presentation, Sensitivity towards multi-cultural workspaces

UNIT-III

Job-Related Communication — **08 Hours**

Resume & Cover Letter, Formal E-mails, Framing Requests, Greetings, Salutations, Close

Course Outcomes: At the end of the course student will be able to

1.	Understand the importance of human conduct.
2.	Demonstrate knowledge of theory and competence in office communication.
3.	Develop and assess various types of communication.
4.	Be Familiar with the current practices of social behaviour.
5.	Prepare and deliver presentation appropriate for the workplace.

Course Outcomes Mapping with Program Outcomes & PSO

Program Outcomes→	1	2	3	4	5	6	7	8	9	10	11	12	**PSO↓**		
↓ Course Outcomes													1	2	3
HU2001-1.1	-	1	-	-	-	2	2	-	3	-	-	-			
HU2001-1.2	-	-	-	-	-	-	-	3	2	1	-	1			
HU2001-1.3	-	-	2	-	-	2	2	2	-	-	-	2			
HU2001-1.4	-	3	-	-	-	-	-	-	2	3	2	-			
HU2001-1.5	2	2	-	1	-	-	-	-	2	-	-	-			

1: Low 2: Medium 3: High

REFERENCE BOOKS:	
1.	R R Gaur, R Sangal, G P Bagaria, “Human Values and Professional Ethics”, Excel Books, New Delhi, 2010.
2.	Ronald B Adler and Jeanne Marquardt Elmhorst, "Communicating at Work – Principles and Practices for Business and the Professions", 6th Edition, McGraw Hill College.
3.	Stephen R. Covey, "The 7 Habits of Highly Effective People", Simon & Schuster, 1994.
4.	Sarvesh Gulati, "Corporate grooming and Etiquette", Rupa Publications India Pvt. Ltd., 2010.
5.	Fred. Luthans, "Organizational Behaviour", McGraw Hill International.
6.	Tom Rath, “Strengths Finder 2.0", Gallup Press, 2007.
7.	M Ashraf Rizvi, "Effective Technical Communication", Tata McGraw- Hill, 2005.
8.	Stephen P. Robbins, "Organizational Behaviour", Prentice Hall.
9.	Dale Carnegie, "How to Win Friends and Influence People", Gallery Books, 2016.

UNIVERSAL HUMAN VALUES

Course Code:	**HU1004-1**	**Course Type**	**HSMC**
Teaching Hours/Week (L: T: P: S)	**1:0:0:0**	**Credits**	**01**
Total Teaching Hours	**15+0+0+0**	**CIE + SEE Marks**	**50+50**

Teaching Department: Humanities

Course Objectives:

1.	Enable students appreciate values, skills and behaviour with an appropriate understanding of 'Self' to attain sustained happiness and prosperity with right aspirations of life.
2.	Develop a holistic perspective among the students towards physical needs and prosperity of life.
3.	Develop a holistic approach and understand the importance of co-existence and living in harmony ensuring mutually fulfilling interaction with the society and nature.
4.	Strengthening of self-reflection.
5.	Development of commitment and courage to act.

UNIT-I

Need, Basic Guidelines, Content and Process for Value Education	**06 Hours**

Self-Exploration; 'Natural Acceptance' and Experiential Validation; Continuous Happiness and Prosperity; Right understanding, Relationship and Physical Facility; Understanding Happiness and Prosperity - living in harmony at various levels.

UNIT-II

Understanding Harmony in the Human Being, Family and Society	**06 Hours**

Understanding human being as a co-existence of the sentient 'I' and the material 'Body; the needs of Self ('I') and 'Body'; the Body as an instrument; Holistic perspective of Physical needs and Prosperity; Visualizing a universal harmonious order in society- Undivided Society, Universal Order- from family to world family.

UNIT-III

Whole existence as Coexistence: Implications of the above Holistic Understanding of Harmony and Professional Ethics	**03 Hours**

Understanding the harmony in the Nature and Existence; Existence as Co-existence, Holistic perception of harmony at all levels of existence; Natural acceptance of human values, Professional Ethics

Course Outcomes: At the end of the course student will be able to

1.	Have a better self-exploration and understanding with a capacity to identify the priorities of life.
2.	Generate Sustainable solution to problems with focus on human values and value-based living.
3.	Have an understanding of the Holistic perspective of Physical needs
4.	Understand and practice living in harmony, co-existence and natural acceptance

5.	Exhibit Professional Ethics in the workplace

Course Outcomes Mapping with Program Outcomes & PSO

Program Outcomes→	1	2	3	4	5	6	7	8	9	10	11	12	**PSO↓**		
↓ Course Outcomes													1	2	3
HU1004-1.1	-	-	-	-	-	-	-	3	-	-	2	2			
HU1004-1.2	-	-	-	-	-	-	-	2	-	-	2	2			
HU1004-1.3	-	-	2	-	-	-	1	2	-	-	2	2			
HU1004-1.4	-	-	-	-	-	-	-	1	-	-	-	-			
HU1004-1.5	-	-	1	-	-	-	-	3	-	-	2	2			

1: Low 2: Medium 3: High

TEXTBOOKS:

1.	R R Gaur, R Sangal, G P Bagaria, "Human Values and Professional Ethics", Excel Books, New Delhi, 2010

REFERENCE BOOKS:

1.	A Nagaraj, "Jeevan Vidya: Ek Parichaya", Jeevan Vidya Prakashan, Amarkantak, 1999
2.	A.N. Tripathi, "Human Values", New Age Intl. Publishers, New Delhi, 2004
3.	The Story of Stuff (Book).
4.	Mohandas Karamchand Gandhi, "The Story of My Experiments with Truth"
5.	E. F Schumacher, "Small is Beautiful"
6.	Cecile Andrews, "Slow is Beautiful"
7.	J C Kumarappa, "Economy of Permanence"
8.	Pandit Sunderlal, "Bharat Mein Angreji Raj"
9.	Dharampal, "Rediscovering India"
10.	Mohandas Karamchand Gandhi, "Indian Home Rule"
11.	Maulana Abdul Kalam Azad, "India Wins Freedom"
12.	Romain Rolland, "Vivekananda"
13.	Romain Rolland, "Gandhi"

Technology Management and Entrepreneurship

Course Code:	**MG1006-1**	**Course Type**	**PEC**
Teaching Hours/Week (L: T: P: S)	**3:0:0:0**	**Credits**	**03**
Total Teaching Hours	**40**	**CIE + SEE Marks**	**50+50**

Teaching Department: Robotics and Artificial Intelligence

Course Objectives:

1.	Define production/Technology management, Explain the technology management framework and activities viz., acquisition and exploitation.
2.	Explain the technology management activities viz., Identification, learning protection and election
3.	Discuss the technology management tools viz., Patent analysis, Portfolio management and Roadmapping
4.	Discuss technology management tools viz., S-Curve, Stage- gate model, and value analysis. Explain Technology management challenges ahead
5.	Discuss Entrepreneurship. Explain the features of Small Scale Industries. Identify and differentiate the different national and state level funding agencies.

UNIT-I

Introduction — **06 Hours**

Definition, Difference between Technology Management (TM) and Innovation Management, TM framework.

TM activities — **07 Hours**

Acquisition – Internal and external acquisition processes, Environment assessment in acquisition decisions

Exploitation – Commercialization/ Marketing and Technology transfer and utilization processes, reverse innovation

Identification – Definition, different identification processes

Learning – Definition, learning process, improving learning environment

Protection – Definition, protection process, recent challenges

Selection – Definition, Selection process, strategic analysis and choices

UNIT-II

TM Tools — **04 Hours**

Patent Analysis - Introduction, where and why it is used, process.

Portfolio Management – Introduction, where and why it is used, process

Roadmapping — **06 Hours**

Introduction, where and why it is used, process, Roadmapping emerging technologies

S – Curve - Introduction, where and why it is used, process, Managing IP through lifecycle.

Stage Gate Model - Introduction, where and why it is used, process, next generation stage gate models

Value Analysis and Innovation — **04 Hours**

Introduction, where and why it is used, expanding value analysis Managing Technology and Challenges ahead.

UNIT-III

Entrepreneurship — **05 Hours**

Concept of Entrepreneurship, Stages in entrepreneurial process, Role of entrepreneurs in Economic Development, Barriers to Entrepreneurship, Meaning of Entrepreneur, Functions of an Entrepreneur, Types of Entrepreneurs, Intrapreneur - an emerging Class.

Small Scale Industries	**04 Hours**
Definition; Characteristics; Need and rationale; Objectives; Scope; role of SSI in Economic Development. Advantages of SSI, Steps to start and SSI, Government policy towards SSI; Different Policies of SSI.	
Institutional Support	**04 Hours**
Different Schemes; TECKSOK; KIADB; KSSIDC; KSIMC; DIC Single Window Agency; SISI; NSIC; SIDBI; KSFC	

Course Outcomes: At the end of the course student will be able to

1.	Define production/Technology management, Explain the technology management framework and activities viz., acquisition and exploitation.
2.	Explain the technology management activities viz., Identification, learning protection and election
3.	Discuss the technology management tools viz., Patent analysis, Portfolio management and Roadmapping
4.	Discuss technology management tools viz., S-Curve, Stage- gate model, and value analysis. Explain Technology management challenges ahead
5.	Discuss Entrepreneurship. Explain the features of Small Scale Industries. Identify and differentiate the different national and state level funding agencies.

Course Outcomes Mapping with Program Outcomes & PSO

Program Outcomes→	1	2	3	4	5	6	7	8	9	10	11	12	PSO↓		
↓ Course Outcomes															
MG1006-1.1	3	1						1	1	1	1	3			**1**
MG1006-1.2	1	2							1	1	2	1			**1**
MG1006-1.3	2	2					1		1	1	2	2			**1**
MG1006-1.4	3	1				1		1	1		3	3			**1**
MG1006-1.5	1	1				1	1	1	1		2	1			**1**

1: Low 2: Medium 3: High

TEXTBOOKS:

1.	Technology management: Activities and Tools – Dilek Cetindamar, Rob Phaal & David Probert, 2nd edition, Palgrave -Macmillan Education, 2016
2.	**Entrepreneurship Development** – Poornima. M. Charantimath – Small Business Enterprises – Pearson Education – 2006 (2 & 4).

REFERENCE BOOKS:

1.	Handbook of Technology management – Gerard H Gaynor, McGraw Hill Publications, 1999
2.	Managing Technology, Competing through New Ventures, Innovation and Corporate Research - Frederick Betz, Prentice Hall, Englewood Cliffs, New Jersey, 1987
3.	Entrepreneurship Development **– S.S.Khanka – S.Chand & Co.**

INTRODUCTION TO IPR

Course Code:	**HU1006-1**	**Course Type:**	**HSMC**
Teaching Hours/Week (L: T: P: S):	**1:0:0:0**	**Credits:**	**01**
Total Teaching Hours:	**15**	**CIE + SEE Marks:**	**50+50**

Teaching Department: Respective Department

Course Objectives:

1.	Enhancing the learning system through innovation and creative thinking skills for effective business process.
2.	Acquaint with special challenges of starting new ventures.
3.	Facilitate Entrepreneurial skills in recognizing opportunities for competitive advantages.
4.	Provide insights of financial aspects in planning and executing a business plan.
5.	Ascertain the role of IPR to protect innovations and intangible assets.

UNIT-I

Intellectual Property Rights (IPR)	**6 Hours**

Introduction to IPR: Business Perspective, IPR in India – Genesis and Development, International Context, Concept of IP Management, Uses in marketing

UNIT-II

Types of Intellectual Property	**6 Hours**

Patent - Procedure, Licensing and Assignment, Infringement and Penalty, Trademark, Example of Trademarks - Domain name, Geographical Indications, Copyright, Industrial Designs, Class Discussion - Major Court Cases regarding violation of Patents

UNIT-III

Basic Tenets of Information Technology Act, 2000	**3 Hours**

IT Act – Introduction, E-Commerce and Legal Provisions, E- Governance, Digital signature and Electronic Signature, Cybercrimes

Course Outcomes: At the end of the course student will be able to

1.	Comprehend Innovation, its process and sources.
2.	Apply the process of building an innovative organization.
3.	Recognize the characteristics of different types of Entrepreneurships
4.	Formulate a business plan based on a business idea in Technology.
5.	Interpret basic tenets of Information Technology Act, 2000.

Course Outcomes Mapping with Program Outcomes & PSO

Program Outcomes→	1	2	3	4	5	6	7	8	9	10	11	12	**PSO↓**	
↓ Course Outcomes													1	2
HU1006-1.1	-	-	-	-	-	-	-	-	-	2	-	3	-	-
HU1006-1.2	-	-	-	-	-	-	-	-	-	3	-	3	-	-
HU1006-1.3	-	-	-	-	-	-	-	-	-	3	-	3	-	-
HU1006-1.4	-	-	-	-	-	-	-	-	2	2	-	2	-	-

HU1006-1.5	-	-	-	-	-	-	-	-	1	2	-	2	-	-

1: Low 2: Medium 3: High

REFERENCES:

1.	Tidd, J., & Bessant, J., "Managing Innovation: Integrating Technological, Market and Organizational Change", Wiley, 2021.
2.	Case Study Materials: To be distributed for Class Discussion
3.	Reddy, G. B., "Intellectual Property Rights and the Law", Gogia Law Agency, 2012.
4.	Wadehra, B. L., "Law relating to Intellectual Property", Universal Law Publishing Co., 2011.
5.	Narayanan, P., "IPR", Eastern Law House Private Ltd, 2017.

MANAGEMENT & ENTREPRENEURSHIP

Course Code:	MG1003-1	Course Type	HSMC
Teaching Hours/Week (L: T: P: S)	3:0:0:0	Credits	03
Total Teaching Hours	39	CIE + SEE Marks	50+50

Teaching Department: Any

Course Objectives:

1.	To introduce the field of management, task of the manager, importance of planning and types of planning, staff recruitment and selection process.
2.	To discuss the ways in which work is allocation, structure of organizations, modes of communication and need of coordination between the manager and staff
3.	To explain the role and importance of the entrepreneur and their functions in economic development and the concepts of entrepreneurship.
4.	To discuss the importance of Small Scale Industries and methods for generating new business ideas and business opportunities
5.	To introduce the concepts of financial concepts in enterprises.

UNIT-I

Management:	**03 Hours**
Definition, Importance – Nature and Characteristics of Management, Management Functions, Roles of Manager, Levels of Management, Managerial Skills, Management & Administration, Management as a Science, Art &Profession.	
Planning:	**03 Hours**
Nature, Importance and Purpose of Planning, Types of Plans, Steps in Planning, Limitations of Planning, Decision Making – Meaning, Types of Decisions- Steps in Decision Making.	
Organizing and Staffing	**04 Hours**
Meaning, Nature and Characteristics of Organization – Process of Organization, Principles of Organization, Departmentalization, Committees – meaning, Types of Committees, Centralization Versus Decentralization of Authority and Responsibility, Span of Control (Definition only), Nature and Importance of Staffing, Process of Selection and Recruitment.	
Directing and Controlling	**04 Hours**
Meaning and Nature of Directing-Leadership Styles, Motivation Theories Communication – Meaning and Importance, Coordination- Meaning and Importance, Techniques of Coordination. Controlling – Meaning, Steps in Controlling	

UNIT-II

Social Responsibilities of Business:	**03 Hours**
Meaning of Social Responsibility, Social Responsibilities of Business towards Different Groups, Social Audit, Business Ethics, and Corporate Governance.	
Entrepreneurship	**05 Hours**
Definition of Entrepreneur, Importance of Entrepreneurship, concepts of Entrepreneurship, Characteristics of successful Entrepreneur, Classification of Entrepreneurs, Intrapreneur – An Emerging Class, Comparison between Entrepreneur and Intrapreneur, Myths of	

Entrepreneurship, Entrepreneurial Development models, Entrepreneurial development cycle, Problems faced by Entrepreneurs and capacity building for Entrepreneurship.

Modern Small Business Enterprises	**05 Hours**

Role of Small Scale Industries, Concepts and definitions of SSI Enterprises, Government policy and development of the Small Scale sector in India, Growth and Performance of Small Scale Industries in India, Sickness in SSI sector, Problems for Small Scale Industries, Impact of Globalization on SSI, Impact of WTO/GATT on SSIs, Ancillary Industry and Tiny Industry (Definition only).

Institutional Support for Business Enterprises	**02 Hours**

Introduction, Policies & Schemes of Central–Level Institutions, State-Level Institutions

UNIT-III

Finance Management in enterprises	**10 Hours**

Introduction, functions, Accounting and Bookkeeping, Financial Statements, Working Capital Management, Break even Analysis, Financial ratio Analysis.

Course Outcomes: At the end of the course student will be able to

1.	Describe the field of management, the task of the manager, planning, and steps in decision making.
2.	Discuss the structure of the organization, importance of staffing, leadership styles, modes of communication, techniques of coordination, and importance of managerial control in the business.
3.	Describe the concepts of entrepreneurship and a businessman's social responsibilities towards different groups.
4.	Develop an understanding of the role of SSI's in the development of country and state/central level institutions/agencies supporting business enterprises.
5.	Apply the concepts of financial management for effective use in enterprises

Course Outcomes Mapping with Program Outcomes & PSO

Program Outcomes→	1	2	3	4	5	6	7	8	9	10	11	12	**PSO↓**	
↓ Course Outcomes													1	2
MG1003-1.1	3	-	-	-	-	-	-	2	2	-	3	-	-	1
MG1003-1.2	3	-	-	-	-	-	-	2	2	-	3	-	-	2
MG1003-1.3	3	-	-	-	-	-	-	2	2	-	3	-	-	2
MG1003-1.4	3	-	-	-	-	-	-	2	2	-	3	-	-	2
MG1003-1.5	3	-	-	-	-	-	-	2	2	-	3	-	-	2

1: Low 2: Medium 3: High

TEXTBOOKS:

1.	P. C. Tripathi, P. N. Reddy, "Principles of Management", McGraw Hill, 6th Edition, 2017.
2.	Poornima M. Charanthimath, "Entrepreneurship Development and Small Business Enterprises", Pearson 2nd Edition, 2014.
3.	W.D Stevenson, "Elements of Power System Analysis", 4th edition, TMH, 2001.

REFERENCE BOOKS:

1.	Vasant Desai, "Dynamics of Entrepreneurial Development and Management", Himalaya Publishing House, 2007.
2.	Harold Koontz, Heinz, Weihrich, "Essentials of Management: An International, Innovation and Leadership perspective", McGraw Hill, 10th Edition, 2016.

FINANCIAL MANAGEMENT

Course Code:	**MG1002-1**	**Course Type**	**HSMC**
Teaching Hours/Week (L: T: P: S)	**3:0:0:0**	**Credits**	**03**
Total Teaching Hours	**39**	**CIE + SEE Marks**	**50+50**

Teaching Department: Any

Course Objectives:

1.	Develop basic financial management knowledge essential to make a managerial career in professional life.
2.	Impart some of the crucial and basic skills required to work in the area of budgeting, investment and financial decision making.
3.	Enable in making a right decisions on selection of projects for investment.
4.	Understand the basics of finance and financial markets, project evaluation and selection.

UNIT-I

Time Value of Money	**15 Hours**

Financial Management: Concepts and Meaning – Introduction to Finance; Objectives of Financial Management; Profit Maximization; EVA; Changing Role of Financial Managers.
Time Value of Money: Techniques and Applications of Compounding and Discounting.

UNIT-II

Capital Budgeting and Working Capital	**15 Hours**

Capital Budgeting (Investment Evaluation Techniques): Payback Period Method; Present Worth Method; Annual Worth Method; Profitability index method; Estimation of IRR.
Cost of Capital: Sources of various Types of Capital; Cost of Debenture Capital; Cost of Preferential Capital; Cost of Term Loans; Cost of Equity Capital.
Working Capital: Factors influencing Working Capital Requirements.

UNIT-III

Inventory Management and Break Even Analysis	**9 Hours**

Inventory Management: Techniques of Inventory Management and Control – EOQ, ABC Analysis, Just-in-Time (JIT) System
Break Even Analysis: Estimation of Break-Even Point and Values.

Course Outcomes: At the end of the course student will be able to

1.	Describe the basic financial management skills required for a professional.
2.	Explain techniques and applications of compounding and discounting and calculate compounded/discounted amount for the given proposal.
3.	Evaluate the given investment option by capital budgeting techniques.
4.	Describe the basics of cost of capital and working capital. Determine the cost of capital for the given investment option.
5.	Describe the basics of inventory management and calculate the economic order quantity and reorder point for the given conditions. Calculate breakeven point for the given manufacturing setup.

Course Outcomes Mapping with Program Outcomes & PSO

Program Outcomes→	1	2	3	4	5	6	7	8	9	10	11	12	**PSO↓**		
↓ Course Outcomes													1	2	3
MG1002-1.1	3	-	-	-	-	-	-	-	1	1	-	1	-	-	-
MG1002-1.2	1	3	-	-	-	-	-	-	1	1	-	1	-	-	-
MG1002-1.3	2	3	-	-	-	-	-	-	1	1	-	1	-	-	-
MG1002-1.4	2	3	-	-	-	-	-	-	1	1	-	1	-	-	-
MG1002-1.5	1	3	-	-	-	-	-	-	1	1	-	1	-	-	-

1: Low 2: Medium 3: High

TEXTBOOKS:

1. M Y Khan, P K Jain , “Financial Management – Text, Problems & Cases”,7th Edition, 2015; McGraw Hill Education (India) Pvt. Ltd, New Delhi.
2. I M Pandey, "Financial Management", 11th Edition, 2015; Vikas Publishing House Pvt. Ltd. (UP) India.
3. James L. Riggs, David D. Bedworth and Sabah U. Randhawa, “Engineering Economics”, 4th Edition, Tata McGraw Hill Edition.

REFERENCE BOOKS:

1. Prasanna Chandra, “Financial Management”, 6th Edition, 2004; Tata McGraw Hill Publishing Company Ltd, New Delhi.
2. S. D. Sharma, “Operation Research” , Kedar Nath Ram Nath Publishers, 2015.

ESSENCE OF INDIAN CULTURE

Course Code:	**HU1005-1**	**Course Type:**	**HEC**
Teaching Hours/Week (L: T: P: S):	**1:0:0:0**	**Credits:**	**01**
Total Teaching Hours:	**15**	**CIE + SEE Marks:**	**50+50**

Teaching Department: Respective Department

Course Objectives:

1.	To facilitate students with the concepts of Indian Culture and to make them understand the roots of knowledge system.
2.	To acquaint students with Indian Culture and inculcate an ability to analyze it.
3.	To apply various approaches for the enhancement of living ideals based on Indian traditional knowledge.

UNIT-I

Introduction to Traditional Knowledge — **6 Hours**

Define traditional knowledge, nature and characteristics, scope and importance, kinds of traditional knowledge, Indigenous Knowledge and its characteristics, Traditional Knowledge vis-a-vis Indigenous Knowledge, Traditional Knowledge vis-a-vis Western Knowledge

UNIT-II

Significance of Traditional Knowledge — **6 Hours**

Value of Traditional Knowledge in global economy, Role of Government in harnessing Traditional Knowledge, Traditional medicine system, Traditional Knowledge in agriculture. food and healthcare.

UNIT-III

Holistic Healthcare for Human Well-being — **3 Hours**

Definition of Ayurveda, Ayurveda for Life, Health and Well-being, Introduction to principles of Ayurvedic healing and Astanga Ayurveda.

Course Outcomes: At the end of the course student will be able to

1.	Identify the concept of Traditional Knowledge and its importance.
2.	Explain the need for and importance of protecting Traditional Knowledge.
3.	Illustrate the various enactments related to Traditional Knowledge.
4.	Familiarize the importance of Holistic Healthcare.

Course Outcomes Mapping with Program Outcomes & PSO

Program Outcomes→	1	2	3	4	5	6	7	8	9	10	11	12	**PSO↓**	
↓ Course Outcomes													1	2
HU1005-1.1	-	-	-	-	-	-	-	-	-	2	2	3	-	-
HU1005-1.2	-	-	-	-	-	-	-	-	-	3	2	3	-	-
HU1005-1.3	-	-	-	-	-	-	-	-	-	3	2	3	-	-
HU1005-1.4	-	-	-	-	-	-	-	-	2	2	2	2	-	-
HU1005-1.5	-	-	-	-	-	-	-	-	1	2	2	2	-	-

	1: Low 2: Medium 3: High
REFERENCES:	

1.	Jha, A., "Traditional Knowledge System in India", Atlantic Publishers, 2002.
2.	Kapoor, K., & Danino, M., "Knowledge Traditions and Practices of India", 2012.
3.	Kapil Kapoor, Michel Danino, "Knowledge Traditions and Practices of India", Medknow Publications and Media.
4.	Jha, R.N., "Science of Consciousness Psychotherapy and Yoga Practices", Delhi: Vidyanidhi Prakashan, 2015.
5.	TEDx Talks. (2015, February 6). Unleashing the Power of Traditional Medicine | Dr. Arvind Singh [Video file]. Retrieved from https://www.youtube.com/watch?v=LZP1StpYEPM

INDIAN KNOWLEDGE SYSTEMS

Course Code:	**HU1009-1**	**Course Type:**	**HEC**
Teaching Hours/Week (L: T: P: S):	**1:0:0:0**	**Credits:**	**01**
Total Teaching Hours:	**15**	**CIE + SEE Marks:**	**50+50**

Teaching Department: Respective Department

Course Objectives:

1.	Enhance knowledge about the History of Ancient India and Rich Culture of the country
2.	Gain an introduction to ancient Indian Engineering Technology and Architecture
3.	Familiarize Indian indigenous wisdom in Modern scientific paradigm
4.	Understanding the Scientific Value of the Traditional Knowledge of our country
5.	Comprehend and compare the Ancient and Current Knowledge Systems

UNIT-I

Indian History — **6 Hours**

History - Land, Environment, and people in Ancient India; Ancient Education System, Takṣaśilā and Nālandā University, Hunting to Agriculture; Introduction to Vedas and Upanishads; Great Indian Epics; Indian Festivals

UNIT-II

Engineering, Technology, and Architecture — **6 Hours**

Pre-Harappan and Sindhu Valley Civilization, Laboratory and Apparatus, Juices, Dyes, Paints and Cements, Glass and Pottery, Metallurgy, Engineering Science and Technology in the Vedic Age and Post-Vedic Records, Iron Pillar of Delhi, Rakhigarhi, Mehrgarh, Sindhu Valley Civilization, Marine Technology

UNIT-III

Science, Astronomy, and Mathematics — **3 Hours**

Concept of Matter, Life and Universe, Gravity, Sage Agastya's Model of Battery, Velocity of Light, Vimāna: Aeronautics, Vedic Cosmology and Modern Concepts, History and Culture of Astronomy, Sun, Earth, Moon, Eclipses, Rotation of Earth, Concepts of Zero and Pi, Number System, Pythagoras Theorem and Vedic Mathematics.

Course Outcomes: At the end of the course student will be able to

1.	Understand the relevance of studying history
2.	Comprehend the origin of Vedas and epics
3.	Realize the scientific value of the Traditional Knowledge of India
4.	Converting the Bhāratīya wisdom into the applied aspect of the modern scientific paradigm
5.	Preserve and disseminate Indian Knowledge Systems in Research and Societal applications

Course Outcomes Mapping with Program Outcomes & PSO

Program Outcomes→	1	2	3	4	5	6	7	8	9	10	11	12	**PSO↓**

↓ Course Outcomes													1	2
HU1009-1.1	-	-	-	-	-	-	-	-	-	-	2	3	-	-
HU1009-1.2	-	-	-	-	-	-	-	-	-	-	3	3	-	-
HU1009-1.3	-	-	-	-	-	-	-	-	-	-	2	3	-	-
HU1009-1.4	-	-	-	-	-	-	-	-	-	-	2	2	-	-
HU1009-1.5	-	-	-	-	-	-	-	-	-	-	2	2	-	-

1: Low 2: Medium 3: High

REFERENCES:

1.	Tripati, R.S., “History of Ancient India”, Motilal Banarsidass, 1942.
2.	Mahajan, V.D.. “Ancient India”, S. Chand and Company, 1985.
3.	Ramasubramanian, K., & Srinivas, M.D., “Development of Calculus in India”, 2010.
4.	Ramasubramanian, K., Srinivas, M.D., & Sriram, M.S., “The Traditional Indian Planetary Model and its Revision by Nilakantha Somayaji”, 2011.
5.	Srinivas, M.D., “Proofs in Indian Mathematics”, Hindustan Book Agency, 2005.
6.	Srinivas, M.D., “The Algorithmic Approach of Indian Mathematics”, 2015.
7.	Srinivas, M.D. “Indian Tradition of Science: An Introductory Overview”, 2016.
8.	Rahika, M., & Balasubramanian, A.V., “Ayurvedic Principles of Food and Nutrition”, Part 1. Lok Swasthya Parampara Samvardhan Samithi, 1990.

ಆಡಳಿತ ಕನ್ನಡ (Kannada for Administration)

Course Code	**HU1003-1**	**Course Type**	**MNC**
Teaching Hours/Week (L:T:P:S)	**1:0:0:0**	**Credits**	**0**
Total Teaching Hours	**15+0+0+0**	**CIE + SEE Marks**	**50+0**

Teaching Department: Any Department

Course Objectives:

1.	ಪದವಿ ವಿದ್ಯಾರ್ಥಿಗಳಾಗಿರುವುದರಿಂದ ಸಾಂಸ್ಕೃತಿಕ ಕನ್ನಡದ ಜೊತೆಗೆ ಕ್ರಿಯಾತ್ಮಕ ಕನ್ನಡವನ್ನು, ಕನ್ನಡ ಸಾಹಿತ್ಯ, ಸಂಸ್ಕೃತಿ ಮತ್ತು ನಾಡು ನುಡಿಯ ಪರಿಚಯ ಮಾಡಿಕೊಡುವುದು.
2.	ವಿದ್ಯಾರ್ಥಿಗಳಲ್ಲಿ ಕನ್ನಡ ಭಾಷೆಯ ವ್ಯಾಕರಣದ ಬಗ್ಗೆ ಅರಿವು ಮೂಡಿಸುವುದು ಮತ್ತು ಕನ್ನಡ ಭಾಷಾ ರಚನೆಯಲ್ಲಿನ ನಿಯಮಗಳನ್ನು ಪರಿಚಯಿಸುವುದು.
3.	ಕನ್ನಡ ಭಾಷಾ ಬರೆಹದಲ್ಲಿ ಕಂಡುಬರುವ ದೋಷಗಳು ಹಾಗು ಅವುಗಳನಿವಾರಣೆ.
4.	ಸಾಮಾನ್ಯ ಅರ್ಜಿಗಳು, ಸರ್ಕಾರಿ ಮತ್ತು ಅರೆಸರ್ಕಾರಿ ಪತ್ರ ವ್ಯವಹಾರದ ಬಗ್ಗೆ ಅರಿವು ಮೂಡಿಡಿಸುವುದು.
5.	ಕನ್ನಡ ಭಾಷಾಭ್ಯಾಸ, ಸಾಮಾನ್ಯ ಕನ್ನಡ ಹಾಗೂ ಆಡಳಿತ ಕನ್ನಡ ದಪದಗಳ ಪರಿಚಯ ಮಾಡಿ ಕೊಡುವುಧು.

UNIT - I

ಲೇಖನಗಳು:

1. ಕರ್ನಾಟಕ ಸಂಸ್ಕೃತಿ: ಹಂಪನಾಗರಾಜಯ್ಯ
2. ಕರ್ನಾಟಕದ ಏಕೀಕರಣ: ಒಂದು ಅಪೂರ್ವಚರಿತ್ರೆ – ಜಿ. ವೆಂಕಟಸುಬ್ಬಯ್ಯ
3. ಆಡಳಿತ ಭಾಷೆಯಾಗಿ ಕನ್ನಡ – ವಿತಾವಿಯ ಆಡಳಿತ ಕನ್ನಡ ಪುಸ್ತಕದಿಂದ ಆಯ್ದ ಲೇಖನ

ಕಾವ್ಯಭಾಗ (ಆಧುನಿಕಪೂರ್ವ)

1. ವಚನಗಳು: ಬಸವಣ್ಣ, ಅಕ್ಕಮಹಾದೇವಿ, ಅಲ್ಲಮಪ್ರಭು, ಆಯ್ದಕ್ಕಿಮಾರಯ್ಯ, ಜೇಡರದಾಸಿಮಯ್ಯ, ಆಯ್ದಕ್ಕಿಲಕ್ಕಮ್ಮ
2. ಕೀರ್ತನೆಗಳು: ಅದರಿಂದೇನು ಫಲ ಇದರಿಂದೇನು ಫಲ – ಪುರಂದರದಾಸ
3. ತಲ್ಲಣಿಸದಿರು ಕಂಡ್ಯ ತಾಳುಮನವೆ – ಕನಕದಾಸ
4. ತತ್ವಪದಗಳು: ಸಾವಿರ ಕೊಡಗಳಸುಟ್ಟು – ಶಿಶುನಾಳಪಂಥಷರೀಫ
5. ಶಿವಯೋಗಿ: ಬಾಲಲೀಲಾ ಮಹಾಂತ ಶಿವಯೋಗಿ
6. ಜನಪದಗೀತೆ: ಬೀಸುವಪದ, ಬಡವರಿಗೆ ಸಾವ ಕೊಡಬೇಡ

06 Hours

UNIT – II

ಕಾವ್ಯಭಾಗ (ಆಧುನಿಕ)

1. ಮಂಕುತಿಮ್ಮನ ಕಗ್ಗ: ಡಿ.ವಿ.ಜಿ.
2. ಕುರುಡು ಕಾಂಚಾಣ: ದ.ರಾ.ಬೇಂದ್ರೆ
3. ಹೊಸಬಾಳಿನ ಗೀತೆ: ಕುವೆಂಪು
4. ಹೆಂಡತಿಯ ಕಾಗದ: ಕೆ .ಎಸ್. ನರಸಿಂಹಸ್ವಾಮಿ
5. ಮಬ್ಬಿನಿಂದ ಮಬ್ಬಿಗೆ: ಜಿ. ಎಸ್. ಶಿವರುದ್ರಪ್ಪ
6. ಆಮರ ಈ ಮರ: ಚಂದ್ರಶೇಖರ ಕಂಬಾರ

06 Hours

7. ಚೋಮನ ಮಕ್ಕಳ ಹಾಡು: ಸಿದ್ಧಲಿಂಗಯ್ಯ

ತಾಂತ್ರಿಕ ವ್ಯಕ್ತಿಪರಿಚಯ, ಕಥೆ ಮತ್ತು ಪ್ರವಾಸ ಕಥನ

1. ಡಾ. ಸ ಎಂ ವಿಶ್ವೇಶ್ವರಯ್ಯ - ವ್ಯಕ್ತಿ ಮತ್ತು ಐತಿಹ್ಯ: ಎ ಎನ್ಮೂರ್ತಿ ರಾವ್
2. ಯುಗಾದಿ: ವಸುಧೇಂದ್ರ
3. ಮೆಗಾನೆ ಎಂಬ ಗಿರಿಜನ ಪರ್ವತ: ಹಿ. ಚಿ. ಬೋರಲಿಂಗಯ್ಯ

UNIT – III

ವಿಜ್ಞಾನ ಮತ್ತು ತಂತ್ರಜ್ಞಾನ:

1. ಕರಕುಶಲ ಕಲೆಗಳು ಮತ್ತು ಪರಂಪರೆಯ ವಿಜ್ಞಾನ: ಕರೀಗೌಡ ಬೀಚನಹಳ್ಳಿ
2. 'ಕ' ಮತ್ತು 'ಬ' ಬರಹ ತಂತ್ರಾಂಶಗಳು ಮತ್ತು ಕನ್ನಡ ಟೈಪಿಂಗ್
3. ಕನ್ನಡ: ಕಂಪ್ಯೂಟರ್ಶಬ್ದಕೋಶ
4. ತಾಂತ್ರಿಕ ಪದಕೋಶ: ತಾಂತ್ರಿಕ ಹಾಗೂ ಪಾರಿಭಾಷಿಕ ಕನ್ನಡ ಪದಗಳು

03 Hours

Course Outcomes: At the end of the course student will be able to

1.	ಪದವಿ ವಿದ್ಯಾರ್ಥಿಗಳಾಗಿರುವುದರಿಂದ ಸಾಂಸ್ಕೃತಿಕ ಕನ್ನಡದ ಜೊತೆಗೆ ಕ್ರಿಯಾತ್ಮಕ ಕನ್ನಡವನ್ನು, ಕನ್ನಡಸಾಹಿತ್ಯ, ಸಂಸ್ಕೃತಿ ಮತ್ತು ನಾಡುನುಡಿಯ ಪರಿಚಯ ಮಾಡಿಕೊಡುವುದು.
2.	ವಿದ್ಯಾರ್ಥಿಗಳಲ್ಲಿ ಕನ್ನಡಭಾಷೆಯ ವ್ಯಾಕರಣದ ಬಗ್ಗೆ ಅರಿವು ಮೂಡಿಸುವುದು ಮತ್ತು ಕನ್ನಡ ಭಾಷಾ ರಚನೆಯಲ್ಲಿನ ನಿಯಮಗಳನ್ನು ಪರಿಚಯಿಸುವುದು.
3.	ಕನ್ನಡ ಭಾಷಾ ಬರೆಹದಲ್ಲಿ ಕಂಡುಬರುವ ದೋಷಗಳು ಹಾಗು ಅವುಗಳ ನಿವಾರಣೆ.
4.	ಸಾಮಾನ್ಯ ಅರ್ಜಿಗಳು, ಸರ್ಕಾರಿ ಮತ್ತು ಅರೆ ಸರ್ಕಾರಿ ಪತ್ರ ವ್ಯವಹಾರದ ಬಗ್ಗೆ ಅರಿವು ಮೂಡಿಸುವುದು.
5.	ಕನ್ನಡ ಭಾಷಾಭ್ಯಾಸ, ಸಾಮಾನ್ಯ ಕನ್ನಡ ಹಾಗೂ ಆಡಳಿತ ಕನ್ನಡದ ಪದಗಳ ಪರಿಚಯ ಮಾಡಿಕೊಡುವುಧು.

Course Outcomes Mapping with Program Outcomes & PSO

Program Outcomes→	1	2	3	4	5	6	7	8	9	10	11	12	**PSO↓**		
↓ Course Outcomes													1	2	3
HU1003-1.1	-	-	-	-	-	-	-	3	-	-	1	1			
HU1003-1.2	-	-	-	-	-	-	-	2	-	-	1	1			
HU1003-1.3	-	-	2	-	-	-	1	2	-	-	1	1			
HU1003-1.4	-	-	-	-	-	-	-	1	-	-	-	-			
HU1003-1.5	-	-	1	-	-	-	-	3	-	-	1	1			

1: Low 2: Medium 3: High

REFERENCE MATERIALS:

1.	ಸಂಕ್ಷಿಪ್ತ ಕನ್ನಡನಿಗಂಟು (ಪರಿಷ್ಕೃತ), ಕನ್ನಡ ಸಾಹಿತ್ಯ ಪರಿಷತ್, ಬೆಂಗಳೂರು.
2.	ಆಡಳಿತ ಪದಕೋಶ, ಕನ್ನಡ ಅಭಿವೃದ್ಧಿಪ್ರಾಧಿಕಾರ, ಬೆಂಗಳೂರು.
3.	ಕಾನೂನು ಪದಕೋಶ (ಪರಿಷ್ಕೃತ) ಕನ್ನಡ- ಇಂಗ್ಲಿಷ್, ಕನ್ನಡ ಮತ್ತು ಸಂಸ್ಕೃತಿ ನಿರ್ದೇಶನಾಲಯ, ಬೆಂಗಳೂರು.
4.	ಡಿ.ಎನ್. ಶಂಕರ್ಭಟ್, ಕನ್ನಡವಾಕ್ಯಗಳ ಒಳರಚನೆ, ೨೦೦೬, ಭಾಷಾಪ್ರಕಾಶನ, ಮೈಸೂರು.
5.	ಕನ್ನಡ ಭಾಷಿಕ (ಅವಿಸ್ತರ)- ಪ್ರಬಂಧ ಮತ್ತು ಆಡಳಿತ ಕನ್ನಡ, ಕರ್ನಾಟಕ ರಾಜ್ಯ ಮುಕ್ತ ವಿಶ್ವವಿದ್ಯಾಲಯ, ಮೈಸೂರು.

6.	ಆಡಳಿತ ಕನ್ನಡ, ಎಚ್ಚೆಸ್ಕೆ, ಚೇತನ ಬುಕ್ಹೌಸ್, ಮೈಸೂರು.

Balake Kannada (Communication in Kannada)

Course Code	**HU1003-1**	**Course Type**	**MNC**
Teaching Hours/Week (L: T: P: S)	**1:0:0:0**	**Credits**	**0**
Total Teaching Hours	**15+0+0+0**	**CIE + SEE Marks**	**50+0**

Teaching Department: Any Department

Course Objectives:

1.	The course will enable the students to cognize Kannada and communicate in basic Kannada language.

UNIT - I

Basic Kannada Grammar Personal Pronouns, Possessive Forms, Interrogative words Possessive forms of nouns, Dubitive question and Relative nouns Qualitative, Quantitative and Colour Adjectives, Numerals Predictive Forms, Locative Case Dative Cases, and Numerals Ordinal numerals and Plural markers Defective / Negative Verbs and Colour Adjectives Permission, Commands, encouraging and Urging words (Imperative words and sentences) Accusative Cases and Potential Forms used in General Communication Helping Verbs "iru and iralla", Corresponding Future and Negation Verbs Comparative, Relationship, Identification and Negation Words Different types of forms of Tense, Time and Verbs Formation of Past, Future and Present Tense Sentences with Verb Forms Karnataka State and General Information about the State Kannada Language and Literature Do's and Don'ts in Learning a Language	**06 Hours**

UNIT – II

Kannada Language Script Part – 1	**06 Hours**

UNIT – III

Kannada Vocabulary List & Kannada Words in Conversation	**03 Hours**

Course Outcomes: At the end of the course student will be able to

1.	Understand the parts of speech of Kannada
2.	Know the script in Kannada
3.	Able to Converse daily usages in Kannada
4.	Enrich Basic Kannada Vocabulary
5.	Have knowledge about Karnataka and its culture

Course Outcomes Mapping with Program Outcomes & PSO

Program Outcomes→	1	2	3	4	5	6	7	8	9	10	11	12	**PSO↓**	
↓ Course Outcomes													1	2
HU1003-1.1	-	-	-	-	-	-	-	3	-	-	1	1		
HU1003-1.2	-	-	-	-	-	-	-	2	-	-	1	1		
HU1003-1.3	-	-	2	-	-	-	1	2	-	-	1	1		
HU1003-1.4	-	-	-	-	-	-	-	1	-	-	-	-		
HU1003-1.5	-	-	1	-	-	-	-	3	-	-	1	1		

1: Low 2: Medium 3: High

REFERENCE MATERIALS:

1.	English –Kannada Rapidex Dictionary of Spoken Words, S N Raju, Bengaluru
2.	English Kannada Standard Dictionary, D K Bharadwaj, Sankeshwar Printers Pvt Ltd, Bengaluru
3.	ಮಾತಾಡುವ ಕನ್ನಡ, ಕನ್ನಡ ಸಾಹಿತ್ಯ ಪರಿಷತ್, ಬೆಂಗಳೂರು (೨೦೧೬).
4.	ಸಂಕ್ಷಿಪ್ತ ಕನ್ನಡನಿಗಂಟು (ಪರಿಷ್ಕೃತ), ಕನ್ನಡ ಸಾಹಿತ್ಯ ಪರಿಷತ್, ಬೆಂಗಳೂರು.
5.	ಆಡಳಿತ ಪದಕೋಶ, ಕನ್ನಡ ಅಭಿವೃದ್ಧಿಪ್ರಾಧಿಕಾರ, ಬೆಂಗಳೂರು.
6.	ಕನ್ನಡ ಭಾಷಾಕೈಪಿಡಿ, ಸಂಗಮೇಶ್ಸವ ದತ್ತಿಮಠ, ರೂಪರಶ್ಮಿ ಪ್ರಕಾಶನ, ಗುಲ್ಬರ್ಗ, ೧೯೯೫.
7.	ಡಿ.ಎನ್. ಶಂಕರ್ಭಟ್, ಕನ್ನಡ ವಾಕ್ಯಗಳ ಒಳ ರಚನೆ, ೨೦೦೬, ಭಾಷಾ ಪ್ರಕಾಶನ, ಮೈಸೂರು.
8.	ಕಾನೂನು ಪದಕೋಶ (ಪರಿಷ್ಕೃತ) ಕನ್ನಡ- ಇಂಗ್ಲಿಷ್, ಕನ್ನಡ ಮತ್ತು ಸಂಸ್ಕೃತಿ ನಿರ್ದೇಶನಾಲಯ, ಬೆಂಗಳೂರು.

LIST OF OPEN ELECTIVE COURSES

Sl No.	Department	Course Codes	Open Elective Courses
1	BT	BT1501-1	Bio Fuel Engineering
2	BT	BT1502-1	Solid Waste Management
3	CS	CS2501-1	Fundamentals of AI and ML
4	CS	CS2502-1	Introduction to Data Structures
5	CV	CV2501-1	Disaster Management
6	CV	CV2502-1	Environmental Hygiene, Sanitation and Waste Management
7	CV	CV2503-1	Environmental Impact Assessment
8	CV	CV2504-1	Introduction to Geoinformatics
9	CY	CY2501-1	Corrosion Science (Only for CV and ME)
10	CY	CY2502-1	Natural Products Chemistry (Only For BT)
11	EC	EC1501-1	Artificial Neural Network Systems
12	EC	EC1502-1	Introduction to MATLAB Programming: A Hands-on Approach (only for CV and BT)
13	EC	EC1503-1	Robotics
14	EC	EC2501-1	Consumer Electronics
15	EC	EC2502-1	PCB Design and Fabrication
16	EC	EC2503-1	Space Technology and Applications
17	EE	EE2501-1	Battery Management System
18	EE	EE2502-1	Biomedical Instrumentation
19	EE	EE2503-1	Electric Vehicle Technology
20	EE	EE2504-1	Fundamentals of PLC and its applications
21	EE	EE2505-1	Motors and Motor Control Circuits
22	EE	EE2506-1	Non-Conventional Energy sources
23	HU	HU1501-1	Elements of Yoga
24	HU	HU1502-1	Intellectual Property Rights
25	HU	HU1503-1	Introduction to German Language
26	HU	HU1504-1	Introduction to Japanese Language
27	HU	HU1505-1	National Cadet Corps: Organization, Functions & Capabilities
28	HU	HU1506-1	Overview of Indian Culture
29	HU	HU1507-1	Philosophy
30	HU	HU1508-1	Principles of Physical Education
31	HU	HU1509-1	Indian Culture – Dance *
32	HU	HU1510-1	Indian Culture – Music *
33	HU	HU1511-1	Engineering Ethics *
34	HU	HU1512-1	Art of Communication and Interpersonal Skills*
35	HU	HU2501-1	Common sense and Critical Thinking
36	HU	HU2502-1	Linguistics & Language Technology
37	IS	IS2501-1	Introduction to Cyber Security (except EC, EE, AM, AD, CC, CS, IS)
38	IS	IS2502-1	Python Application Programming
39	IS	IS2503-1	Software Engineering Practices
40	IS	IS2504-1	Web technologies
41	MA	MA1501-1	Graph Theory (for BT, CV, EC, EE, ME and RI)

Sl No.	Department	Course Codes	Open Elective Courses
42	MA	MA1502-1	Number Theory
43	MA	MA3501-1	Linear Algebra (for BT, CV, EE, ME and RI)
44	ME	ME1501-1	Automotive Engineering
45	ME	ME1502-1	Industrial Pollution Control
46	ME	ME1503-1	Sustainable Development Goals
47	ME	ME1504-1	Technology Innovation
48	MG	MG1501-1	Human Resource Management
49	MG	MG1502-1	Management Accounting and Control Systems
50	MG	MG1503-1	Operations and Quality Management
51	MG	MG1504-1	Organizational Behaviour
52	MG	MG1505-1	Taxation for Engineers
53	MG	MG1506-1	Working Capital Management
54	PH	PH2501-1	Nanotechnology
55	PH	PH2502-1	Optoelectronic Devices (EC, EE, CSE, ISE, AM and CC branches)
56	RI	RI2501-1	Autonomous Mobile Robots
57	RI	RI2502-1	Medical Robotics (for all except AI)
58	RI	RI2503-1	PLC Control of Hydraulic and Pneumatic Circuits (for all except AI)

*** For students admitted under Twinning Program**

BIOFUEL ENGINEERING

Course Code:	**BT1501-1**	**Course Type:**	**OEC**
Teaching Hours/Week (L: T: P: S):	**3:0:0:0**	**Credits:**	**03**
Total Teaching Hours:	**40**	**CIE + SEE Marks:**	**50+50**

Teaching Department: Biotechnology

Course Objectives:

1.	To learn the fundamental concepts of biofuels, types of biofuels, their production technologies.
2.	To learn the concepts of feedstock utilization and energy conversion technologies.

UNIT-I

Liquid Biofuels — **15 Hours**

Description and classification of Biofuels; Primary biomass: Plant Materials-Woody biomass, Lignocellulosic and agroindustrial by-products, starchy and sugary crops. Secondary biomass: Waste residues and co-products- wood residues, animal waste, municipal solid waste. Biomass production for fuel – algal cultures, yeasts (Lipid and carbohydrate).

Production of biodiesel: Sources of Oils – edible and non-edible; Esterification and Transesterification. Free fatty acids; saponification; Single step and two step biodiesel production. Catalysts for biodiesel production – homogeneous (alkali/acidic) and heterogeneous; Lipase mediated process. General procedure of biodiesel production and purification Quality Control Aspects: GC analysis of biodiesel, fuel property measurements, ASTM (D-6751) and Indian standards (IS15607). Algal Biodiesel production.

Production of Bioethanol: Bioethanol production using Sugar; Starch and Lignocellulosic feedstocks; Pretreatment of lignocellulosic feed stock

UNIT-II

Biohydrogen and Microbial Fuel Cells — **15 Hours**

Enzymes involved in H_2 Production; Photobiological H_2 Production: Biophotolysis and Photo fermentation; H_2 Production by Fermentation: Biochemical Pathway, Batch Fermentation, Factors affecting H_2 production, Carbon sources, Detection and Quantification of H_2. Reactors for biohydrogen production.

Microbial Fuel cells: Biochemical Basis; Fuel Cell Design: Anode & Cathode Compartment, Microbial Cultures, Redox Mediators, Exchange Membrane, Power Density; MFC Performance Methods: Substrate & Biomass Measurements, Basic Power Calculations, MFC Performance: Power Density, Single vs Two-Chamber Designs, Wastewater Treatment Effectiveness;
Advances in MFC.

UNIT-III

Recovery of Biological Conversion Products — **10 Hours**

Bio gasification of municipal solid waste: Anaerobic processing; Types of digesters, Biogas plant in India.

Thermochemical processing: Planning an incineration facility, Incineration technologies: Mass burning system; Refuse derived fuel (RDF) system; modular incineration; Fluidized bed incineration; energy recovery; Fuel production through biomass incineration, Pyrolysis and gasification, hydrothermal processing.

Course Outcomes: At the end of the course student will be able to

1.	Mark the significance of biofuels and raw materials and Identify suitable feedstock for production of biofuels.
2.	Illustrate the production of liquid biofuels from various feed stocks.
3.	Demonstrate production of biohydrogen using microbial sources.
4.	Extend the concepts of microbial fuel cells towards development of specific application.
5.	Understand and apply the concepts of biochemical processing to harvest energy from waste products/streams.

Course Outcomes Mapping with Program Outcomes

Program Outcomes→ **↓ Course Outcomes**	1	2	3	4	5	6	7	8	9	10	11	12
BT1501-1.1	-	2	-	-	-	-	-	-	1	-	-	-
BT1501-1.2	-	2	-	-	-	-	-	-	1	-	-	-
BT1501-1.3	-	2	-	-	-	-	-	-	1	-	-	-
BT1501-1.4	-	2	-	-	-	-	-	-	1	-	-	-
BT1501-1.5	-	2	-	-	-	-	-	-	1	-	-	-

1: Low 2: Medium 3: High

REFERENCE BOOKS:

1.	Drapcho, C. M., Nhuan, N. P.and Walker, T. H. , "Biofuels Engineering Process Technology", Mc Graw Hill Publishers, New York, 2008.
2.	Jonathan R.M, Biofuels, "Methods and Protocols (Methods in Molecular Biology Series)", Humana Press, New York, 2009.
3.	Olsson L. (Ed.), "Biofuels (Advances in Biochemical Engineering/Biotechnology Series", Springer-Verlag Publishers, Berlin, 2007.
4.	Glazer, A. and Nikaido, H., "Microbial Biotechnology – Fundamentals of Applied Microbiology", 2 Ed., Cambridge University Press, 2007.
5.	Godfrey Boyle (Ed). "Renewable Energy- Power for sustainable future", 3rd Ed. Oxford. 2012.
6.	Ramachandran, T. V., "Management of municipal solid waste", Environmental Engineering Series. Teri Press, 2016.

SOLID WASTE MANAGEMENT

Course Code:	**BT1502-1**	**Course Type:**	**OEC**
Teaching Hours/Week (L: T: P: S):	**3:0:0:0**	**Credits:**	**03**
Total Teaching Hours:	**40**	**CIE + SEE Marks:**	**50+50**

Teaching Department: Biotechnology

Course Objectives:

1.	To learn types of solid wastes, collection, treatment and disposal methods.
2.	To understand various processing techniques and regulations of treatment and disposal.

UNIT-I

Introduction to Solid Wastes and its Segregation & Transportation	**15 Hours**

Solid waste – Definition, Sources of waste, Classification of Solid waste, Characteristics of Solid Waste (Physical, Chemical, Biological), Solid waste problems – impact on environment and health. Concept of waste reduction, recycling and reuse.

Waste collection and segregation: Solid waste generation, Onsite handling and segregation of wastes at source, Collection and storage of municipal solid wastes, Equipment used and manpower required in collection, Collection systems and routes.

Transportation: Transfer stations: types, location, maintenance, Methods and means of transportation.

UNIT-II

Processing Techniques, Recovery of Resources and Waste Disposal	**15 Hours**

Processing Techniques: Unit operations for separations and processing, mechanical and thermal volume reduction, Incineration of solid wastes – process and types of incinerators (liquid injection, rotary kiln and fluid bed), Biological processing – composting, vermicomposting, biomethanation, fermentation, Drying and dewatering of wastes.

Recovery of Resources: Heat recovery in incineration process, energy recovery and conversion of products from biological processes.

Dumping of solid wastes, Landfills – Types, site selection, preliminary design, operation, case study, Advantages and disadvantages of landfills, Leachate and landfill gases: Collection and treatment, Landfill disposal for hazardous wastes, biomedical waste.

UNIT-III

Solid Waste Management Rules and Planning Issues	**10 Hours**

Legislative trends and impacts: Major legislations, Government agencies. Municipal Solid Waste Management Act (1999), Hazardous Wastes (Handling and Management) Rules, Biomedical Waste (Handling and Management) Rule (1998), e-Waste (Management and Handling) Rule 2011.

Planning and developing a site for solid waste management, Site Remediation: Assessment and Inspection, Remedial techniques, Siting guidelines.

Course Outcomes: At the end of the course student will be able to

1.	Identify the sources, classification and characteristics of solid wastes

2.	Develop insight into the collection, transfer, and transport of solid waste.
3.	Apply waste processing techniques and recovery of resources from the waste.
4.	Select the alternatives of solid waste disposals and its impacts.
5.	Acquire knowledge about solid and hazardous waste management legislative rules.

Course Outcomes Mapping with Program Outcomes

Program Outcomes→ **↓ Course Outcomes**	1	2	3	4	5	6	7	8	9	10	11	12
BT1502-1.1	1	-	-	-	-	-	-	-	1	-	-	-
BT1502-1.2	1	1	-	-	-	1	1	-	1	-	-	-
BT1502-1.3	-	2	-	-	-	-	-	-	1	-	-	-
BT1502-1.4	-	2	-	-	-	1	1	-	1	-	-	-
BT1502-1.5	1	-	-	-	-	-	-	-	1	-	-	1

1: Low 2: Medium 3: High

REFERENCE BOOKS:

1.	Tchobanaglous, G., Theisen, H. and Vigil, S. A. "Integrated Solid Waste Management", McGraw – Hill. 1993.
2.	Tchobanoglous, G., Thiesen, H., Ellasen, "Solid Waste Engineering Principles and Management", McGraw – Hill, 1997.
3.	Landrefh, R. E. and Sundaresan, B. B. "Solid Waste Management in Developing Countries", Indian National Scientific Documentation Centre. New Delhi, 2000.

FUNDAMENTALS OF AI AND ML

Course Code:	**CS2501-1**	**Course Type:**	**OEC**
Teaching Hours/Week (L: T: P: S):	**3:0:0:0**	**Credits:**	**03**
Total Teaching Hours:	**40+0+0**	**CIE + SEE Marks:**	**50**
Prerequisite	**CS1002-1**		

Teaching Department: Computer Science & Engineering

Course Objectives:

1.	Analyze the most fundamental knowledge to the students so that they can understand what the AI is.
2.	Gain a historical perspective of AI and its foundations
3.	Investigate applications of AI techniques in intelligent agents, expert systems, artificial neural networks and other machine learning models.
4.	Experience AI development tools such as an 'AI language', expert system shell, and/or data mining tool.
5.	Explore the current scope, potential, limitations, and implications of intelligent systems.

UNIT-I

Introduction — **15 Hours**

What is AI? Foundation of AI, Early History of AI, The Middle Ages and Dark Ages of AI, Renaissance, Future of AI.

Intelligence of AI

AI An Impossible Task, Animal Intelligence, Brain Size And Performance, Sensing And Movement, Subjective Intelligence, Iq Tests. Comparative Intelligence,

Chapter No 1: Introduction and Intelligence (Page No 11-37)

UNIT-II

Classical Artificial Intelligence — **15 Hours**

Introduction, Expert Systems, Conflict Resolution, Multiple Rules, Forward Chaining, Backward Chaining, Problems With Expert Systems, Fuzzy Logic, Fuzzification, Fuzzy Rules, Defuzzification, Fuzzy Expert System, Problem Solving. Chapter No 2: Classical AI (Page No 38-45)

UNIT-III

Foundations of Machine Learning — **10 Hours**

What is machine learning? Applications of Machine learning, Understand Data, Types of machine learning: Supervised, Unsupervised, Reinforcement Learning, Theory of learning: feasibility of learning, error and noise, training versus testing, theory of generalization, bias and variance, learning curve,.

Course Outcomes: At the end of the course student will be able to

1.	Explain the fundamental understanding of the history of artificial intelligence (AI) and its foundation
2.	Interpret the basic principles of AI in solutions that require problem solving, inference, perception, knowledge representation, and learning.

3.	Describe the awareness and a fundamental understanding of various applications of AI techniques in intelligent agents, expert systems, artificial neural networks and other machine learning models
4.	Identify and explain the proficiency developing applications in an 'AI language', expert system shell, or data mining tool.
5.	Explain the fundamental concept and importance of machine learning.

Course Outcomes Mapping with Program Outcomes

Program Outcomes→ / **↓ Course Outcomes**	1	2	3	4	5	6	7	8	9	10	11	12
CS2501-1.1	3	3	-	-	-	-	-	-	-	-	-	-
CS2501-1.2	3	3	-	-	-	-	-	-	-	-	-	-
CS2501-1.3	3	3	-	-	-	-	-	-	-	-	-	-
CS2501-1.4	3	3	2	-	-	-	-	-	-	-	-	-
CS2501-1.5	3	3	2	-	-	-	-	-	-	-	-	-

1: Low 2: Medium 3: High

TEXTBOOKS:

1.	Kevin Warwick, "Artificial Intelligence the basics", Typeset in Bembo by Wearset Ltd, Boldon, Tyne and Wear, Library of Congress Cataloging in Publication Data Warwick, K. ISBN: 978-0-415-56482-3 (hbk).

REFERENCE BOOKS:

1.	Stuart Russel and Peter Norvig, "Artificial Intelligence A Modern Approach", Pearson 3rd Edition , 2016.
2.	Dan W Patterson, "Introduction to Artificial Intelligence and Expert Systems", Pearson, 1st edition 2015.
3.	Elaine Rich, "Artificial Intelligence", Mc Graw Hill 3rd Edition, 2017.

E Books / MOOCs/ NPTEL

1.	Practical Artificial Intelligence Programming With Java, Third Edition ,Mark Watson
2.	Artificial Intelligence -http://www.nptelvideos.in/2012/11/artificial-intelligence.html
3.	http://nptel.ac.in/courses/106105077/
4.	https://www.udemy.com/artificial-intelligence
5.	https://www.edx.org/course/artificial-intelligence-ai-columbiax-csmm-101x-4

INTRODUCTION TO DATA STRUCTURES

Course Code:	**CS2502-1**	**Course Type:**	**OEC**
Teaching Hours/Week (L:T:P:S):	**3:0:0:0**	**Credits:**	**03**
Total Teaching Hours:	**40+0+0**	**CIE + SEE Marks:**	**50**
Prerequisite	**CS1001-1**		

Teaching Department: Computer Science & Engineering

Course Objectives:

1.	Outline the concepts of data structures, types, operations, structures, pointers
2.	Implement linear data structures stacks, queues and usage of stacks in various applications.
3.	Implement the operations of singly linked lists
4.	Identify and differentiate different types of binary trees and binary search trees data structures
5.	Illustrate and classify threaded binary trees.

UNIT-I

Introduction	**15 Hours**
Data Structure, Classification (Primitive and non-primitive), data structure operations, Arrays, Pointers and structures, Dynamic Memory Allocation Functions,	
Linear Data Structures – Stacks	
Introduction and Definition, Representation of stack: Array and structure representation of stacks, Operations on stacks,	
Applications of Stack	
Conversion of Expressions, Evaluation of expressions, Recursion: Implementation, Simulating Recursion, examples on Recursion.	

UNIT-II

Linear Data Structures – Queues	**15 Hours**
Introduction and Definition Representation of Queue: Array and Structure, representation of Queue, Various queue structures: ordinary queue, circular Queue	
Linear Data Structures - Linked Lists	
Definition and concepts singly linked List: Representation of link list in memory, Operations on singly Linked List, Circular Linked List, Doubly Linked List: Representation and Operations, Circular doubly Link list: Representation and Operations.	

UNIT-III

Nonlinear Data Structures- Tree Data Structures	**10 Hours**
Basic Terminologies, Binary Trees: Properties, Representation of Binary Tree: Linear representation, Linked representation, Operations on Binary Tree: Insertion, traversals. Introduction to Binary Search Tree	

Course Outcomes: At the end of the course student will be able to

1.	Acquire the fundamental knowledge of various types of data structures and pointers.
2.	Apply the fundamental programming knowledge of data structures to design stack and use them for solving problems.
3.	Apply the fundamental programming knowledge of data structures to design queues and use them for solving problems.
4.	Design various functions for implementation of linked list.
5.	Implement and apply the concept of binary trees and binary search tree data structure.

Course Outcomes Mapping with Program Outcomes

Program Outcomes→ **↓ Course Outcomes**	1	2	3	4	5	6	7	8	9	10	11	12
CS2502-1.1	-	-	-	-	-	-	-	-	-	-	-	-
CS2502-1.2	3	1	2	-	-	-	-	1	-	-	-	1
CS2502-1.3	3	2	2	-	-	-	-	1	-	-	-	1
CS2502-1.4	3	2	-	-	-	-	-	1	-	-	-	1
CS2502-1.5	-	-	-	-	-	-	-	-	-	-	-	-

1: Low 2: Medium 3: High

TEXTBOOKS:

1.	Aaron M. Tenenbaum, Yedidyah Langsam& Moshe J. Augenstein, "Data Structures using C", Pearson Education/PHI, 2009.
2.	Ellis Horowitz and Sartaj Sahni, "Fundamentals of Data Structures in C", 2nd edition, Universities Press, 2014.

REFERENCE BOOKS:

1.	Seymour Lipschutz, "Data Structures, Schaum's Outlines", Revised 1st edition, McGraw Hill, 2014.

E Books / MOOCs/ NPTEL

1.	Data Structures Using C, ISRD Group, Tata McGraw Hill, 2006.
2.	Data Structures Using C, Reema Thareja, 2nd edition, Oxford University Press, 2014
3.	Introduction to Data Structures by edx , URL: https://www.edx.org/course/
4.	Data structures by Berkley, URL: https://people.eecs.berkeley
5.	Advance Data Structures by MIT OCW , URL: https://www.mooclab.club/
6.	Data Structure by Harvard Extension School, URL: http://www.extension.harvard.

DISASTER MANAGEMENT

Course Code:	**CV2501-1**	**Course Type**	**OEC**
Teaching Hours/Week (L:T:P:S)	**3:0:0:0**	**Credits**	**03**
Total Teaching Hours	**40**	**CIE + SEE Marks**	**50+50**
Prerequisite	**CV1002-1**		

Teaching Department: Civil Engineering

Course Objectives:

1.	Understand difference between Disaster, Hazard, Vulnerability, and Risk.
2.	Know the Types, Trends, Causes, Consequences and Control of Disasters
3.	Apprehend Disaster Management Cycle and Framework.
4.	Know the Disaster Management in India
5.	Appreciate Applications of Science and Technology for Disaster Management.

UNIT-I

Understanding Disasters — **04 Hours**

Understanding the Concepts and definitions of Disaster, Hazard, Vulnerability, Risk, Capacity – Disaster and Development, and disaster management.

Types, Trends, Causes, Consequences and Control of Disasters — **10 Hours**

Geological Disasters (earthquakes, landslides, tsunami, mining); Hydro-Meteorological Disasters (floods, cyclones, lightning, thunder-storms, hail storms, avalanches, droughts, cold and heat waves) Biological Disasters (epidemics, pest attacks, forest fire); Technological Disasters (chemical, industrial, radiological, nuclear) and Manmade Disasters (building collapse, rural and urban fire, road and rail accidents, nuclear, radiological, chemicals and biological disasters) Global Disaster Trends – Emerging Risks of Disasters – Climate Change and Urban Disasters

UNIT-II

Disaster Management Cycle and Framework — **10 Hours**

Disaster Management Cycle and Framework: Disaster Management Cycle – Paradigm Shift in Disaster Management Pre-Disaster – Risk Assessment and Analysis, Risk Mapping, zonation and Micro zonation, Prevention and Mitigation of Disasters, Early Warning System; Preparedness, Capacity Development; Awareness During Disaster – Evacuation – Disaster Communication – Search and Rescue – Emergency Operation Centre – Incident Command System – Relief and Rehabilitation – Post-disaster – Damage and Needs Assessment, Restoration of Critical Infrastructure – Early Recovery – Reconstruction and Redevelopment; IDNDR, Yokohama Strategy, Hyogo Framework of Action.

Disaster Management in India — **06 Hours**

Disaster Management in India: Disaster Profile of India – Mega Disasters of India and Lessons Learnt, Disaster Management Act 2005 – Institutional and Financial Mechanism National Policy on Disaster Management, National Guidelines and Plans on Disaster Management; Role of Government (local, state and national), Non-Government and Inter-Governmental Agencies.

UNIT-III

Applications of Science and Technology for Disaster Management — **06 Hours**

Geo-informatics in Disaster Management (RS, GIS, GPS and RS) Disaster Communication System (Early Warning and Its Dissemination) Land Use Planning and Development

Regulations Disaster Safe Designs and Constructions Structural and Non Structural Mitigation of Disasters S&T Institutions for Disaster Management in India

Case Studies	**04 Hours**
Study of Recent Disasters (at local, state and national level), Preparation of Disaster Risk Management Plan of an Area or Sector, Role of Engineers in Disaster Management	

Course Outcomes: At the end of the course student will be able to

1.	Explain Concepts, Types, Trends, Causes of Disasters
2.	Describe Consequences and Control of Disasters
3.	Explain Disaster Management Cycle and Framework
4.	Explain the lesson learnt from the disasters in India and discuss the financial mechanism, roles and responsibilities of Non-Government and Inter-Governmental Agencies for Disaster management
5.	Describe the Applications of Science and Technology recent disasters, role of engineers for Disaster Management and prepare a report of Disaster Risk Management Plan.

Course Outcomes Mapping with Program Outcomes

Program Outcomes→ **↓ Course Outcomes**	1	2	3	4	5	6	7	8	9	10	11	12
CV2501-1.1	-	-	-	-	-	3	2	-	-	-	1	2
CV2501-1.2	-	-	-	-	-	3	2	-	-	-	1	2
CV2501-1.3	-	-	-	-	-	3	2	-	-	-	1	2
CV2501-1.4	-	-	-	-	-	3	2	-	-	-	1	2
CV2501-1.5	-	-	-	-	-	3	2	-	-	-	1	2

1: Low 2: Medium 3: High

TEXTBOOKS:

1.	Noble, L. , "Introduction to environmental impact assessment. A Guide to Principles and Practice", 2nd edition, Oxford University Press, Don Mills, Ontario, 2010.
2.	Larry W. Canter, "Environmental Impact Assessment", McGraw Hill Inc. Singapore, 1996.

REFERENCE BOOKS:

1.	Morris and Therivel, "Methods of Environmental Impact Assessment", 3rd edition. New York, NY: Routledge, 2009.
2.	Hanna, K. S., "Environmental impact assessment", Practice and Participation. 2nd edition. Oxford, University Press, Don Mills, Ontario, 2009.

E Books / MOOCs/ NPTEL

1.	http://nptel.ac.in/courses/120108004/
2.	http://nptel.ac.in/courses/120108004/module3/lecture3.pdf

ENVIRONMENTAL HYGIENE, SANITATION AND WASTE MANAGEMENT

Course Code:	**CV2502-1**	**Course Type**	**OEC**

Teaching Hours/Week (L:T:P:S)	**3:0:0:0**	**Credits**	**03**
Total Teaching Hours	**40**	**CIE + SEE Marks**	**50+50**
Prerequisite	**CV1002-1**		

Teaching Department: Civil Engineering

Course Objectives:

1.	Creation of awareness among student's health issues and Swachh Bharath mission and the consequent responsibilities.
2.	To understand the culture cleanliness, engineering applications in creation of ODF (Open defecation free) concept, Importance of legal & cultural issues related to Environmental Hygiene.
3.	To know the importance of sanitation, gender sensitive sanitation issues & use of engineering technology in construction of toilets.
4.	To know the importance of waste management system, wastewater audit and waste water treatment process.
5.	To study the role of student in Swachh Bharata Abhiyan, solid and waste water treatment process.

UNIT-I

Prospective: Environmental Hygiene (EH), Sanitation, Solid Waste and Wastewater	**06 Hours**

Introduction- Swachh Bharath Mission (SBM)-Mission Objectives-Duration- Components Environmental Hygiene-Benefits-Sanitation-Waste Management. Work opportunities in Environmental Hygiene, Sanitation and Waste Management. Participatory Learning for Environmental Hygiene, Sanitation and Waste Management.

Sociology of environmental hygiene management, solid waste and waste water and impacts	**08 Hours**

Open Defecation-Habits & attitude towards waste-Goals of SBA. Community Consciousness and Engagement on Sanitation Aspects, Roles & Responsibilities, Job Charts, Frequency, Schedules and Timelines in Swachhata Management, Culture of Cleanliness (Swachh Bharat Abhiyan), Behaviour Change Communication, Role of Habits and Attitudes in Environmental Hygiene Management, Waste and Wastewater Disposal; Change Management.

UNIT-II

Infrastructure for Sanitation	**08 Hours**

Containment-Preparation of toilets –Toilet Types Evaluation of Construction and Maintenance of Community, Public, Institutional and Individual Sanitation Infrastructure Toilets-Proportion and Number of toilets, Gender Sensitive Sanitation Facilities, Ramps for Differently Abled, Types – Indian and Western. Faecal Sludge treatment - Single / Twin pit, Eco San, Septic Tank and Formal Sewerage.

Solid Waste Management	**08 Hours**

Swachh Survekshan- Solid Waste management- Steps- Waste Audit-Classification Methods of Solid Waste Disposal and Management-Composting-Different types of composting- Waste Minimization-Waste Management.

UNIT-III

Waste & Wastewater Audit	**06 Hours**

Waste Audit -Environmental Impact Assessment, Waste Characterization, Quantity Determination, Primary Collection Methods, Secondary Transportation.

Wastewater Audit-Water Budget, Types of Wastewater, Survey of Distribution Network and Feasibility of Various Wastewater Treatment Methods.

Swachh Bharath Mission and Inclusivity	**04 Hours**

Swacch Bharath Mission in rural & Urban Context-Gender Issues in sanitation. Role of women in Sanitation.

Course Outcomes: At the end of the course student will be able to

1.	Creation of awareness among student's health issues and Swachh Bharath mission and the consequent responsibilities.
2.	To understand the culture cleanliness, engineering applications in creation of ODF (Open defecation free) concept, Importance of legal & cultural issues related to Environmental Hygiene.
3.	To know the importance of sanitation, gender sensitive sanitation issues & use of engineering technology in construction of toilets.
4.	To know the importance of waste management system, wastewater audit and waste water treatment process.
5.	To study the role of student in Swachh Bharata Abhiyan, solid and waste water treatment process.

Course Outcomes Mapping with Program Outcomes

Program Outcomes→ / **↓ Course Outcomes**	1	2	3	4	5	6	7	8	9	10	11	12
CV2502-1.1	1	1	-	-	-	2	3	2	-	-	-	-
CV2502-1.2	1	1	-	-	-	2	3	2	-	-	-	-
CV2502-1.3	1	1	-	-	-	2	3	2	-	-	-	-
CV2502-1.4	1	1	-	-	-	2	3	2	-	3	-	-
CV2502-1.5	1	1	-	3	-	2	3	2	-	-	-	3

1: Low 2: Medium 3: High

TEXTBOOKS:

1.	Joanne E. Drinan and Frank Spellman, "Water and Wastewater Treatment: A Guide for the Non-engineering Professional".
2.	M. S. Bhatt and Asheref Illiyan, "Solid Waste Management: An Indian Perspective".
3.	Jagbir Singh, "Solid Waste Management: Present and Future Challenges".
4.	M. S. Bhatt, "Solid Waste Management: An Indian Perspective".
5.	T. V. Ramachandra, "Management of Municipal Solid Waste".
6.	Syed R. Qasim, "Wastewater Treatment Plants: Planning, Design and Operation".

REFERENCE BOOKS:

1.	Swachhbharatmission.gov.in/
2.	https://www.india.gov.in//swachh-bharat-mission-gramin-portal
3.	https://www.swachhsurvekshan2018.org/
4.	https://zerowasteeurope,eu/
5.	www.zerowasteindia.in/
E Books / MOOCs/ NPTEL	
1.	http://www.un.org/waterforlifedecade/pdf/award_south_africa_eng_for_web.pdf
2.	http://www.sulabhinternational.org
3.	http://swachhbharatmission.gov.in/sbmcms/writereaddata/images/pdf/Guidelines/Complete-set-guidelines.pdf

ENVIRONMENTAL IMPACT ASSESSMENT

Course Code:	**CV2503-1**	**Course Type**	**OEC**
Teaching Hours/Week (L:T:P:S)	**3:0:0:0**	**Credits**	**03**
Total Teaching Hours	**40**	**CIE + SEE Marks**	**50+50**
Prerequisite	**CV1002-1**		

Teaching Department: Civil Engineering

Course Objectives:

1.	Identify the need to assess and evaluate the impact of projects on environment.
2.	Explain major principles of environmental impact assessment.
3.	Understand the different steps within environmental impact assessment.
4.	Appreciate the importance of EIA for sustainable development and a healthy environment.

UNIT-I

Evolution of EIA — **16 Hours**

Concepts of EIA, EIA methodologies (Adhoc, Network Analysis, Checklists, Map overlays, Matrix method), Screening and scoping, Rapid EIA and Comprehensive EIA, General Framework for Environmental Impact Assessment, EIA Specialized areas like environmental health impact assessment, Environmental risk analysis.

UNIT-II

14 Hours

Baseline data study, Prediction, and assessment of impacts on physical, biological, and socio-economic environment, Legislative and environmental clearance procedures in India, Public participation, Resettlement, and rehabilitation.

UNIT-III

10 Hours

Fault free analysis, Consequence Analysis, Introduction to Environmental Management Systems, Environmental management plan-Post project monitoring Environmental Audit: Cost Benefit Analysis, Life cycle Assessment. Case studies on project, regional and sectoral EIA.

Course Outcomes: At the end of the course student will be able to

1.	Understand phenomena of impacts and know the impact quantification of various projects in the environment.
2.	Liaise with and list the importance of stakeholders in the EIA process.
3.	Know the role of public in EIA studies.
4.	Overview and assess risks posing threats to the environment.
5.	Assess different case studies/examples of EIA in practice.

Course Outcomes Mapping with Program Outcomes

Program Outcomes→ ↓ Course Outcomes	1	2	3	4	5	6	7	8	9	10	11	12
CV2503-1.1	1	1	-	-	-	2	3	2	-	-	-	-
CV2503-1.2	1	1	-	-	-	2	3	2	-	-	-	-
CV2503-1.3	1	1	-	-	-	2	3	2	-	-	-	-
CV2503-1.4	1	1	-	-	-	2	3	2	-	3	-	-
CV2503-1.5	1	1	-	3	-	2	3	2	-	-	-	3

1: Low 2: Medium 3: High

TEXTBOOKS:

1.	Noble, L., "Introduction to environmental impact assessment. A Guide to Principles and Practice", 2nd edition, Oxford University Press, Don Mills, Ontario, 2010.
2.	Larry W. Canter, "Environmental Impact Assessment", McGraw Hill Inc. Singapore, 1996.

REFERENCE BOOKS:

1.	Morris and Therivel, "Methods of Environmental Impact Assessment", 3rd edition. New York, NY: Routledge, 2009.
2.	Hanna, K. S., "Environmental impact assessment. Practice and Participation". 2nd edition. Oxford, University Press, Don Mills, Ontario, 2009.

E Books / MOOCs/ NPTEL

1.	http://nptel.ac.in/courses/120108004/
2.	http://nptel.ac.in/courses/120108004/module3/lecture3.pdf

INTRODUCTION TO GEOINFORMATICS

Course Code:	**CV2504-1**	**Course Type**	**OEC**
Teaching Hours/Week (L:T: P:S)	**3:0:0:0**	**Credits**	**03**
Total Teaching Hours	**40**	**CIE + SEE Marks**	**50+50**
Prerequisite	**CV1001-1, CV1002-1**		

Teaching Department: Civil Engineering

Course Objectives:

1.	Explain the basic principles of Geoinformatics comprising Remote sensing, Photogrammetry, GPS, GNSS & GIS.
2.	Explain the stages and techniques of photogrammetry, aerial photo interpretation, visual & digital image processing, enhancement and interpretation.
3.	Explain and Appraise GIS - its components, data structures, process and operation, Map and its projections, components, preparation and overlays
4.	Explain the GIS functionality and Appraise the significance of GEOINFORMATICS (Photogrammetry, RS, GPS, GNSS & GIS) in real world applications.

UNIT-I

16 Hours

Remote sensing and its Principles: Physics of remote sensing, EM spectrum, Blackbody concept, atmospheric windows, spectral response of common earth features.
Platforms & Sensors: Ground based, Air borne and Space borne platforms, Active and Passive Sensors, Photographic sensors, scanners, radiometers, RADAR and thermal infrared, hyper spectral remote sensing, Indian satellites and sensors: capabilities, data products
Photogrammetry: Basic principles of Aerial photography and Photogrammetry, Flight procedures, Aerial Photo Interpretation and Analysis techniques.
Satellite Image Interpretation and Analysis techniques: Visual & Digital Image interpretation, Interpretation elements, False Colour Composites (FCC).

UNIT-II

15 Hours

Digital Image Processing and Analysis: Digital image formats, pre-processing and processing (DIP), image restoration/enhancement procedures, information extraction, pattern recognition concepts, post processing procedures.
Geographic Information System -concept and spatial models: Fundamentals of GIS, spatial and non-spatial data, vector and raster GIS, GIS Hardware and software, georeferencing, digitization, thematic maps, Overlay Analysis, Operation of GIS, Co-ordinate systems and map projections, Map scale, data display and cartography.

UNIT-III

09 Hours

Geoinformatics and Virtual GIS: Modern Surveying and Geoinformatics, GPS & GNSS, GIS Functionality: Introduction, data acquisition, preliminary data processing, data storage and retrieval, spatial search and analysis, graphics and interaction, Virtual GIS and Real world applications.

Course Outcomes: At the end of the course student will be able to

1.	Define and explain the principles of Remote Sensing and list various types of platforms, sensors & resolutions in RS with a special reference to Indian satellites and data products.
2.	Explain Photogrammetry, its basic principles, elements of photo interpretation, Visual & Digital Image interpretation techniques
3.	Explain different stages involved in Digital Image Processing, various image enhancement techniques, list and classify the digital image formats and the extracted information for various purposes.
4.	Explain and Appraise GIS - its components, data structures, process and operation, Map and its projections, components, preparation and Overlays.
5.	Explain the GIS functionality and appraise the significance of GEOINFORMATICS (Photogrammetry, RS, GPS, GNSS & GIS) and Virtual GIS in real world applications.

Course Outcomes Mapping with Program Outcomes

Program Outcomes→ **↓ Course Outcomes**	1	2	3	4	5	6	7	8	9	10	11	12
CV2504-1.1	2	2	-	-	-	2	-	-	-	-	-	-
CV2504-1.2	2	2	-	-	-	2	1	-	-	-	-	-
CV2504-1.3	2	2	-	-	-	2	1	-	-	-	-	-
CV2504-1.4	2	2	-	-	-	2	1	-	-	-	-	-
CV2504-1.5	2	2	-	-	-	2	1	-	-	-	-	-

1: Low 2: Medium 3: High

TEXTBOOKS:

1.	Anji Reddy, M, "Text Book of Remote Sensing and Geographical Information Systems", Fourth Edition, BS Publication, Hyderabad, 2012.
2.	Bhatta, Basudeva, "Remote Sensing and GIS", 2nd edition, Oxford University Press, N. Delhi, 2011.
3.	Lillesand, T.M., Kiefer, R.W and Chipman, J. W., "Remote sensing and Image Interpretations", 7th edition, John Wiley and sons, New Delhi, 2015.

REFERENCE BOOKS:

1.	Anji Reddy, M. and Hari Shankar, Y., "Digital Image Processing", BS Pub., Hyd, 2006.
2.	Bernhardsen, Tor, "Geographic Information Systems", 3rd Ed., Wiley India, Delhi, 2002.
3.	Canada Centre for Remote Sensing, Fundamentals of Remote sensing-Tutorial, 2011.
4.	Chang, Kang-tsung, "Introduction to Geographic Information Systems", 4th Ed., Tata McGraw Hill Publishing Company Limited, New Delhi, 2008.
5.	Korte, George B., "The GIS Book", Onword Press, Thomson Learning Inc., USA, 2001.
6.	Kumar, S., "Basics of Remote sensing and GIS", Laxmi Publications (P) Ltd., Delhi, 2008.

7.	Longler, Paul A., Goodchild, Michael F., Maguire, David J., Rhind. David W., "Geographic Information Systems and Science", John Wiley & Sons Ltd., ESRI Press, 2004.
8.	Sabins, F. L., "Remote Sensing: Principles and Interpretation" 3rd edn. WH Freeman and Company, New York, 1997.
E Books / MOOCs/ NPTEL	
1.	https://www.youtube.com/user/edusat2004
2.	https://eclass.iirs.gov.in/login

CORROSION SCIENCE

Course Code:	**CY2501-1**	**Course Type**	**OEC**
Teaching Hours/Week (L:T:P: S)	**3:0:0:0**	**Credits**	**03**
Total Teaching Hours	**40**	**CIE + SEE Marks**	**50+50**
Prerequisite	**CY1001-1**		

Teaching Department: Chemistry

Course Objectives:

1.	To provide fundamental understanding aspects of electrochemistry and material science related to corrosion. To understand the types of corrosion attacking on the metal and its preventions.
2.	To impart knowledge on corrosion science and its applications to the engineering materials.
3.	To identify practice for the prevention and remediation of the corrosion. To provide methodologies for measuring the corrosion performance of materials.

UNIT-I

Fundamentals of Corrosion	**09 Hours**
Definition, cost of corrosion, Corrosion Damage and consequences, Classification of corrosion, Electrochemical Aspects of corrosion, Electrochemical reactions, Different Environmental aspects, polarization and passivity, Corrosion Rate Expression, Determination. Standard electrode potential, EMF and Galvanic series, Potential-pH (Roubaix Diagram).	
Forms of Corrosion	**08 Hours**
Galvanic corrosion, Crevices corrosion, Filiform corrosion, Pitting corrosion, Uniform corrosion and Atmospheric corrosion, Inter granular corrosion, Selective leaching, Erosion corrosion, Cavitation damage, Stress corrosion , Impingement attack, Inlet tube corrosion, Corrosion fatigue, Hydrogen blistering, Hydrogen embrittlement.	

UNIT-II

Corrosion at Elevated Temperature	**08 Hours**
High temperature materials, Metal oxides, Pilling bed worth rule, oxide defect structure, Hot corrosion, Corrosion of mineral acids-corrosion of steel, stainless steel, Cu and Al.	
Corrosion Testing	**07 Hours**
Weight loss method, Tafel extrapolation test, linear polarization test and AC impedance method.	

UNIT-III

Corrosion Prevention Methods	**08 Hours**
Materials Selections, Design, Change of the environments: Atmospheric corrosion, Control of atmospheric corrosion, Changing medium, Inhibitors, Cathodic and Anodic protection, Protective coatings.	

Course Outcomes: At the end of the course student will be able to

1.	Explain the fundamentals of difference in electrode potential across an interface in particular a metal/ electrolyte and the relationship between rates of electrochemical reactions and the potential drop across interfaces.
2.	Analyze the causes and mechanisms of various types of corrosion including uniform, galvanic, crevice, pitting, inter granular and various modes of environmentally cracking. Acquire knowledge of influence of a materials composition, the effect of an electrolytes composition on the corrosion of metals and microstructure on its corrosion performance.
3.	Identify the materials that will exhibit adequate corrosion resistance in a particular environment and remedial action that will reduce corrosion to a acceptable level. Explain the concepts of different measuring techniques of corrosion.

Course Outcomes Mapping with Program Outcomes

Program Outcomes→ **↓ Course Outcomes**	1	2	3	4	5	6	7	8	9	10	11	12
CY2501-1.1	3	3	3	-	-	1	1	-	-	-	-	-
CY2501-1.2	3	3	3	-	-	1	1	-	-	-	-	-
CY2501-1.3	3	3	3	-	-	1	1	-	-	-	-	-

1: Low 2: Medium 3: High

TEXTBOOKS:

1	Mars G Fontana, "Corrosion Engineering", 3rd Edition, Tata Mcgraw-Hill Edition.

REFERENCE BOOKS:

1	Chamberlian and K. Trethway, "Corrosion", Longman scientific and technical, John Wiley and Sons.

NATURAL PRODUCTS CHEMISTRY

Course Code:	**CY2502-1**	**Course Type**	**OEC**
Teaching Hours/Week (L:T:P: S)	**3:0:0:0**	**Credits**	**03**
Total Teaching Hours	**40**	**CIE + SEE Marks**	**50+50**
Prerequisite	**CY1001-1**		

Teaching Department: Chemistry

Course Objectives:

1.	Identify the structure of terpenoids and their biosynthesis. Elucidate the structure of β-carotene, haemoglobin and chlorophyll.
2.	Understand the chemistry underlying steroids and sex hormones. Get introduced to the different types of prostaglandins as well as theory and chemistry behind natural dyes.
3.	Gain knowledge on general methods of structural determination of some of the important alkaloids.

UNIT-I

Terpenoids & Carotenoids	**08 Hours**

Introduction and classification, isoprene rules, general methods of determination of structure of terpenoids. Structure elucidation of the following terpenoids-geraniol, α-pinine, camphene and farnesol. Biosynthesis of terpenoids.
Introduction and classification of carotenes. Structural elucidation of β-carotene.

Porphyrins	**07 Hours**

Introduction to porphyrins, structure and degradation products of haemoglobin and chlorophyll.

UNIT-II

Steroids	**08 Hours**

Introduction, Dile's hydrogenation. Chemistry of cholesterol, Blanc's rule, Barbier-Wielman degradation, Oppenuer oxidation. Constitution of bile acids.
Sex hormones: Chemistry of oestrone, progesterone, androsterone and testosterone.

Prostaglandins & Natural Dyes	**08 Hours**

Introduction, nomenclature, classification, and biological role of prostagladins. Structure elucidation of PGE_1, Biosynthesis of PGE_2 and $PGF_{2\alpha}$.
Introduction, Witt's theory of colour, methods of dyeing, chemical constitution of alizarin.

UNIT-III

Alkaloids	**09 Hours**

Definition, Classification and isolation of alkaloids. General methods of structural determination of alkaloids. Detailed study of structure elucidation of the following alkaloids- papaverine, cinchonine and nicotine.

Course Outcomes: At the end of the course student will be able to

1	Elucidate the structure of terpenoids like geraniol, a-pinine, camphene and farnesol. Explain the structural chemistry of carotenoids and porphyrins.

2	State the basic reactions governing steroids and sex hormones. Explain the biological role and structure of prostaglandins and state the methods employed for dyeing.
3	Apply the general methods of structural determination to elucidate the structure of alkaloids like papaverine, cinchonine and nicotine.

Course Outcomes Mapping with Program Outcomes

Program Outcomes→ **↓ Course Outcomes**	1	2	3	4	5	6	7	8	9	10	11	12
CY2502-1.1	3	3	-	-	-	1	1	-	-	-	-	-
CY2502-1.2	3	3	-	-	-	1	1	-	-	-	-	-
CY2502-1.3	3	3	-	-	-	1	1	-	-	-	-	-

1: Low 2: Medium 3: High

TEXTBOOKS:

1. Agarwal, "Organic Chemistry of Natural Products", Vol.-I & Vol.-II, O.P. Goel Publishing House, 2014.

REFERENCE BOOKS:

1. K. Nakanishi, T. Goso, S. Ito, S. Natori and S. Nozoe, "Natural Products Chemistry", Vol. I & II, Academic Press, Ny, 1974.

2. Gurudeep R. Chatwal, "Organic Chemistry of Natural Products", Vol. I & II, Himalaya Publishing House, 2013.

3. G.A. Swal, "An Introduction to Alkaloids", Backwell Scientific Publications, 1967.

4. Hand book of naturally occurring Compounds, Vol. II, terpenes, T.K. Davon, A.I. Scott, Academic Press, Ny, 1974.

ARTIFICIAL NEURAL NETWORK SYSTEMS

Course Code:	**EC1501-1**	**Course Type**	**OEC**
Teaching Hours/Week (L: T: P: S)	**3:0:0:0**	**Credits**	**03**
Total Teaching Hours	**40+0+0+0**	**CIE + SEE Marks**	**50+50**

Teaching Department: Electronics & Communication Engineering

Course Objectives:

1.	To learn basic building blocks of ANNs and its terminology
2.	To understand the working of McCulloch-Pitts Neuron and different types of learning rules
3.	To understand decision regions, discriminant functions and training concept
4.	To understand the working of perceptron as classifier
5.	To understand the mathematics behind different types of single layer feedback networks

UNIT-I

Introduction to Artificial Neural networks	**16 Hours**

Introduction, Basic building blocks: network architecture, setting the weights, activation functions, ANN terminologies: weights, activation functions, bias, threshold, McCulloch-Pitts Neuron Model, Learning Rules

UNIT-II

Single Layer Perceptron Classifiers	**15 Hours**

Classification Model, Features, and Decision Regions, Discriminant Functions, Linear Machine and Minimum Distance Classification, Nonparametric Training Concept, Training and Classification Using the Discrete Perceptron: Algorithm and Example, Single-Layer Continuous Perceptron Networks for Linearly Separable Classifications, Multicategory Single-Layer Perceptron Networks

UNIT-III

Single-Layer Feedback Networks	**09 Hours**

Basic Concepts of Dynamical Systems, Mathematical Foundations of Discrete-Time Hopfield Networks, Mathematical Foundations of Gradient-Type Hopfield Networks. Transient Response of Continuous-Time Networks, Relaxation Modeling in Single-Layer Feedback Networks

Course Outcomes: At the end of the course student will be able to

1.	Describe the building blocks of artificial neural and terminologies
2.	Describe the working of neural network and learning rules
3.	Describe training of Single layer perceptron and classification using it.
4.	Explain use of Single layer perceptron for linearly separable and multicategory problems
5.	Explain the mathematics behind different single-layer feedback networks

Course Outcomes Mapping with Program Outcomes

Program Outcomes→ ↓ Course Outcomes	1	2	3	4	5	6	7	8	9	10	11	12
EC1501-1.1	3	-	-	-	-	-	-	-	-	-	-	-
EC1501-1.2	3	-	-	-	-	-	-	-	-	-	-	-
EC1501-1.3	3	-	-	-	-	-	-	-	-	-	-	-
EC1501-1.4	3	-	-	-	-	-	-	-	-	-	-	-
EC1501-1.5	3	-	-	-	-	-	-	-	-	-	-	-

1: Low 2: Medium 3: High

TEXTBOOKS:

1.	S. N. Sivanandam, S. Sumathi, S. N. Deepa, "Introduction to Neural Networks Using MATLAB 6.0", Tata McGraw-Hill Education, 2006
2.	Jacek M. Zurada "Introduction to Artificial Neural Systems", 1st Edition, St. Paul West Publishers-USA, 1992.
3.	Michael A Neilsen, "Neural Networks and Deep Learning", Determination Press, 2015

INTRODUCTION TO MATLAB PROGRAMMING: A HANDS-ON APPROACH

Course Code:	**EC1502-1**	**Course Type**	**OEC**
Teaching Hours/Week (L: T: P: S)	**2:0:2:0**	**Credits**	**03**
Total Teaching Hours	**27+0+26+0**	**CIE + SEE Marks**	**50+50**

Teaching Department: Electronics & Communication Engineering
Offered to Civil & BT

Course Objectives:

1.	To demonstrate basic understanding of MATLAB programming
2.	To use and write functions
3.	To use MATLAB programming for image processing

Unit-I	**27 Hours**

Introduction to MATLAB: Starting MATLAB and familiarization with its user interface, syntax and semantics, ways in which MATLAB provides help, create plots in MATLAB.
Matrices and Operators: defining matrices, manipulation of matrices, extract parts of them and combine them to form new matrices, use of operators to add, subtract, multiply, and divide matrices, and we will learn that there are several different types of multiplication and division.
Functions: creating reusable functions, how the environment inside a function is separated from the outside via a well-defined interface through which it communicates with that outside world, define a function to allow input to it when it initiates its execution.
Programmer’s Toolbox: polymorphism and how MATLAB exploits it to change a function's behavior on the basis of the number and type of its inputs, random number generator, how to get input from the keyboard, how to print to the Command Window, and how to plot graphs in a Figure window, how to find programming errors with the help of the debugger, how to print to the Command Window, and how to plot graphs in a Figure window, how to find programming errors with the help of the debugger.
Selection Statement and Loops: how to use the if-statement, how to use relational operators and logical operators, how to write polymorphic functions and how to make functions resistant to error, the for-loop and the while-loop, how the break-statement works, nested loops, logical indexing and implicit loops.
Data Types: character arrays and how the characters in them are encoded as numbers, string and datetime datatype, how to produce heterogeneous collections of data via structs and cells.
File Input/Output: reading and writing files, how to create, read from, and write into MAT-files, Excel files, text files, and binary files, how to navigate among folders with MATLAB commands.
Image Processing using MATLAB: pre-processing – conversion of color image to gray scale image, decomposition of color images to single color component image, histogram of image, thresholding

List of Experiments

1	Starting MATLAB and familiarization with its user interface, syntax and semantics, ways in which MATLAB provides help, create plots in MATLAB.

2	Defining matrices, manipulation of matrices, extract parts of them and combine them to form new matrices, use of operators to add, subtract, multiply, and divide matrices, and we will learn that there are several different types of multiplication and division.
3	creating reusable functions, how the environment inside a function is separated from the outside via a well-defined interface through which it communicates with that outside world, define a function to allow input to it when it initiates its execution.
4	Polymorphism and how MATLAB exploits it to change a function's behavior on the basis of the number and type of its inputs, random number generator, how to get input from the keyboard, how to print to the Command Window
5	How to plot graphs in a Figure window, how to find programming errors with the help of the debugger, how to print to the Command Window, and how to plot graphs in a Figure window, how to find programming errors with the help of the debugger.
6	How to use the if-statement, how to use relational operators and logical operators, how to write polymorphic functions and how to make functions resistant to error.
7	The for-loop and the while-loop, how the break-statement works, nested loops, logical indexing and implicit loops.
8	Character arrays and how the characters in them are encoded as numbers, string and datetime datatype, how to produce heterogeneous collections of data via structs and cells.
9	Reading and writing files, how to create, read from, and write into MAT-files, Excel files, text files, and binary files, how to navigate among folders with MATLAB commands.
10	Reading an image, saving, basic manipulation of images, arithmetic operations
11	Pre-processing – conversion of color image to gray scale image, decomposition of color images to single color component image.
12	Histogram processing.
13	Thresholding operation.

Course Outcomes: At the end of the course student will be able to

1.	Use matrices and operators in MATLAB programming
2.	Use and write functions; use MATLAB toolbox
3.	Use toolbox and selection statement in MATLAB programming
4.	Write MATLAB programs using loops and summarize data types
5.	Summarize file input/output methods using MATLAB commands and apply pre-processing and thresholding operations on images

Course Outcomes Mapping with Program Outcomes

Program Outcomes→ **↓ Course Outcomes**	1	2	3	4	5	6	7	8	9	10	11	12
EC1502-1.1	1	-	-	-	3	-	-	-	-	-	-	-
EC1502-1.2	1	-	-	-	3	-	-	-	-	-	-	-
EC1502-1.3	1	-	-	-	3	-	-	-	-	-	-	-

EC1502-1.4	1	-	-	-	3	-	-	-	-	-	-	-
EC1502-1.5	1	-	-	-	3	-	-	-	-	-	-	-

1: Low 2: Medium 3: High

TEXTBOOKS:

1.	Stormy Attaway, "Matlab: A Practical Introduction to Programming and Problem Solving", Second Edition, Butterworth-Heinemann, 2011
2.	Fitzpatrick and Ledeczi, "Computer Programming with MATLAB", eBook, 2013
3.	Rafael C. Gonzalez, Richard E. Woods and Steven L. Eddins, Digital Image Processing using MATLAB, first edition, Dorling Kindersley Pvt Ltd, 2006.

REFERENCE BOOKS:

1.	Duane C. Hanselman, Bruce L. Littlefield, "Mastering MATLAB" , first edition, Pearson, 2011

E Books / MOOCs/ NPTEL

1.	https://nptel.ac.in/courses/103/106/103106118/
2.	https://www.coursera.org/learn/matlab

ROBOTICS

Course Code:	**EC1503-1**	**Course Type**	**OEC**
Teaching Hours/Week (L: T: P: S)	**3:0:0:0**	**Credits**	**03**
Total Teaching Hours	**40+0+0+0**	**CIE + SEE Marks**	**50+50**

Teaching Department: Electronics & Communication Engineering

Course Objectives:

1.	Understand Anatomy of a robot.
2.	Analyse the robot motion using translation and rotational matrix.
3.	Discuss Robot trajectory planning and robot control.
4.	Categorise the various sensors used in robotics
5.	Understand the robot programming.

UNIT-I

Introduction — **16 Hours**

Definition, anatomy of robot, classification configurations, robot links and joints, robot specifications, resolution accuracy and repeatability, simple numerical problems, robot drive systems, hydraulic, pneumatic and electric drive systems, wrist and its motions, end effectors, types of end effectors, mechanical & Non-mechanical grippers, methods of constraining parts in grippers.

Motion analysis

Direct kinematics and inverse kinematics, 3D homogeneous transformations, rotation, translation and displacement matrix, composite rotation matrix, rotation matrix about an arbitrary axis.

UNIT-II

Control and trajectory planning — **15 Hours**

Trajectory planning, definition, steps in trajectory planning, joint space techniques, use of a p-degree polynomial as interpolation function, cubic polynomial trajectories, linear function with parabolic blends, joint space verses, simple numerical problems on joint space trajectory planning.

Sensors

Classification, Types- Contact & Non-Contact sensors.

Machine Vision

Machine vision, functions of machine vision system, sensing and digitizing, imaging devices, analog to digital signal conversion, quantization and encoding, simple numerical problems, image storage, image processing and analysis, image data reduction, segmentation, feature extraction, object recognition, robotic machine vision applications, inspection, identification, visual surveying and navigation.

UNIT-III

Programming — **09 Hours**

Introduction to robot programming, robot cell layout, work cell control and interlocks, manual programming, lead through and walkthrough programming, off-line programming, robot programming languages, examples

Course Outcomes: At the end of the course student will be able to

1.	Explain the working principle, various performance parameters of robots and identify the types of robots employed in industry.
2.	Discuss the concept of direct and inverse kinematics. Determine the position and orientation of End-Effector subjected to transformations. Demonstrate the applications of Denavit-Hartenberg (DH) method for different robot configurations.
3.	Determine the technique of trajectory planning, control schemes for robot joints and understand the types of the sensors used in robotics.
4.	Apply engineering knowledge in robot visual surveying and navigation.
5.	Analyze and formulate different types of robot cell layouts and use modern tools to write robot programs for different tasks.

Course Outcomes Mapping with Program Outcomes

Program Outcomes→ **↓ Course Outcomes**	1	2	3	4	5	6	7	8	9	10	11	12
EC1503-1.1	3	2	2	1	-	-	-	-	-	-	-	1
EC1503-1.2	3	3	2	2	-	-	-	-	3	3	-	1
EC1503-1.3	3	2	2	2	-	-	-	-	3	3	-	1
EC1503-1.4	3	2	2	1	-	-	-	-	-	-	-	1
EC1503-1.5	3	3	3	2	2	-	-	-	-	-	-	1

1: Low 2: Medium 3: High

TEXTBOOKS:

1.	R. K. Mittal and I. J. Nagrath, “Robotics and Control”, Tata-McGraw-Hill Publications, 2007.
2.	Mikell P. Groover, Mitchel Weiss, Roger N. Nagel and Nicholas G. Odrey, “Industrial Robotics”, McGraw-Hill Publications, International Edition, 2008

REFERENCE BOOKS:

1.	Fu K. S., Gonzelez R. C., Lee C. S. G., "Robotics: Control, Sensing, Vision, Intelligence," , McGraw Hill Book Co., International edition, 2008.
2.	Yorem Koren, "Robotics for Engineers", McGraw-Hill Publication, International edition, 1987.
3.	Craig, J. J., "Introduction to Robotics: Mechanics and Control", 3rd Edition, Pearson PrenticeHall Publications, 2005.
4.	Schilling R. J., "Fundamentals of Robotics, Analysis and Control", Prentice-Hall Publications, Eastern Economy edition, 2007.
5.	AppuKuttan K. K., "Robotics", I.K. International Publications, First Edition, 2007.
6.	James G. Keramas, "Robot Technology Fundamentals", Cengage Learning, 1999.
7.	Richard K. Barnhart, Stephen B. Hottman, Douglas M. Marshall, Eric Shappee, "Introduction to Unmanned Aircraft Systems", CRC Press, 2012.
8.	Ghosh, "Control in Robotics and Automation", Allied Publishers.
9.	Deb, "Robotics Technology", Wiley India.

E Books / MOOCs/ NPTEL

1.	https://nptel.ac.in/courses/112105249

CONSUMER ELECTRONICS

Course Code:	**EC2501-1**	**Course Type**	**OEC**
Teaching Hours/Week (L: T: P: S)	**3:0:0:0**	**Credits**	**03**
Total Teaching Hours	**40+0+0+0**	**CIE + SEE Marks**	**50+50**
Prerequisite	**EC1001-1**		

Teaching Department: Electronics & Communication Engineering

Course Objectives:

1.	To provide basic knowledge on sound and transducers
2.	To provide basic knowledge on different display units and camera
3.	To understand the recording process and storage mechanism
4.	To provide basic knowledge on communication and broadcasting
5.	To understand the working of various electronic gadgets

UNIT-I

Sound & Vision **15 Hours**

Sound: Definition and properties of sound, Transducers: Micro Phone – characteristics and types, and Loud Speakers – characteristics and types, Enclosures and baffles, mono-stereo, audio amplifiers-characteristics, Synthesizers.
Vision: Displays-LED, LCD, PLASMA, Camera: basic principle, CCTV Camera.

UNIT-II

Recording, Playback, Communication & Broadcasting Systems **15 Hours**

Recording and Playback: Audio recording methods-magnetic recording, optical recording, digital recording, erasing methods, optical discs- recording and playback, Film projector, Theatre Sound, HiFi system.
Communications And Broadcasting: Modulation: AM, FM PCM, Radio transmitters, Radio receivers - Tuned radio frequency receiver and Superheterodyne receiver. Fiber optics, Radio and TV broadcasting. Cellular communication: digital cellular phone, establishing a call.

UNIT-III

Other Electronic Systems **10 Hours**

Fax machine, Xerox machine, electronic Calculator, Microwave ovens, Washing Machines, A/C and refrigeration, ATM, Auto Electronics, Industrial Electronics and Robotics, Electronics in health / Medicine.

Course Outcomes: At the end of the course student will be able to

1.	Recall basics of sound and transducers.
2.	Understand the working principles of display units and CCTV camera.
3.	Explain basic working of Recording, storage devices
4.	Explain basics of communication and broadcasting
5.	Recall basic working of commonly used electronic gadgets

Course Outcomes Mapping with Program Outcomes

Program Outcomes→ ↓ **Course Outcomes**	1	2	3	4	5	6	7	8	9	10	11	12
EC2501-1.1	1	-	-	-	-	1	-	-	-	-	2	2
EC2501-1.2	1	-	-	-	-	1	-	-	-	-	2	2
EC2501-1.3	1	-	-	-	-	1	-	-	-	-	2	2

EC2501-1.4	1	-	-	-	-	1	-	-	-	-	2	2
EC2501-1.5	1	-	-	-	-	1	-	-	-	-	2	2

1: Low 2: Medium 3: High

TEXTBOOKS:

1.	Anand, “Consumer Electronics”, Khanna publications, 2011.
2.	Bali S. P., “Consumer Electronics”, Pearson Education, 2005.

REFERENCE BOOK:

1.	Gulati R. R. "Modern Television Engineering", Wiley Eastern.

PCB DESIGN AND FABRICATION

Course Code	**EC2502-1**	**Course Type**	**OEC**
Teaching Hours/Week (L: T: P: S)	**1:0:4:0**	**Credits**	**03**
Total Teaching Hours	**15+0+52+0**	**CIE + SEE Marks**	**50+50**
Prerequisite	**EC1001-1**		

Teaching Department: Electronics & Communication Engineering

Course Objectives:

1.	To enable students to gain knowledge of Schematic Design techniques & PCB design techniques
2.	To expose students to complete PCB Design & manufacturing process

Unit-I

Circuit Schematic — **05 Hours**

Introduction to Kicad schematic design tool, features, node connections, labeling, creating new component.

Unit-II

PCB Layout: — **05 Hours**

Introduction to Kicad layout editor, features, layer selections, manual and auto routing in Kicad, verification of footprint, creating footprint for a given component.

Unit-III

PCB Fabrication — **05 Hours**

Generating and verifying the PCB Gerber file, preparing artwork for a single side PCB fabrication, preparing PCB artwork for double side PCB, Etching process, tin plating, legend printing, green masking and through hole plating

List of Experiments

1	Exploring the Kicad Schematic and layout tool
2	Developing a schematic circuit for microphone preamplifier
3	Designing a single side PCB layout for microphone preamplifier
4	Developing a schematic circuit for a microcontroller development board
5	Designing a double side PCB layout for a microcontroller development board
6	Choosing a new sensor/display module and building a schematic circuit for the user level application
7	Building a layout using single or double side PCB for the sensor/display module
8	Preparing the film for the bottom copper, solder mask and top silk (legend) to fabricate a single side PCB using chemical process
9	Preparing the film for the top copper, bottom copper, top solder mask, bottom solder mask and legend to fabricate double side PCB using chemical process
10	PCB routing, etching, cutting and drilling using CNC machine

Course Outcomes: At the end of the course student will be able to

1.	Draw schematic circuit and create PCB layout for single or multilayer PCB
2.	Fabricate single and double-layer PCB

Course Outcomes Mapping with Program Outcomes

Program Outcomes→ ↓ Course Outcomes	1	2	3	4	5	6	7	8	9	10	11	12
EC2502-1.1	3	-	-	-	-	-	-	-	-	-	-	-
EC2502-1.2	3	-	-	-	-	-	-	-	-	-	-	-

1: Low 2: Medium 3: High

TEXTBOOKS:

1. Peter Dalmaris, “Kicad Like a Pro”, Tech Exploration.

REFERENCE BOOKS:

1. Peter Dalmaris, “Kicad Like a Pro”, Tech Exploration.
2. David L. Jones, “PCB Design Tutorials”, Alternate zone, 2004.

E Books / MOOCs/ NPTEL

1. www.alternatezone.com

SPACE TECHNOLOGY AND APPLICATIONS

Course Code:	**EC2503-1**	**Course Type**	**OEC**
Teaching Hours/Week (L: T: P: S)	**3:0:0:0**	**Credits**	**03**
Total Teaching Hours	**40+0+0+0**	**CIE + SEE Marks**	**50+50**
Prerequisite	**EC1001-1**		

Teaching Department: Electronics & Communication Engineering

Course Objectives:

1.	Understand the general laws governing satellite orbits and its parameters.
2.	Discuss effect of space environment on satellite signal propagation.
3.	Illustrate various segments employed in satellite and ground station.
4.	Calculate the uplink / downlink subsystem characteristics.
5.	know the effects on the EM waves in propagation through space.
6.	Explain the satellite launch in the space and their applications in remote sensing.
7.	Discuss the different communication systems used for satellite access.
8.	Summarise Advanced space systems for mobile communication, VSAT, GPS.

UNIT-I

Satellite Technology — **15 Hours**

Satellite communications: Introduction, Kepler's laws, definitions, orbital element, apogee and perigee heights, orbit perturbations, inclined orbits.

Space environment: Earth's Atmosphere, Ionosphere and Meteorological effects on space systems, propagation of signal, Transmission losses in space environment.

Satellite Technology: Space segment, Ground segment, Quality and Reliability, Satellite Communication systems.

UNIT-II

Space Applications — **15 Hours**

Launch Vehicles: Working, stages, Fuel, payload protection, Navigation, guidance and control, Reliability, launching into outer space and launch bases. Types of launch vehicles.

Space Applications: Digital DBS TV, DBS-TV System Design, Master Control Station and Uplink Antennas. Introduction, Radio and Satellite Navigation,

Remote Sensing: Introduction to Remote Sensing, Concepts and Applications of satellite Remote sensing.

UNIT-III

Advanced Space Systems — **10 Hours**

Satellite Access: Introduction, Single Access, Pre-assigned FDMA, Demand-Assigned FDMA, Spade system.

Advanced space systems: Satellite mobile services, VSAT, Radarsat, orbital communication**.** Global Positioning Satellite System (GPS).

Course Outcomes: At the end of the course student will be able to

1.	Discuss the fundamental principles of Satellite communication systems.
2.	Understand the Propagation impairments of satellite link.

3.	Explain various segments employed in satellite and ground station.
4.	Discuss the satellite launch mechanism and roll of those satellite in remote sensing.
5.	Understand the different communication systems used for satellite access and list the recent satellites that have been launched for mobile communication, GPS.

Course Outcomes Mapping with Program Outcomes

Program Outcomes→ / **↓ Course Outcomes**	1	2	3	4	5	6	7	8	9	10	11	12
EC2503-1.1	3	2	2	-	1	-	-	-	-	-	-	-
EC2503-1.2	-	3	-	-	2	1	-	-	-	-	-	-
EC2503-1.3	3	-	-	1	-	1	1	-	-	-	-	-
EC2503-1.4	-	-	-	-	-	1	3	-	-	-	-	-
EC2503-1.5	-	-	-	-	-	3	3	2	-	-	-	-

1: Low 2: Medium 3: High

TEXTBOOKS:

1.	Dennis Roddy, "Satellite Communications", McGraw Hill ,1996.
2.	Timothy Pratt, "Satellite Communications", Wiley India Ltd , 2006.
3.	K Ramamurthy, "Rocket Propulsion", McMillan Publishers India Ltd, 2010.

REFERENCE BOOKS:

1.	George Joseph, "Fundamentals of Remote Sensing", Universities press, India 2003.
2.	B C Pande, "Remote sensing and Applications", VIVA Books pvt ltd, 2009.
3.	Meynart Roland, "Sensors systems and next generation satellites", SPIE Publication.
4.	Thyagarajan , "Space Environment", ISRO Hand Book Publication.

E Books / MOOCs/ NPTEL

1.	https://nptel.ac.in/courses/101106046

BATTERY MANAGEMENT SYSTEM

Course Code:	**EE2501-1**	**Course Type**	**OEC**
Teaching Hours/Week (L: T: P: S)	**3:0:0:0**	**Credits**	**03**
Total Teaching Hours	**40**	**CIE + SEE Marks**	**50+50**
Prerequisite	**EE1001-1**		

Teaching Department: Electrical & Electronics Engineering

Course Objectives:

1	To familiarize various concepts of BMS
2	To understand functional blocks of BMS
3	To study design steps of BMS
4	To introduce hardware implementation of BMS

UNIT-I

Battery System	**08 Hours**

Introduction, Cells, Batteries, and Packs, Resistance, Li-Ion Cells, Formats, Chemistry, Safety, Safe Operating Area, Efficiency, Aging, Modeling, Unequal Voltages in Series Strings, Li-Ion BMSs, BMS Definition, Li-Ion BMS Functions, Custom Versus Off-the-Shelf, Li-Ion Batteries, SOC, DOD, and Capacity, Balance and Balancing, SOH

BMS Options	**07 Hours**

Functionality, CCCV Chargers, Regulators, Meters, Monitors, Balancers, Protectors, Functionality Comparison, Technology, Simple (Analog), Sophisticated (Digital), Technology Comparison, Topology, Centralized, Modular Master-Slave, Distributed, Topology Comparison

UNIT-II

BMS Functions	**07 Hours**

Measurement, Voltage, Temperature, Current, Management, Protection, Thermal Management, Balancing, Redistribution, Distributed Charging, Evaluation, State of Charge and Depth of Discharge, Capacity, Resistance, State of Health (SOH), External Communications, Dedicated Analog Wire, Dedicated Digital Wire, Data Link, Logging and Telemetry, Off-the-Shelf BMSs, Cell Manufacturers' BMSs, Comparison

Custom BMS Design	**08 Hours**

Using BMS ASICs , BMS ASIC Comparison, Analog BMS Design, Analog Regulator, Analog Monitor, Analog Balancer, Analog Protector, Ready-Made, Digital BMS Designs, ATMEL's BMS Processor, Elithion's BMS Chip Set, National Semiconductors' Complete BMS, Peter Perkin's Open Source BMS, Texas Instruments' bq29330/bq20z90, Texas Instruments' bq78PL114/bq76PL102, Custom Digital BMS Design, Voltage and Temperature Measurement, Current Measurement, Evaluation, Communications, Optimization, Switching, Logging, Cell Interface, Non-distributed, Distributed, Distributed Charging

UNIT-III

Deploying a BMS	**10 Hours**

Installing, Battery Pack Design, BMS Connections to Pack, BMS Connections to System, Configuring, Cell Configuration, Pack Configuration, System Configuration, Testing, Troubleshooting, Grounding, Shielding, Filtering, Wire Routing

Course Outcomes: At the end of the course student will be able to

1	Identify process to implement BMS
2	Describe various communication protocol involved in BMS
3	Illustrate functionality of BMS
4	Apply concepts of BMS using application specific IC
5	Analyse the hardware implementation aspects of BMS

Course Outcomes Mapping with Program Outcomes

Program Outcomes→ **↓ Course Outcomes**	1	2	3	4	5	6	7	8	9	10	11	12
EE2501-1.1	1	3	-	-	-	-	-	-	-	-	-	-
EE2501-1.2	1	3	-	-	-	-	-	-	-	-	-	-
EE2501-1.3	1	2	3	-	-	-	-	-	-	-	-	-
EE2501-1.4	1	2	2	3	-	-	-	-	-	-	-	-
EE2501-1.5	1	3	-	-	-	-	-	-	-	-	-	-

1: Low 2: Medium 3: High

TEXTBOOKS:

1	Davide Andrea, "Battery Management Systems for Large Lithium-Ion Battery Packs", ARTECH HOUSE 2010.

REFERENCE BOOKS:

1	Rui Xiong, "Battery Management Algorithm for Electric Vehicles", Springer 2019.
2	Nicolae Tudoroiu, "Battery Management Systems of Electric and Hybrid Electric Vehicles", MDPI 2021

BIOMEDICAL INSTRUMENTATION

Course Code:	**EE2502-1**	**Course Type**	**OEC**
Teaching Hours/Week (L: T: P: S)	**3:0:0:0**	**Credits**	**03**
Total Teaching Hours	**40**	**CIE + SEE Marks**	**50+50**
Prerequisite	**EC1001-1**		

Teaching Department: Electrical & Electronics Engineering

Course Objectives:

1.	The course is designed to give the basic concepts of Instrumentation involved in medical field and human physiology.
2.	To introduce an fundamental of transducers as applicable to physiology
3.	To explore the human body parameter measurements setups
4.	To make the students understand the basic concepts of forensic techniques.
5.	To give basic ideas about Electrophysiological measurements, medical imaging

UNIT-I

Physiology and transducers	**08 Hours**

Cell and its structure, Resting and Action Potential, Nervous system: Functional organization of the nervous system, Structure of nervous system, neurons, synapse, transmitters and neural communication, Cardiovascular system, respiratory system, Basic components of a biomedical system, Transducers, selection criteria, Piezo-electric, ultrasonic transducers, Temperature measurements, Fiber optic sensors.

Electro – Physiological measurements	**09 Hours**

Electrodes: Limb electrodes, floating electrodes, pre-gelled disposable electrodes, Micro, needle and surface electrodes, Amplifiers: Preamplifiers, differential amplifiers, chopper amplifiers, Isolation amplifier. ECG, EEG, EMG, ERG, Lead systems and recording methods, Typical waveforms. Electrical safety in medical environment: shock hazards, leakage current-Instruments for checking safety parameters of biomedical equipment.

UNIT-II

Non-electrical parameter measurements	**08 Hours**

Measurement of blood pressure, Cardiac output, Heart rate, Heart sound Pulmonary function measurements, spirometer, Photo Plethysmography, Body Plethysmography, Blood Gas analyzers : pH of blood, measurement of blood pCO_2, pO_2, finger-tip oximeter, ESR, GSR measurements

Medical Imaging	**07 Hours**

Radiographic and fluoroscopic techniques, X rays, Computer tomography, Mammography, MRI, fMRI, Ultrasonography, Endoscopy, Thermography, Different types of biotelemetry systems and patient monitoring

UNIT-III

Assisting and therapeutic equipments:	**08 Hours**

Pacemakers, Defibrillators, Ventilators, Nerve and muscle stimulators, Diathermy, Heart Lung machine, Audio meters, Dialyzers, Lithotripsy

Course Outcomes: At the end of the course student will be able to

1	Understand the physiology of biomedical system
2	Measure biomedical and physiological information
3	Discuss the application of Electronics in diagnostics and therapeutic area.
4	Analyze the images and do a prediction using image processing.
5	Understand the different equipment's used for various measurements of physiology

Course Outcomes Mapping with Program Outcomes

Program Outcomes→ / **↓ Course Outcomes**	1	2	3	4	5	6	7	8	9	10	11	12
EE2502-1.1	3	3	-	2	1	1	-	-	-	-	-	-
EE2502-1.2	2	2	2	2	-	-	-	-	-	-	-	-
EE2502-1.3	3	2	2	1	2	1	-	-	-	-	-	-
EE2502-1.4	2	3	-	-	1	-	-	-	-	-	1	-
EE2502-1.5	3	3	-	-	2	-	-	-	-	-	2	-

1: Low 2: Medium 3: High

TEXTBOOKS:

1.	Leslie Cromwell, Fred J.Weibell, Erich A.Pfeiffer, "Bio-Medical Instrumentation and Measurements", II edition, Pearson Education, 2002.
2.	R. S. Khandpur, "Handbook of Bio-Medical instrumentation", Tata McGraw Hill Publishing CoLtd., 2003.
3.	J. Webster, "Medical Instrumentation", John Wiley & Sons, 1995.
4.	L. A. Geddes and L. E. Baker, "Principles of Applied Bio-Medical Instrumentation", John Wiley & Sons, 1975.
5.	David. Cooney and Michel Deckker, "Bio- Medical Engineering Principles", INC.

REFERENCE BOOKS:

1	David Cooney, "Bio-Medical Engineering Principles", 2015, 1st Edition, Marcel Deckker Pub Co., New York.

ELECTRIC VEHICLE TECHNOLOGY

Course Code:	**EE2503-1**	**Course Type**	**OEC**
Teaching Hours/Week (L: T: P: S)	**3:0:0:0**	**Credits**	**03**
Total Teaching Hours	**40+0+0**	**CIE + SEE Marks**	**50+50**
Prerequisite	**EE1001-1**		

Teaching Department: Electrical & Electronics Engineering

Course Objectives:

1	To Understand the fundamental laws and vehicle mechanics.
2	To Understand working of Electric Vehicles and recent trends.
3	Ability to analyze different power converter topology used for electric vehicle application
4	Ability to develop the electric propulsion unit and its control for application of electric vehicles

UNIT-I

Vehicle Mechanics — **07 Hours**

Roadway Fundamentals, Laws of Motion, Vehicle Kinetics, Dynamics of Vehicle Motion, Propulsion Power, Force-Velocity Characteristics, Maximum Gradability, Velocity and Acceleration, Constant FTR, Level Road, Velocity Profile, Distance Traversed, Tractive Power, Energy Required, Nonconstant FTR, General Acceleration, Propulsion System Design..

Electric and Hybrid Electric Vehicles — **07 Hours**

Configuration of Electric Vehicles, Performance of Electric Vehicles, Traction motor characteristics, Tractive effort and Transmission requirement, Vehicle performance, Tractive effort in normal driving, Energy consumption Concept of Hybrid Electric Drive Trains, Architecture of Hybrid Electric Drive Trains, Series Hybrid Electric Drive Trains, Parallel hybrid electric drive train).

UNIT-II

Energy storage for EV and HEV — **08 Hours**

Energy storage requirements, Battery parameters, Types of Batteries, Modelling of Battery, Fuel Cell basic principle and operation, Types of Fuel Cells, PEMFC and its operation, Modelling of PEMFC, Supercapacitors.

Electric Propulsion — **08 Hours**

EV consideration, DC motor drives and speed control, Induction motor drives, Permanent Magnet Motor Drives, Switch Reluctance Motor Drive for Electric Vehicles, Configuration and control of Drives.

UNIT-III

Design of Electric and Hybrid Electric Vehicles — **10 Hours**

Series Hybrid Electric Drive Train Design: Operating patterns, control strategies, Sizing of major components, power rating of traction motor, power rating of engine/generator, design of PPS Parallel Hybrid Electric Drive Train Design: Control strategies of parallel hybrid drive train, design of engine power capacity, design of electric motor drive capacity, transmission design, energy storage design.

Course Outcomes: At the end of the course student will be able to

1	Explain the roadway fundamentals, laws of motion, vehicle mechanics and propulsion system design
2	Explain the working of electric vehicles and hybrid electric vehicles in recent trends.
3	Model batteries, Fuel cells, PEMFC and super capacitors.
4	Analyze DC and AC drive topologies used for electric vehicle application.
5	Develop the electric propulsion unit and its control for application of electric vehicles.

Course Outcomes Mapping with Program Outcomes

Program Outcomes→ **↓ Course Outcomes**	1	2	3	4	5	6	7	8	9	10	11	12
EE2503-1.1	2	3	-	-	-	-	-	-	-	-	-	-
EE2503-1.2	1	2	3	-	-	-	-	-	-	-	-	-
EE2503-1.3	1	2	3	-	-	-	-	-	-	-	-	-
EE2503-1.4	1	2	3	-	-	-	-	-	-	-	-	-
EE2503-1.5	1	2	2	-	-	-	-	-	-	-	3	-

1: Low 2: Medium 3: High

TEXTBOOKS:

1	Iqbal Husain, "Electric and Hybrid Vehicles: Design Fundamentals", CRC Press, 2003.
2	M. Ehsani, Y. Gao, S.Gay and Ali Emadi, "Modern Electric, Hybrid Electric, and Fuel Cell Vehicles: Fundamentals, Theory, and Design", CRC Press, 2005.

REFERENCE BOOKS:

1	Sheldon S. Williamson, "Energy Management Strategies for Electric and Plug-in Hybrid Electric Vehicles", Springer, 2013.
2	C.C. Chan and K.T. Chau, "Electric Vehicle Technology", OXFORD University, 2001
3	Chris Mi, M. Abul Masrur, David Wenzhong Gao, "Hybrid Electric Vehicles Principles And Applications with Practical Perspectives", Wiley Publication, 2001

E Books / MOOCs/ NPTEL

1.	Introduction to Mechanics | Coursera
2.	Electric Vehicles - Part 1 - Course (nptel.ac.in)
3.	NPTEL: Electrical Engineering - Introduction to Hybrid and Electric Vehicles
4.	Hybrid Vehicles (edX) | MOOC List (mooc-list.com)
5.	Electric Cars: Technology | My MOOC (my-mooc.com)

FUNDAMENTALS OF PLC AND ITS APPLICATIONS

Course Code:	**EE2504-1**	**Course Type**	**OEC**
Teaching Hours/Week (L: T: P: S)	**3:0:0:0**	**Credits**	**03**
Total Teaching Hours	**40**	**CIE + SEE Marks**	**50+50**
Prerequisite	**EC1001-1**		

Teaching Department: Electrical & Electronics Engineering

Course Objectives:

1.	To understand main parts and their functions, basic sequence of operation of PLC.
2.	To study the different programming languages and fundamental wiring diagrams.
3.	To explain the functions of PLC counter instructions, applying combinations of counters and timers to control systems.
4.	To explain the basic operation of PLC closed-loop control system, various forms of mechanical sequencers and their operations
5.	To discuss the operation of various processes, structures of control systems and the method of communication between different industrial processes

UNIT-I

Programmable Logic Controllers	**02 Hours**
Introduction, Parts of a PLC, Principles of Operation, PLC Size and Application.	
PLC Hardware Components	**05Hours**
The I/O Section, Discrete I/O Modules, Analog I/O Modules, Special I/O Modules, I/O Specifications, The Central Processing Unit (CPU), Memory Design, Memory Types, Programming Terminal Devices, Human Machine Interface (HMIs).	
Basic Programming Language	**05Hours**
Ladder diagrams, Ladder conventions, Logic functions with timing diagram, latching, multiple outputs, entering programs, Functional blocks, Program examples, instruction list, branch codes, programming examples, Sequential functions charts, branching and convergence, actions, Structured Text, conditional and iteration statements	
Developing Fundamental PLC Wiring Diagrams and Ladder Logic Programs	**03Hours**
Electromagnetic Control Relays, Contactors, Motor Starters, Manually Operated Switches, Mechanically Operated Switches, Sensors, Output Control Devices, Seal-In Circuits, Latching Relays, Converting Relay Schematics into PLC Ladder Programs, Writing a Ladder Logic Program Directly from a Narrative Description.	

UNIT-II

Programming Timers	**02 Hours**
Introduction, Necessity of Energy Storage and Methods of Energy Storage (Classification and brief description using block diagram representation)	
Programming Counters	**04 Hours**
Counter Instructions, Up-Counter, Down-Counter, Cascading Counters, Incremental Encoder-Counter Applications, Combining Counter and Timer Functions.	

Program Control Instructions	**05 Hours**
Master Control Reset Instruction, Jump Instruction, Subroutine Functions, Immediate Input and Immediate Output Instructions, Forcing External I/O Addresses, Safety Circuitry, Selectable Timed Interrupt, Fault Routine, Temporary End Instruction, Suspend Instruction.	
Data Manipulation Instructions	**02 Hours**
Data Manipulation, Data Transfer Operations, Data Compare Instructions, Data Manipulation Programs, Numerical Data I/O Interfaces, Closed-Loop Control.	
Math Instructions	**02 Hours**
Math Instructions, Addition Instruction, Subtraction Instruction, Multiplication Instruction, Division Instruction, Other Word-Level Math Instructions, File Arithmetic Operations	

UNIT-III

Sequencer and Shift Register Instructions	**05 Hours**
Mechanical Sequencers, Sequencer Instructions, Sequencer Programs, Bit Shift Registers, Word Shift Operations.	
Process Control, Network Systems, and SCADA	**05 Hours**
Types of Processes, Structure of Control Systems, On/Off Control, PID Control, Motion Control, Data Communications, Supervisory Control and Data Acquisition (SCADA).	

Course Outcomes: At the end of the course student will be able to

1.	Identify main parts, functions of PLC and describe basic circuitry for I/O modules to select PLC for desired application
2.	Apply suitable logic using various programming languages to achieve specific control mechanism for a given application
3.	Identify timer/counter resources of a PLC to design control logic for interfaced device.
4.	Interpret data manipulation and math instructions as they apply to a PLC program
5.	Develop programs that use shift registers and explain functions of control elements of a closed loop control system

Course Outcomes Mapping with Program Outcomes

Program Outcomes→ **↓ Course Outcomes**	1	2	3	4	5	6	7	8	9	10	11	12
EE2504-1.1	3	-	-	-	-	-	-	-	-	-	-	-
EE2504-1.2	1	3	-	-	-	-	-	-	-	-	-	-
EE2504-1.3	1	2	3	-	-	-	-	-	-	-	-	-
EE2504-1.4	1	2	3	-	-	-	-	-	-	-	-	-
EE2504-1.5	1	2	3	-	-	-	-	-	-	-	-	-

1: Low 2: Medium 3: High

TEXTBOOKS:

1.	Frank Petruzella, "Programming Logic Controllers", Fifth Edition.
2.	W Bolton, "Programmable Logic controllers", 6th edition, Elsevier- newness, 2015.

REFERENCE BOOKS:

1.	John W Webb, Ronald A Reis, "Programmable logic controllers - principles and applications", 5th edition, 2nd impression, Pearson education, 2009
2.	L. A Bryan, E. A Bryan, "Programmable Controller Theory and Implementations", 2nd edition, 2003
3.	S. P. Sukhumi, J. K. Nayak, "Solar Energy: Principles Collection and Storage", 3rd edition, McGraw-Hill Education (India) , 2009.
E Books / MOOCs/ NPTEL	
1.	https://library.automationdirect.com/category/product/programmable-control/
2.	https://www.coursera.org/lecture/intelligent-machining/programmable-logic-controllers-plc-fGz3r
3.	https://www.udemy.com/course/plc-programming-from-scratch/

MOTORS AND MOTOR CONTROL CIRCUITS

Course Code:	**EE2505-1**	**Course Type**	**OEC**
Teaching Hours/Week (L: T: P: S)	**3:0:0:0**	**Credits**	**03**
Total Teaching Hours	**40**	**CIE + SEE Marks**	**50+50**
Prerequisite	**EE1001-1**		

Teaching Department: Electrical & Electronics Engineering

Course Objectives:

1.	Study architecture of induction motor and synchronous motor
2.	Understanding control of AC motor
3.	Study principle of operation of different dc motors
4.	Understand the different types of control techniques
5.	Study different sensors and their role in control of a motor

UNIT-I

AC Motor Designs — **08 Hours**

Introduction, Three phase AC motor architecture, Torque speed curve, wound rotor, Synchronous motors

Single phase AC motors, split phase motor, capacitor start and shaded pole motors, Universal and gear motors, AC Motor Specifications, Specifying an AC motor for an application.

AC Motor Control: — **07 Hours**

AC motor Enclosures, AC motor control components, Manual motor starting systems, Direct On Line Starter, semi-automatic star delta starter, fully automatic star delta starter, control circuit for sequence operation of two motors

UNIT-II

DC Motors — **07 Hours**

DC motor principle of operation, Brushed DC motors, shunt, series and compound wound motors, Brushless DC motors, driving a brushless DC motor, Commutation, Specifying a DC motor

DC Motor Control and Stepper Motors — **08 Hours**

Stepper motor principles of operation, Illustrative example of a stepper motor drive, stepper motor specification and operation, commercial stepper motor drive chips and packages, Direction Controller- H Bridge, Speed Controller: Pulse Width Modulation (PWM), Armature Controller: Variable resistance, DC vs.AC motors

UNIT-III

Sensors — **10 Hours**

Unipolar Hall Effect Switches, Omnipolar Hall Effect Switches, Latched Hall Effect Switches, Current Sensors: Shunt resistor, Current-sensing transformer, Hall effect current sensor, Speed/position sensors: Quadrature encoder, Hall effect tachometer, Back EMF/Sensorless control method, BLDC motor control with Hall sensor, Block diagram approach of BLDC Fan and Motor Control

Course Outcomes: At the end of the course student will be able to

1.	Demonstrate an understanding of the general principles of AC Motor.
2.	Understand the basic principles of AC motor controls which includes starters, contactors, and control relays
3.	Demonstrate an understanding of the general principles of DC Motor.
4.	Understand the basic principles of DC motor controls which includes starters, contactors, and control relays
5.	Set up sensors in order to give feedback to a control circuit

Course Outcomes Mapping with Program Outcomes

Program Outcomes→ **↓ Course Outcomes**	1	2	3	4	5	6	7	8	9	10	11	12
EE2505-1.1	3	-	-	-	-	-	-	-	-	-	-	-
EE2505-1.2	2	3	3	-	-	2	-	-	-	-	-	-
EE2505-1.3	3	-	-	-	-	-	-	-	-	-	-	-
EE2505-1.4	2	3	3	-	-	2	-	-	-	-	-	-
EE2505-1.5	2	3	3	-	-	2	-	-	-	-	-	-

1: Low 2: Medium 3: High

TEXTBOOKS:

1.	S. K. Bhattacharya Birjindersingh, "Control of electrical machines", New Age International.
2.	Gary J. Rockis & Glen A. Mazura, "Electrical Motor Controls", 5th Edition, ISBN number is 9780826912268

REFERENCE BOOKS:

1.	Stephen L. Herman, "Industrial Motor Control", Delmar Publishers, Inc., latest Edition.

E Books / MOOCs/ NPTEL

1.	https://www.coursera.org/learn/motors-circuits-design
2.	http://ww1.microchip.com/downloads/en/appnotes/00894a.pdf

NON-CONVENTIONAL ENERGY SOURCES

Course Code:	**EE2506-1**	**Course Type**	**OEC**
Teaching Hours/Week (L: T: P: S)	**3:0:0:0**	**Credits**	**03**
Total Teaching Hours	**40**	**CIE + SEE Marks**	**50+50**
Prerequisite	**EE1001-1**		

Teaching Department: Electrical & Electronics Engineering

Course Objectives:

1.	To understand the principle of extraction of energy from conventional, nonconventional sources
2.	To understand the working principle and applications of solar based thermal, electrical and PV systems.
3.	To justify the usage of energy storage techniques and understand the process of design and implement wind based energy conversion systems.
4.	To understand the process of design and implement biomass based energy conversion systems

UNIT-I

Energy Sources	**03 Hours**
Introduction, Importance of Energy Consumption as Measure of Prosperity, Per Capita Energy Consumption, Classification of Energy Resources, Conventional Energy Resources- Availability and their Limitations, Non-Conventional Energy Resources- Classification, Advantages, Limitations, Comparison of Conventional and Non-Conventional Energy Resources, World Energy Scenario, Indian Energy Scenario	
Solar Energy Basics	**05 Hours**
Introduction, Solar Constant, Basic Sun-Earth Angles – definitions and their representation, Solar Radiation Geometry (numerical problems), Estimation of Solar Radiation of Horizontal and Tilted Surfaces (numerical problems), Measurement of Solar Radiation Data – Pyranometer and Pyrheliometer	
Solar Thermal Systems	**04 Hours**
Principle of Conversion of Solar Radiation into Heat, Solar Water Heaters (Flat Plate Collectors), Solar Cookers – Box type, Concentrating dish type, Solar driers, Solar Still, Solar Furnaces, Solar Green House.	
Solar Electric Systems	**04 Hours**
Solar Thermal Electric Power Generation, Solar Pond and Concentrating Solar Collector(Parabolic Trough, Parabolic Dish, Central Tower Collector), Advantages and Disadvantages; Solar Photovoltaic – Solar Cell fundamentals, characteristics, classification, construction of module, panel and array. Solar PV Systems- stand-alone and grid connected, Applications- Street lighting, Domestic lighting and Solar Water pumping systems.	

UNIT-II

Energy Storage	**04 Hours**
Introduction, Necessity of Energy Storage and Methods of Energy Storage (Classification and brief description using block diagram representation)	
Wind Energy	**04 Hours**

Introduction, Wind and its Properties, History of Wind Energy Wind Energy Scenario – World and India. Basic principles of WECS, Classification, Parts of a WECS,
Derivation for Power in the wind, Electrical Power Output and Capacity Factor of WECS. Wind site selection consideration, Advantages and Disadvantages of WECS.

Biomass Energy	**06 Hours**

Introduction, Photosynthesis process, Biomass fuels, Biomass conversion technologies, Urban waste to Energy Conversion, Biomass Gasification, Biomass to Ethanol Production, Biogas production from waste biomass, Factors affecting biogas generation, types of biogas plants- KVIC and Janata model, Biomass program in India

UNIT-III

Energy From Ocean	**05 Hours**

Tidal Energy – Principle of Tidal Power, Components of Tidal Power Plant, Classification of Tidal Power Plant, Estimation of Energy – Single basin and Double basin type TPP (no derivations, Simple numerical problems), Advantages and Limitation of TPP. Ocean Thermal Energy Conversion (OTEC): Principle of OTEC system, Methods of OTEC power generation – Open Cycle (Claude cycle), Closed Cycle (Anderson cycle), Hybrid cycle, Site-selection criteria, Biofouling, Advantages & Limitation of OTEC

Emerging Technologies	**05 Hours**

Fuel Cell, Small Hydro Resources, Hydrogen Energy and Wave Energy (Principle of Energy generation using block diagrams, advantages and limitations)

Course Outcomes: At the end of the course student will be able to

1.	Describe non-conventional energy sources and solar radiation geometry to estimate and measure solar radiation.
2.	Apply the principle of solar radiation into heat to understand the operation of solar thermal and solar electric systems.
3.	Describe energy storage methods and wind–energy conversion systems to understand the factors influencing power generation.
4.	Review the biomass conversion technologies to design biomass-based energy systems.
5.	Describe tidal, ocean thermal and fuel cell energy conversion systems to understand emerging non-conventional energy technologies.

Course Outcomes Mapping with Program Outcomes

Program Outcomes→ **↓ Course Outcomes**	1	2	3	4	5	6	7	8	9	10	11	12
EE2506-1.1	2	3	-	-	-	1	2	1	-	-	-	-
EE2506-1.2	2	3	-	-	-	1	2	1	-	-	-	-
EE2506-1.3	2	3	-	-	-	1	2	1	-	-	-	-
EE2506-1.4	2	3	-	-	-	1	2	1	-	-	-	-
EE2506-1.5	2	3	-	-	-	1	2	1	-	-	-	-

1: Low 2: Medium 3: High	
TEXTBOOKS:	
1.	Rai G. D., "Non-Conventional Sources of Energy", 4th Edition, Khanna Publishers, New Delhi, 2007.
REFERENCE BOOKS:	
1.	Mukherjee D. and Chakrabarti, S., "Fundamentals of Renewable Energy Systems", New Age International Publishers, 2005.
2.	Khan, B. H., "Non-Conventional Energy Resources", TMH, New Delhi, 2006.
3.	S. P. Sukhumi, J. K. Nayak "Solar Energy: Principles Collection and Storage", 3rd edition, McGraw-Hill Education (India) , 2009.
E Books / MOOCs/ NPTEL	
1.	https://nptel.ac.in/courses/108108078

ELEMENTS OF YOGA

Course Code:	**HU1501-1**	**Course Type**	**OEC**
Teaching Hours/Week (L:T:P:S)	**3:0:0:0**	**Credits**	**03**
Total Teaching Hours	**40+0+0+0**	**CIE + SEE Marks**	**50+50**

Teaching Department: Mechanical Engineering

Course Objectives:

1.	To give a brief history of the development of Yoga
2.	Identify names of different classical texts on Yoga
3.	To illustrate how Yoga is important for healthy living
4.	To explain the Asanas and other Yogic practices
5.	To explain, how Yoga practices can be applied for overall improvement

UNIT-I

Yoga	**09 Hours**

Meaning and initiation, definitions and basis of yoga, History and development, Astanga yoga, Streams of yoga. Yogic practices for healthy living.
General guidelines for Yoga practices for the beginners: Asanas, Pranayama.

Classification of Yoga and Yogic texts	**07 Hours**

Yogasutra of Patanjali, Hatha yogic practices- Asanas, Pranayama, Dharana, Mudras and bandhas.

UNIT-II

Yoga and Health	**06 Hours**

Concept of health and Diseases-Yogic concept of body – pancakosa viveka, Concept of disease according to Yoga Vasistha.

	04 Hours

Yogic concept of healthy living- rules & regulations, yogic diet, ahara, vihara. Yogic concept of holistic health.

Applied Yoga for elementary education	**04 Hours**

Personality development- physical level, mental level, emotional level. Specific guidelines and Yoga practices for - Concentration development, Memory development

UNIT-III

Yoga and physical development	**05 Hours**

Mind-body, Meditation, Yogasanas and their types. Different Yoga practices and Benefits.

	05 Hours

Specific guidelines and Yoga practices for – Flexibility, Stamina, Endurance (Surya Namaskara)

Course Outcomes: At the end of the course student will be able to

1.	Understand a brief history of the development of Yoga
2.	Know important practices and principles of Yoga
3.	Explain how Yoga is important for healthy living

4.	Practice meditation to improvement of concentration etc.
5.	Have knowledge about specific guidelines of yoga practices

Course Outcomes Mapping with Program Outcomes

Program Outcomes→ **↓ Course Outcomes**	1	2	3	4	5	6	7	8	9	10	11	12
HU1501-1.1	-	-	-	-	-	1	-	-	1	-	-	1
HU1501-1.2	-	-	-	-	-	1	-	-	1	-	-	3
HU1501-1.3	-	-	-	-	-	2	-	-	1	-	-	3
HU1501-1.4	-	-	-	-	-	3	-	-	2	-	-	3
HU1501-1.5	-	-	-	-	-	2	-	-	2	-	-	3

1: Low 2: Medium 3: High

TEXTBOOKS:

1.	B. K. S. Iyengar, "Light on Yoga: The Classic Guide to Yoga by the World's Foremost Authority", Thorsons publisher 2016.
2.	Makarand Madhukar Gore, "Anatomy and Physiology of Yogic Practices: Understanding of the Yogic Concepts and Physiological Mechanism of the Yogic Practices", Motilal Banarsidass Publishers; 6 edition (2016).
3.	Swami Satyananda Saraswati, "Asana, Pranayama, Mudra and Bandha: 1", Yoga Publications Trust.

REFERENCE BOOKS:

1.	Ann Swanson, "Science of Yoga: Understand the Anatomy and Physiology to Perfect Your Practice".
2.	Dianne Bondy, "Yoga for Everyone : 50 Poses For Every Type of Body".

E Books / MOOCs/ NPTEL

1.	https://onlinecourses.swayam2.ac.in/aic19_ed29/preview
2.	https://youtu.be/FMf3bPS5wDs

INTELLECTUAL PROPERTY RIGHTS

Course Code	**HU1502-1**	**Course Type**	**OEC**
Teaching Hours/Week (L:T:P: S)	**3:0:0:0**	**Credits**	**03**
Total Teaching Hours	**40+0+0+0**	**CIE + SEE Marks**	**50+50**

Teaching Department: Humanities

Course Objectives:

1.	Understand the creativity component in intellectual property, different types of legal protection of intellectual properties and other basic concepts of Intellectual property.
2.	Analyze different types of protection for inventions, different types of agreements and treaties for Intellectual properties with an ability to examine patent types, specifications and patent search and database for 'prior art'.
3.	Understand the basic procedure of drafting claims, apply for patents, other legal forms of intellectual property rights and also to examine the protocol involved in protection of inventions like patents.

UNIT - I

Introduction to Intellectual Property	**08 Hours**

Invention and Creativity - Intellectual Property (IP) – Importance, Jurisprudential definition and concept of property, rights, duties and their correlation; History and evaluation of IPR – like Patents, Trademarks, Copyright & Related Rights, Industrial Design, Traditional Knowledge, Geographical Indications.

Agreements and Treaties	**08 Hours**

History - General Agreement on Trade and Tariff (GATT). Indian Position vis-a-vis WTO and Strategies; TRIPS Agreement; Madrid Agreement; Hague Agreement; WIPO Treaties; International convention relating to Intellectual Property - Establishment of WIPO - Mission and Activities – Budapest Treaty; PCT; Indian Patent Act 1970 & recent amendments – Patent (Amendment) Rules, 2017

UNIT - II

Basics of Patents and Concept of Prior Art	**08 Hours**

Introduction to Patents; Types of patent applications: Ordinary, PCT, Conventional, Divisional and Patent of Addition; Specifications: Provisional and complete; Forms and fees Invention in the context of “prior art”; Patent databases; Searching International Databases; Country-wise patent searches (USPTO, EPO, WIPO, IPO, etc.)

Patent filing procedures	**08 Hours**

National & PCT filing procedure; Time frame and cost; Status of the patent applications filed; Structure of Patent document, Precautions while patenting – disclosure/non-disclosure; Financial assistance for patenting - introduction to existing schemes; Patent licensing and agreement; Patent infringement- meaning, scope, litigation, case studies.

UNIT - III

Case Studies	**08 Hours**

Patents: Biological Cases - i) Basmati rice ii) Turmeric iii) Neem; Non-biological cases – (i) TVS V/S Hero, (ii) Samsung V/S Nokia – Copyright and related rights – Trade Marks – Trade secrets - Industrial design and Integrated circuits – Geographic indications – Protection against unfair competition; Technology transfer and license agreements (US anti-HIV drug license to Africa).

Course Outcomes: At the end of the course student will be able to

1.	Have a General understanding of the Intellectual Property Rights.
2.	Have awareness of different forms of intellectual property rights, national and international IPR related legislations.
3.	Have a general understanding about the provisions, privileges and limitations of intellectual property right holders with an understanding of the legal aspects (civil or criminal) of the use of intellectual property rights.
4.	Acquire Knowledge of National and International Trade Agreements and Agencies functioning in relation to intellectual property rights
5.	Be aware and have a general understanding of patenting procedures and licensing.

Course Outcomes Mapping with Program Outcomes

Program Outcomes→ **↓ Course Outcomes**	1	2	3	4	5	6	7	8	9	10	11	12
HU1502-1.1	-	3	3	2	-	3	-	-	2	2	-	3
HU1502-1.2	2	2	3	-	-	3	-	3	1	1	2	2
HU1502-1.3	2	-	-	2	-	3	-	-	2	2	2	3
HU1502-1.4	-	-	1	1	-	3	-	-	1	2	-	3
HU1502-1.5	3	2	1	-	-	3	-	-	3	1	-	2

1: Low 2: Medium 3: High

REFERENCE MATERIALS:

1.	BAREACT, "Indian Patent Act 1970 Acts & Rules", Universal Law Publishing Co. Pvt. Ltd., 2007.
2.	Kankanala C., "Genetic Patent Law & Strategy", 1st Edition, Manupatra Information Solution Pvt. Ltd., 2007.
3.	Subbaram N.R., "Handbook of Indian Patent Law and Practice", S. Viswanathan (Printers and Publishers) Pvt. Ltd., 1998.
4.	Eli Whitney, United States Patent Number: 72X, Cotton Gin, March 14, 1794.
5.	Intellectual Property Today: Volume 8, No. 5, May 2001.
6.	M B Rao, "WTO and International Trade", Vikas Publishing House Pvt. Ltd.
7.	Correa, Carlos M. "Intellectual property rights, the WTO and developing countries: the TRIPS agreement and policy options", Zed Books, New York 2000.
8.	Wadehra, B. L. "Law relating to patents, trademarks, copyright designs & geographical indications", 2 ed. Universal Law Publishing 2000.
9.	Sinha, Prabhas Chandra, "Encyclopedia of Intellectual Property Rights", 3 Vols. Eastern Book Corporation, 2006.
10.	Rachna Singh Puri and Arvind Vishwanathan, "Practical Approach to Intellectual Property Rights"; I. K. International Publishing House Pvt. Ltd.

E-RESOURCES:	
1.	http://www.w3.org/IPR/
2.	http://www.wipo.int/portal/index.html.en
3.	http://www.ipr.co.uk/IP_conventions/patent_cooperation_treaty.html
4.	www.patentoffice.nic.in
5.	www.iprlawindia.org/

INTRODUCTION TO GERMAN LANGUAGE

Course Code	**HU1503-1**	**Course Type**	**OEC**
Teaching Hours/Week (L:T:P: S)	**3:0:0:0**	**Credits**	**03**
Total Teaching Hours	**40+0+0+0**	**CIE + SEE Marks**	**50+50**

Teaching Department: Mechanical

Course Objectives:

1.	Distinguish - definite and indefinite articles, declension of singular and plural nouns by adding certain endings to them to differentiate between subjects, objects and indirect objects and construct sentences of simple day to day usage.
2.	Differentiate between nomnative and akkusative cases with transitive and intransitive verbs, and negation with Kein/e/er
3.	Differentiate use of dative object besides the subject for some specific verbs and Apply the grammar principles of use of personal pronoun as a substitute for noun as per the case, number and gender of the noun.
4.	Differentiate preposition forms when used exclusively in akkusative or Dative forms or on combination of the two cases
5.	Differentiate conjugation of verbs in present, present-perfect and past participle tenses, separable and inseparable verbs, application of conjugation of modal verbs and position of modal verb in a sentence.

UNIT - I

15 Hours

Introduction: Mein Name ist (saying who you are, greeting people and saying goodbye, asking people where they come from and where they live. Language point: I and you), Lesen der politischen Karte der Welt, Nationalitaeten und Spachen, Die Uhrzeit (The time) telling time and talking about daily routine, Tage der Woche, die Monate, die vier Jahreszeiten, die Jahre

Mir geht es gut: Asking people how they are, saying how you are, saying which cities and counries people come from, Language points: verb endings),

Wie schreibt man das (how do you write that?) Counting from 1-100 and above, alphabet, spelling our names and words, talking about us and them. Language points: Yes-no questions

Artikel (Articles): As in English, there are definite (der/die/das) and indefinite (ein/eine) articles:

the · der/die/das; a/an · ein/eine

Die vier Fälle (The four cases): Nominativ, Akkusativ, Dativ, Genitiv(Not in level A-1)

Deklination des bestimmten Artikels der/die/das

Deklination des unbestimmten Artikels ein/eine

(Deklination/Declension: the variation of the form of a noun, pronoun, or adjective, by which its grammatical case, number, and gender are identified)

Deklination von Substantiven (Declension of nouns) (Singular and Plural)

(German nouns are declined by attaching certain endings to them, according to case, number and gender. This helps to differentiate between subjects, objects and indirect objects).

Nominativ und Akkusativ(nominative and accusative cases)
The verb determines the case of the noun. Some verbs only go with the nominative, others only with the accusative (or the dative). Thus, German verbs are either transitive or intransitive.
(Nominative and accusative cases) Intransitive Verben (intransitive verbs) Transitive Verben (transitive verbs)

Negation „kein/e/er "(negation with „kein/e/er ")
(Singular und Plural)
The negation of the indefinite article (ein/eine/ein) is kein/keine/kein. For this, you just have to put a „k" at the beginning of the declined form of ein/eine/ein.
Peter sieht ein Haus. · Negation · Peter sieht kein Haus.
(Peter sees a house. · negation · Peter does not see a house.)

(With examples, writing and hearing exercises, and German to English Glossary as applicable)

UNIT - II

14 Hours

Dativ (the dative)
(You are already familiar with verbs which require a direct accusative object in addition to the subject, which is in the nominative case. But there also some verbs which require a dative object besides the subject. To identify the dative object you ask "(To) whom?")

Der Plural (the plural)
There are many different forms of the plural in the German language. Principally, the gender and the ending of the noun determine the plural form. Then, you either attach a plural ending
to the noun, change a vowel, or keep the noun as it is in the singular.

Das Personalpronomen (the personal pronoun)
The personal pronoun is a substitute for a noun. Its forms are determined by the case, number and gender of the noun which is to be replaced.

Die Formen des Personalpronomen im Nominativ
(The nominative forms of the personal pronoun):

Präpositionen (prepositions)
German prepositions are followed by an object, either in the accusative or the dative case.Some prepositions always take an accusative object, others always a dative object. But thereare also prepositions which can be followed by both. In this case, the question "Where(to)?"

(· accusative) or "Where?" (· dative) determines the case of the object.

Präpositionen mit Akkusativ und Dativ
(Prepositions with accusative and dative)
1.Präpositionen mit Akkusativ (prepositions with accusative)
2.Präpositionen mit Dativ (prepositions with dative)
3.Präpositionen mit Akkusativ oder Dativ (prepositions with accusative or dative)

(With examples, writing and hearing exercises, and German to English Glossary as applicable)

UNIT - III

11 Hours

Konjugation von Verben im Präsens
(Conjugation of verbs in present tense)
Verbs are conjugated by attaching certain endings, depending on the person and number ofthe subject.

Trennbare und untrennbare Verben
(separable and inseparable verbs)
Verbs with prefixes are dinstinguished between separable and inseparable verbs.
The prefix of an inseparable verb must never be separated from the stem. Here the stress is on the stem: be-kommen. The prefix of a separable verb gets separated from the stem when the verb is conjugated. In the infinitive, the stress is on the prefix: an-kommen
1.Trennbare Verben (separable verbs)
2.Untrennbare Verben (inseparable verbs)

Konjugation von Verben im Perfekt
(Conjugation of verbs in present perfect)
The present perfect (Perfekt) describes something which happened in the past and isespecially used in spoken German. It is formed with the present tense form of „haben" or „sein" and the past participle of the main verb.
1. Die Bildung des Partizips
(the formation of the past participle)
2. Die Bildung des Perfekts mit „haben" und „sein"
(the formation of the present perfect with „haben" and „sein")

Modalverben (modal verbs)
A modal verb is rarely used as a main verb; instead, it usually modifies the main verb. Whilethe main verb remains in the infinitive, the modal verb is conjugated.
In German, there are 7 modal verbs:
können (can/be able), dürfen (may/be allowed), wollen (want),
müssen (must/have to), sollen (shall), mögen (to like), möchten (wish/would like)

1. Konjugation der Modalverben
(Conjugation of the modal verbs)

2. Stellung des Modalverbs im Satz
(Position of the modal verb within a sentence)

(With examples, writing and hearing exercises, and German to English Glossary as applicable)

Course Outcomes: At the end of the course student will be able to

1.	Distinguish - definite and indefinite articles, declension of singular and plural nouns by adding certain endings to them to differentiate between subjects, objects and indirect objects and construct sentences of simple day to day usage.
2.	Differentiate between nomnative and akkusative cases with transitive and intransitive verbs, and negation with Kein/e/er
3.	Differentiate use of dative object besides the subject for some specific verbs and Apply the grammar principles of use of personal pronoun as a substitute for noun as per the case, number and gender of the noun.
4.	Differentiate preposition forms when used exclusively in akkusative or Dative forms or on combination of the two cases
5.	Differentiate conjugation of verbs in present, present-perfect and past participle tenses, separable and inseparable verbs, application of conjugation of modal verbs and position of modal verb in a sentence.

Course Outcomes Mapping with Program Outcomes

Program Outcomes→	1	2	3	4	5	6	7	8	9	10	11	12
↓ Course Outcomes												
HU1503-1.1	-	-	-	-	-	3	-	-	2	1	-	1
HU1503-1.2	-	-	-	-	-	3	-	-	2	1	-	1
HU1503-1.3	-	-	-	-	-	3	-	-	2	1	-	1
HU1503-1.4	-	-	-	-	-	3	-	-	2	1	-	1
HU1503-1.5	-	-	-	-	-	3	-	-	2	1	-	1

1: Low 2: Medium 3: High

TEXT BOOKS:

1.	Ulrich Haessermann, Georg Dietrich, Christianne C. Guenther, Diethelm Kaminski, Ulrike Woods and Hugo Zenker, Sprachkurs Deutsch Neusaffung 1, Unterrichtswerk fuer Erwachsene, Verlag Moritz Diesterweg, Universitaetsdruckerei H. Stuertz AG Wuerzburg, 1989.
2.	Paul Coggle and Heiner Schenke, Teach Yourself German (a complete course in understanding, speaking and writing), Teach Yourself Books, Hodden & Stoughton Educational, UK, 2001
3.	Langenscheidt German In 30 Days: Book + Cd Paperback, www.amazon.in, – 1 September 2011

REFERENCE MATERIALS:

1.	Deutsche Sprachlehre für Ausländer.
2.	Themen Aktuell (Text and workbook).
3.	Deutsch als Fremdsprache 1A.
4.	Tangram Aktuell 1A/1B (Text and workbook).

5.	Wherever required the Videos/Audios are also played in the class room sessions
E-RESOURCES:	
1.	https://onlinecourses.nptel.ac.in/noc21_hs30/preview NPTEL-Swayam, German-I by Prof. Milind Brahme | IIT Madras
2.	https://www.traingerman.com/en/ powered by Sprachinstitut TREFFPUNKT Online

INTRODUCTION TO JAPANESE LANGUAGE

Course Code	**HU1504-1**	**Course Type**	**OEC**
Teaching Hours/Week (L:T:P:S)	**3:0:0:0**	**Credits**	**03**
Total Teaching Hours	**40+0+0+0**	**CIE + SEE Marks**	**50+50**

Teaching Department:

Course Objectives:

1.	Have basic spoken communication skills
2.	Write Simple Sentences
3.	Listen and comprehend basic Japanese spoken Japanese
4.	Read and understand basic Japanese characters including Kanji

UNIT - I

(Lessons 1-6) **15 Hours**

Grammar – Introduction, Alphabets, Accents, Noun, Pronoun, Present Tense, Past tense
Vocabulary – Numbers, Days, week days, months, Seasons, Nature, Dialogs and Video Clips

UNIT - II

(Lessons 7-13) **14 Hours**

Communication skills – Time, Addective, Seasons, Conversation, Q&A, Hobby, 5-W/1-H, Entering School/Company, Body Parts, Colours, Features etc**.**

UNIT - III

(Lessons 14-20) **11 Hours**

Japanese Counting System, Birth/Death, Dialogs (Going to Party, Restaurant), My day, Success/Failure, Kanji Characters, and sentence making, Video Clips

Course Outcomes: At the end of the course student will be able to

1.	Understand Simple words, expressions and sentences, spoken slowly and distinctly
2.	Speak slowly and distinctly to comprehend
3.	Read and Understand common words and sentences
4.	Ask Basic questions and speak in simple sentences
5.	Write Hiragana/Katakana and Kanji (120) characters.

Course Outcomes Mapping with Program Outcomes

Program Outcomes→ **↓ Course Outcomes**	1	2	3	4	5	6	7	8	9	10	11	12
HU1504-1.1	-	-	-	-	-	3	-	-	2	1	-	1
HU1504-1.2	-	-	-	-	-	3	-	-	2	1	-	1
HU1504-1.3	-	-	-	-	-	3	-	-	2	1	-	1
HU1504-1.4	-	-	-	-	-	3	-	-	2	1	-	1
HU1504-1.5	-	-	-	-	-	3	-	-	2	1	-	1

1: Low 2: Medium 3: High

NATIONAL CADET CORPS: ORGANIZATION, FUNCTIONS AND CAPABILITIES

Course Code	HU1505-1	Course Type	OEC
Teaching Hours/Week (L:T:P:S)	3:0:0:0	Credits	03
Total Teaching Hours	40+0+0+0	CIE + SEE Marks	50+50

Teaching Department: Chemistry

Course Objectives:

1.	To create evolved youth, who will be equipped to contribute in the development of the nation.
2.	To train students so as to achieve their physical and mental endurance. To acquire body language of smart soldier and to inculcate the sense of authority by commanding the troop under him/her.
3.	To inculcate spirit of adventure, undertake adventure activities, to hone leadership qualities and risk-taking abilities.
4.	To understand and develop life skills, soft skills and to improve emotional quotient of the student.
5.	To impart basic military training, to develop awareness about the defense forces and expose learners to military ethos / values

UNIT - I

NCC: Aims, Objectives and Organization — **07 Hours**

NCC General, Aims, Objectives and Organization of NCC. Duties of NCC Cadets, NCC Camps: Types and Conduct. National Integration: Importance and Necessity, Unity in Diversity.

Personality Development — **07 Hours**

Self-Awareness, Empathy, Critical and Creative Thinking, Decision Making and Problem Solving. Communication Skills, Coping with stress and emotions. Leadership: Traits, Indicators, motivation, moral values, Honor Code. Social Service and Community Development.

UNIT - II

Naval Communication and Seamanship — **08 Hours**

Naval Communication: Introduction, Semaphore, Navigation: Navigation of Ships- Basic requirements, Chart work.

Seamanship: Introduction to Anchor work, Rigging Capsule, Boat work- Parts of Boat, Boat pulling instructions, Whaler sailing instructions. Ship Modeling.

Disaster management and environmental awareness — **08 Hours**

Disaster Management- Organization, Types of Disasters, Essential Services, Assistance, Civil Defence organization. Adventure Activities.

Dos and Don'ts, Fire services and Firefighting, Environmental Awareness and Conservation.

UNIT - III

Naval Orientation — **10 Hours**

Naval Orientation- Armed Forces and Navy Capsule, EEZ Maritime Security & ICG. Border & Coastal Areas: Security setup and Boarder/Coastal management in the area. Naval Orientation: Modes of Entry- IN, ICG, Merchant Navy.

Border and Coastal areas: Security Challenges & role of cadets in Border management

Course Outcomes: At the end of the course student will be able to

1.	Display sense of patriotism, secular values and shall be transformed into motivated youth who will contribute towards nation building through national unity and social cohesion.
2.	Demonstrate the sense of discipline, improve bearing, smartness, turnout and develop the quality of immediate and implicit obedience of orders, with good reflexes.
3.	Acquaint, expose & provide knowledge about Army/Navy/ Air force and acquire information about expanse of Armed Forces, service subjects and important battles.

Course Outcomes Mapping with Program Outcomes

Program Outcomes→	1	2	3	4	5	6	7	8	9	10	11	12	**PSO ↓**	
↓ Course Outcomes													1	2
HU1505-1.1	-	-	-	-	-	3	3	1	-	-	-	-	-	-
HU1505-1.2	-	-	-	-	-	3	3	-	-	-	-	-	-	-
HU1505-1.3	-	-	-	-	-	-	-	-	1	-	-	-	-	-

1: Low 2: Medium 3: High

REFERENCE BOOKS:

1. R.K. Guptha, "Cadets Handbook", Ramesh Publishing House, New Delhi.

OVERVIEW OF INDIAN CULTURE

Course Code	**HU1506-1**	**Course Type**	**OEC**
Teaching Hours/Week (L:T:P: S)	**3:0:0:0**	**Credits**	**03**
Total Teaching Hours	**40+0+0+0**	**CIE + SEE Marks**	**50+50**

Teaching Department: Humanities

Course Objectives:

1.	To understand the relevance of Culture in Human Life, dynamism of Indian Culture and Arts through ages.
2.	To understand the local culture and its vibrancies.
3.	To develop awareness about Indian Society, Culture and Arts under Western rule.
4.	To comprehend different dimension and aspects of the Indian culture and arts.
5.	To appreciate cultural performances in India.

UNIT - I

Knowing Culture	**08 Hours**
What is Culture, Different aspects of Culture, Cultural expression, Importance of Culture	
Influence of Culture	**07 Hours**
Relationship of Culture with: Language, Religion and History, Gender	

UNIT - II

Media and Culture	**07 Hours**
Role of News Papers, Indian Cinema, Music, Advertisements	
Languages, Literature and Culture	**07 Hours**
Role of Sanskrit, Vedas, Upanishads, Ramayana and Mahabharata, Puranas, other Sanskrit Literature, Buddhist and Jain Literature, Dravidian Languages and Literature, North Indian Languages and Literature, Subaltern Literature	

UNIT - III

Arts and Culture	**07 Hours**
Indian Theatre and Performing Arts, Ritual performances, and Tuluva cultural and ritual performances.	
(Self-study Component) **Contribution of Indian History to Culture**	**04 Hours**

Ancient India – Persian and Macedonian invasions and its impact on Indian Culture, Development of Culture and Arts during the Mauryan Empire (Ashoka), the Guptas, the South Indian Dynasties – the Cholas, Nalanda as a Centre of Learning.
Medieval India – Life of People under Delhi Sultanate, Rise of Islam and Sufism, Political Scene of India, Bhakti Movement, Folk Arts, Rise of Modern Indian Languages.
Modern India – British Ruling and its impact on Indian Culture, Social and Religious Reforms, Indian National Movement and Achievement of Independence.

Course Outcomes: At the end of the course student will be able to

1.	Examine how the culture has a very important role in human life and growth of human civilization and have a general awareness on historical perspective of growth of Indian Culture and Arts.

2.	Appreciate their own local culture from an academic perspective.
3.	Know about the impact of Western Rule in India and Indian Struggle for Freedom and also its impact on Indian Culture and Arts and able to appreciate and the role of language in connecting people, growth of culture and arts beyond the barriers of religion and ages.
4.	Take interest in learning these forms of arts, and also appreciate and preserve them for the future generations feeling proud of Indian Culture, Arts and Architecture.
5.	Appreciate art performances in India which will enable them to get exposed to an artistic sphere, which eventually help them to be creative and imaginative.

Course Outcomes Mapping with Program Outcomes

Program Outcomes→ **↓ Course Outcomes**	1	2	3	4	5	6	7	8	9	10	11	12
HU1506-1.1	-	1	-	-	-	3	-	3	3	1	-	3
HU1506-1.2	-	-	-	2	-	3	-	2	3	3	-	3
HU1506-1.3	-	-	-	-	-	3	-	1	-	-	-	1
HU1506-1.4	-	-	-	-	-	3	-	2	1	2	-	3
HU1506-1.5	-	-	-	-	-	3	-	3	3	3	-	2

1: Low 2: Medium 3: High

PHILOSOPHY

Course Code	**HU1507-1**	**Course Type**	**OEC**
Teaching Hours/Week (L:T:P: S)	**3:0:0:0**	**Credits**	**03**
Total Teaching Hours	**40+0+0+0**	**CIE + SEE Marks**	**50+50**

Teaching Department: Visiting

Course Objectives:

1.	To provide a new understanding based on which one can move to overcome the current problems, both at the individual level as well as at the societal level.
2.	To introduce an orientation course for humanities courses in general and for philosophy courses in particular.
3.	To relate philosophy to literature, culture, society and lived experience.
4.	To train students in already available philosophical systems.
5.	To bridge the gap between theory and practice.

UNIT - I

Knowledge (Vidya) and Ignorance (Avidya)	**14 Hours**

Upanishads
Six systems orthodox and Heterodox schools of Indian philosophy
Greek philosophy

Origin of the universe

NasidiyaSukta: "Who really knows?"
Brhadaranyaka Upanishad; Chandogya Upanishad: Non-Self, real and unreal
Taithriya Upanishad: SikshaValli
Plato's Symposium: Lack as the source if desire and knowledge.
Socratic method of knowledge as discovery
Language: word as root of knowledge (Bhartrahari's Vakyapadiyam)
Fourteen Knowledge basis as a source of Vidya: Four Vedas, six auxiliary sciences (vedangas); Purana, Nyaya, Mimamsa and Dharma Sastras.

UNIT - II

Knowledge as Power	**16 Hours**

Francis Bacon. Knowledge as both power and self- realization in Bhagavad Gita.

Knowledge as Oppression

M. Foucault. Discrimination between Ram and Satyam in Indian Philosophy.

Knowledge as Invention

Modern definition of creativity; scientific activity in the claim that science invents new things at least through technology.

UNIT - III

	10 Hours

Knowledge about the self, transcendental self; knowledge about society, polity and nature
Knowledge about moral an ethics codes.

Course Outcomes: At the end of the course student will be able to

1.	To provide a new understanding based on which one can move to overcome the current problems, both at the individual level as well as at the societal level.
2.	To introduce an orientation course for humanities courses in general and for philosophy courses in particular.
3.	To relate philosophy to literature, culture, society and lived experience.
4.	To train students in already available philosophical systems.
5.	To bridge the gap between theory and practice.

Course Outcomes Mapping with Program Outcomes

Program Outcomes→ **↓ Course Outcomes**	1	2	3	4	5	6	7	8	9	10	11	12
HU1507-1.1	-	-	-	-	-	3	-	-	2	1	-	1
HU1507-1.2	-	-	-	-	-	3	-	-	2	1	-	1
HU1507-1.3	-	-	-	-	-	3	-	-	2	1	-	1
HU1507-1.4	-	-	-	-	-	3	-	-	2	1	-	1
HU1507-1.5	-	-	-	-	-	3	-	-	2	1	-	1

1: Low 2: Medium 3: High

REFERENCE MATERIALS:

1.	Copleston, Frederick, "History of Philosophy", Vol. 1. Great Britain: Continuum.
2.	Hiriyanna, M. , "Outlines of Indian Philosophy", Motilal Banarsidass Publishers; Fifth Reprint edition, 2009.
3.	Sathaye, Avinash, "Translation of Nasadiya Sukta".
4.	Raju, P. T. "Structural Depths of Indian Thought", Albany: State University of New York Press.
5.	Plato, Symposium, Hamilton Press

PRINCIPLES OF PHYSICAL EDUCATION

Course Code	**HU1508-1**	**Course Type**	**OEC**
Teaching Hours/Week (L:T:P: S)	**3:0:0:0**	**Credits**	**03**
Total Teaching Hours	**40+0+0+0**	**CIE + SEE Marks**	**50+50**

Teaching Department: Physical Education

Course Objectives:

1.	Express understanding of constitution of sports organizations
2.	Demonstrate considerate familiarity of various food practices
3.	Grasp understanding of first aid and physical education
4.	Awareness on the importance of exercise
5.	Leadership skills and the rules of different sports

UNIT - I

15 Hours

History of Physical Education - Olympic games, Modern Olympic games, Olympic Ideals & Objectives, Olympic Symbols, Olympic Flag, Olympic Emblem, Olympic Motto, Olympic Flame, Asian games
International Olympic Committee (IOC), Indian Olympic Association (IOA)
Sports awards - Eligibility, Objectives & Criteria
Yoga - Meaning and Importance
World Health organization (WHO)

UNIT - II

14 Hours

Concept of Health - Meaning of Health, Health Definition, Factors Affecting Health, Qualities of Healthy Person. Health Hazards of College Students, Physical Fitness and Exercises.
Food and Nutrition - Food & Nutrition Defined, Nutrients and their Functions - i) Proteins ii) Carbohydrates iii) Fats iv) Vitamins
Balanced Diet & Malnutrition
Health Education - Meaning of Health Education, Health Education Defined, Scope of Health Education, Importance of Health Education.
Posture - Concept of Posture, Correct Postures, Common Postural Defects
First Aid - First Aid Defined, Need and importance of First Aid, The Requisites of First Aid, Scope of First Aid, Qualities of a First Aider, Fundamental Principles to be followed and the Duties to be performed by the First Aider, First Aid in Different Cases.
Physical Education - Concept of Physical Education, Physical Education Defined, Importance of Physical Education, Scope of Physical Education, Aims and Objectives of Physical Education.
Teaching Aid in Physical Education
Competition - Introduction, Types of competition, Knock out, League or Round Robin Tournament.

UNIT - III

	11 Hours
Training in Sports – Meaning, Principles, Warming Up & Limbering Down Importance of Anatomy and Physiology in Physical Education, Oxygen Debt and Second wind Leadership and Supervision – Leadership, Qualities of a good leader in Physical Education, Types of Leadership in Physical Education - 1. Teacher Leadership 2. Student Leadership. Measurement & specification of various playing fields – Cricket, Volley Ball, Basket Ball, Badminton, Ball Badminton, Foot Ball, Hand Ball & their basic playing skills.	

Course Outcomes: At the end of the course student will be able to

1.	Demonstrate knowledge of structure of the world sports organizations
2.	Display understanding of different type of food and nutrition for a healthy diet
3.	Comprehend awareness of first aid and physical education
4.	Elucidate about training and the importance of Physical Education
5.	Aware of leadership skills and the knowledge of various sports

Course Outcomes Mapping with Program Outcomes

Program Outcomes→ / **↓ Course Outcomes**	1	2	3	4	5	6	7	8	9	10	11	12
HU1508-1.1	-	-	-	-	-	3	-	-	2	1	-	1
HU1508-1.2	-	-	-	-	-	3	-	-	2	1	-	1
HU1508-1.3	-	-	-	-	-	3	-	-	2	1	-	1
HU1508-1.4	-	-	-	-	-	3	-	-	2	1	-	1
HU1508-1.5	-	-	-	-	-	3	-	-	2	1	-	1

1: Low 2: Medium 3: High

LINGUISTICS & LANGUAGE TECHNOLOGY

Course Code	**HU2501-1**	**Course Type**	**OEC**
Teaching Hours/Week (L:T:P:S)	**3:0:0:0**	**Credits**	**03**
Total Teaching Hours	**40+0+0+0**	**CIE + SEE Marks**	**50+50**
Pre-requisite	**HU1001-1 (Technical English)**		

Teaching Department: Humanities

Course Objectives:

1.	Introspect about the consciousness in one's language
2.	Learn pronunciation and how the process helps to communicate effectively.
3.	Build contextual speech and writing with the pedagogy in sentence structure.
4.	Improve skill of applying language to enunciate words.
5.	Progress on the speech aspects by understanding the acquisition of Second Language.

UNIT - I

Introduction to Linguistics	**08 Hours**

Broad understanding of Linguistics, Language and characteristic features, Scientific Language, Levels of Linguistic Analysis (Phonetics, Phonology, Morphology, Syntax and Semantics); Approach to Linguistics (Traditional, Structural and Cognitive).

Phonology and Morphology	**08 Hours**

Perspectives in Linguistics, Phonemes, Allophones, Phonemic Analysis, Morphology and Morphemes, Word building process, Morphological Analysis.

UNIT - II

Syntax	**16 Hours**

Constituent structure (Simple Sentence, Noun Phrase, Verb Phrase, Prepositional Phrase, Adjective Phrase, Adverb Phrase, Structure Rules), Tree Diagrams, Case

UNIT - III

Sociolinguistics & Psycholinguistics, Artificial Intelligence	**08 Hours**

Notion of Language Variety, Languages in Contact, Language and Mind, Error Analysis.

Course Outcomes: At the end of the course student will be able to

1.	Understand the importance of language and its facets.
2.	Demonstrate knowledge of sounds and competence in process of word building.
3.	Evolve to reason the constituent parts of a sentence.
4.	Understand the techniques of how 'meaning' is applied.
5.	Analyze errors in day-to-day-conversations and how language is related to society.

Course Outcomes Mapping with Program Outcomes

Program Outcomes→ / ↓ Course Outcomes	1	2	3	4	5	6	7	8	9	10	11	12
HU2501-1.1	-	1	-	-	1	1	-	-	1	-	-	2
HU2501-1.2	-	-	2	-	-	-	-	-	2	2	-	-
HU2501-1.3	2	3	-	3	-	-	-	-	3	2	-	-
HU2501-1.4	-	-	-	-	2	-	-	-	1	2	-	-
HU2501-1.5	-	2	-	-	-	2	1	-	-	-	-	1

1: Low 2: Medium 3: High

REFERENCE MATERIALS:

1.	Akmaijan, A, R. A. Dimers and R. M. Harnish. "Linguistics: An Introduction to Language and Communication". London: MIT Press, 1979.
2.	Chomsky, Noam. "Language in Mind". New York: Harcourt Brace Jovanovich, 1968.
3.	Fabb, Nigel. "Sentence Structure". London: Routledge, 1994.
4.	Hockett, C. "A Course in Modern Linguistics". New York: Macmillan, 1955.
5.	O'Grady, W., O. M. Dobrovolsky and M. Aronoff. "Contemporary Linguistics: An Introduction". New York: St. Martin's Press, 1991.
6.	Pride, J. B. and J. Holmes. "Sociolinguistics". Harmondsworth: Penguin, 1972.
7.	Richards, J. C. "Error Analysis: Perspectives in Second Language Acquisition". London: Longman, 1974.
8.	Salkie, R. "The Chomsky Update: Linguistics and Politics". London: Unwin Hyman Ltd., 1990.
9.	Sinclair, J. M. C. H. and R. M. Coulthard. "Towards an Analysis of Discourse". Oxford: OUP, 1975.
10.	Thomas, Linda. "Beginning Syntax". Oxford: Blackwell, 1993.
11.	Verma, S. K. and N. Krishnaswamy. "Modern Linguistics: An Introduction". New Delhi: OUP, 1989.
12.	Wekker, Herman and Liliane Haegeman. "A Modern Course in English Syntax". Kent: Croom Helm, 1985.

PROFESSIONAL & COGNITIVE COMMUNIQUÉ

Course Code	**HU2502-1**	**Course Type**	**OEC**
Teaching Hours/Week (L:T:P:S)	**3:0:0:0**	**Credits**	**03**
Total Teaching Hours	**40+0+0+0**	**CIE + SEE Marks**	**50+50**
Pre-requisite	**HU1001-1 (Technical English)**		

Teaching Department: Humanities

Course Objectives:

1.	To Problematize Commonsense & Apply Critical thinking skills
2.	Comprehend etiquettes and manners in different situations
3.	Be gender sensitive in both offline and online behavior
4.	Exhibit better comprehension of the social implications of human body
5.	Understand the importance of reading and writing skills

UNIT - I

Common sense and Emotional Intelligence	**15 Hours**
Common sense, Commonsensical Consensus, Critical thinking, Unsettling commonsensical Consensus, Role of language in Common sense and Critical Thinking;Nature & Functions of Emotional Intelligence, Emotions, Intelligence and Creativity, Growth of Emotional Intelligence	
Etiquettes & Workplace	
Etiquette, Workplace Etiquettes, Workplace Readiness Skills, Significance of Cross-Cultural Understanding; Cultural Sensitivity, Impact of social media in Workplace	

UNIT - II

Social Networking Sites and its Impacts	**15 Hours**
Emergence of social media, Impact on Gender and Self Representation, Regulatory and Liberatory aspects of social media, Offline Norms & Online Behaviour	
Gender and Body	
Gender & Sex, Genderization, Homogeneity and Heterosexuality, Gender Expressions, Gender Schooling, Representations of Body, Objectification, Gender Perspectives of Body, Different Ways of Seeing the Body, Discipline & Coercion, ISA & RSA	

UNIT - III

Writing	**10 Hours**
Types of Writing, Note Taking Methods, Plagiarism	
Reading	
Styles of Reading, Types of Reading, Scanning, Skimming	

Course Outcomes: At the end of the course student will be able to

1.	Problematize Commonsense & Apply Critical thinking skills
2.	Comprehend etiquettes and manners in different situations
3.	Be gender sensitive in both offline and online behavior
4.	Exhibit better comprehension of the social implications of human body
5.	Understand the importance of reading and writing skills

Course Outcomes Mapping with Program Outcomes

Program Outcomes→ ↓ Course Outcomes	1	2	3	4	5	6	7	8	9	10	11	12
HU2502-1.1	-	3	-	-	-	-	-	-	3	3	-	3
HU2502-1.2	-	2	-	-	-	-	-	3	2	3	-	2
HU2502-1.3	-	3	-	-	-	-	-	-	2	2	-	3
HU2502-1.4	-	3	-	-	-	-	-	-	2	2	-	3
HU2502-1.5	-	2	-	-	-	-	-	-	3	3	-	2

1: Low 2: Medium 3: High

REFERENCE MATERIALS:

1. Geetha.V. Gender. Kolkatta: Web Impressions, 2009.
2. Bailey, Jane, et al. "Negotiating with Gender Stereotypes On Social Networking Sites: From "Bicycle Face" to Facebook." Journal of Communication Enquiry 37.2 (2013): 91-112.
3. Barry, Peter. "Beginning Theory". New Delhi: Viva Books, 2010.
4. Berger, John. "Ways of Seeing". London: Penguin Books, 1977.
5. Cranny-Francis, Anny, et al. "Gender Studies: Terms and Debates". New York: Palgrave Macmillan, 2003.
6. Gauntlett, David. "Media, Gender and Identity: An Introduction". London: Routledge, 2008
7. Pilcher, Jane, and Imelda Whelehan. "50 Key Concepts in Gender Studies". London: Sage, 2004. Print.
8. Jeanne, Haraway Donna. Simians, Cyborgs, and Women. London: Free Association Books, 1991. Web.
9. Koskela, Hille. "Webcams, TV Shows and Mobile Phones: Empowering Exhibitionism." Surveillance & Society 2.3 (2004): 199-215.Web.

E-RESOURCES:

1. http://www.cyberpsychology.eu/view.php?cisloclanku=2009061501/ >.
2. http://www.surveillance-and-society.org/articles2(2)/webcams.pdf
3. http://eprints.rclis.org/19790/>.

INTRODUCTION TO CYBER SECURITY

Course Code:	**IS2501-1**	**Course Type**	**OEC**
Teaching Hours/Week (L: T: P: S)	**3:0:0:0**	**Credits**	**03**
Total Teaching Hours	**40**	**CIE + SEE Marks**	**50+50**
Prerequisite	**IS1651-1**		

Teaching Department: Information Science & Engineering

Course Objectives:

1.	Define the area of cybercrime and forensics and to understand the security threat
2.	Explain the motive and causes for cybercrime, detection, and handling.
3.	Investigate Areas affected by cybercrime.
4.	Illustrate tools used in cyber forensic

UNIT-I

Introduction to Cyber Security — **15 Hours**

Concepts of Cyber Security, Formal Methods of Security Validation, CIA framework-Confidentiality, Integrity and Authenticity, Threat modelling, Domains of cyber security, Security attacks, Security services, Security Mechanisms, Fundamental security design principles, Types of Cyber Threat.

UNIT-II

Tools and methods used in Cybercrime — **14 Hours**

Introduction, Proxy Servers and Anonymizers, Intruders and Hackers, Insider threats, Cybercrimes. Network Threats: Active/ Passive – Interference – Interception –Impersonation – Worms –Virus – Spam's – Ad ware - Spy ware – Trojans and covert channels –Backdoors – Bots – IP, Spoofing - ARP spoofing - Session Hijacking, Introduction to Phishing, Identity Theft (ID Theft).

UNIT-III

Understanding Computer Forensics — **11 Hours**

Introduction, Digital Forensics Science, The Need for Computer Forensics, Cyberforensics and Digital Evidence, Forensics Analysis of E-Mail, Digital Forensics Life Cycle, Chain of Custody Concept, Network Forensics, Approaching a Computer Forensics Investigation, Setting up a Computer Forensics Laboratory: Understanding the Requirements, Computer Forensics and Steganography, Relevance of the OSI 7 Layer Model to Computer Forensics, Forensics and Social Networking Sites: The Security/Privacy Threats, Computer Forensics from Compliance Perspective, Challenges in Computer Forensics, Special Tools and Techniques, Forensics Auditing, Antiforensics.

Course Outcomes: At the end of the course student will be able to

1.	Comprehend the Cybercrime and its origin
2.	Analyse Security Threat Management and understand the security elements.
3.	Apply tools and methods used in Cyber crimes
4.	Analyse Phishing and ID Theft
5.	Comprehend Digital Forensics

Course Outcomes Mapping with Program Outcomes

Program Outcomes→ ↓ Course Outcomes	1	2	3	4	5	6	7	8	9	10	11	12
IS2501-1.1	2	-	-	-	-	1	-	3	-	-	-	-
IS2501-1.2	-	3	-	1	-	2	-	-	2	-	-	-
IS2501-1.3	-	3	2	-	-	-	-	-	-	-	-	-
IS2501-1.4	2	-	-	-	-	2	-	-	-	-	-	-
IS2501-1.5	-	-	-	-	-	-	-	3	-	-	-	-

1: Low 2: Medium 3: High

TEXTBOOKS:

1.	William Stallings, "Cryptography and Network Security: Principles and Practice", Pearson Education, 2006.
2.	Swiderski, Frank and Syndex, "Threat Modeling", Microsoft Press, 2004.
3.	Sunit Belapure and Nina Godbole, "Cyber Security: Understanding Cyber Crimes, Computer Forensics and Legal Perspectives", Wiley India Pvt Ltd, ISBN: 978-81-265-21791, Publish Date 2013.

REFERENCE BOOKS:

1.	Thomas J. Mowbray, "Cybersecurity: Managing Systems, Conducting Testing, and Investigating Intrusions", John Wiley & Sons, Inc, ISBN: 978 -1-118 -84965 -1, 2014.
2.	James Graham, Ryan Olson, Rick Howard, "Cyber Security Essentials'', CRC Press, 15-Dec 2010. Anti- Hacker Tool Kit (Indian Edition) by Mike Shema, Publication Mc Graw-Hill.
3.	Santosh B. J., K. V. S. S. S. S. Sairam, Shubham Kumar, Chandu Jagan Sekhar M, "Information and Cyber Security", Scientific International Publishing House, ISBN-978-93-5625-694-1.

PYTHON APPLICATION PROGRAMMING

Course Code:	**IS2502-1**	**Course Type**	**OEC**
Teaching Hours/Week (L: T: P: S)	**3:0:0:0**	**Credits**	**03**
Total Teaching Hours	**40**	**CIE + SEE Marks**	**50+50**
Prerequisite	**CS1002-1**		

Teaching Department: Information Science & Engineering

Course Objectives:

1.	Construct Python programs using data types and looping.
2.	Design object-oriented Python programs using classes and objects.
3.	Design useful stand-alone and CGI applications in

UNIT-I

Functions, Classes and OOP	**15 Hours**

Functions: Design with functions: hiding redundancy, complexity; arguments and return values; formal vs actual arguments, named arguments. Program structure and design. Recursive functions

Classes and OOP: Classes, objects, attributes and methods; defining classes; design with classes, data modelling; persistent storage of objects, inheritance, polymorphism, operator overloading (_eq_, _str_, etc); abstract classes; exception handling, try block

UNIT-II

Lists, Tuples, and Dictionaries	**14 Hours**

Lists, tuples, and dictionaries: Basic list operators, replacing, inserting, removing an element; searching and sorting lists; dictionary literals, adding and removing keys, accessing, and replacing values; traversing dictionaries.

File Handling: Reading From Text Files, Writing to Text Files, Working with Excel Sheets ,CSV, PDF, Word,

UNIT-III

Essential Python Libraries	**11 Hours**

Working with SciPy, Numpy, Matplotlib, Pandas.

Graphical user interfaces: event-driven programming paradigm; creating simple GUI; buttons, labels, entry fields, dialogs; widget attributes - sizes, fonts, colors layouts, nested frames Simple CGI form.

Course Outcomes: At the end of the course student will be able to

1.	Demonstrate the basics of Python programming like data types and looping
2.	Apply the basic data structures in solving the problems
3.	Experiment with usage of functions in a given problem
4.	Develop Objects by creating classes and apply object-oriented features
5.	Develop applications in Python using File Programming &User Interface

Course Outcomes Mapping with Program Outcomes

Program Outcomes→ ↓ Course Outcomes	1	2	3	4	5	6	7	8	9	10	11	12
IS2502-1.1	2	-	-	-	2	-	-	-	-	-	-	3
IS2502-1.2	2	-	-	-	2	-	-	-	-	-	-	3
IS2502-1.3	2	-	-	-	2	-	-	-	-	-	1	3
IS2502-1.4	-	-	-	-	-	-	-	-	-	-	-	-
IS2502-1.5	-	-	-	-	-	-	-	-	-	-	-	-

1: Low 2: Medium 3: High

TEXTBOOKS:

1.	Kenneth A. Lambert, "The Fundamentals of Python: First Programs", 2011, Cengage Learning, ISBN: 978-1111822705.

SOFTWARE ENGINEERING PRACTICES

Course Code:	**IS2503-1**	**Course Type**	**OEC**
Teaching Hours/Week (L: T: P: S)	**3:0:0:0**	**Credits**	**03**
Total Teaching Hours	**40**	**CIE + SEE Marks**	**50+50**
Prerequisite	**CS1002-1**		

Teaching Department: Information Science & Engineering

Course Objectives:

1.	Outline software engineering principles and activities involved in building large software programs.
2.	Explain the importance of architectural decisions in designing the software.
3.	Describe the process of Agile project development.
4.	Recognize the importance of software testing and describe the intricacies involved in software evolution.
5.	Identify several project planning and estimation techniques and explain the importance of software quality.

UNIT-I

Introduction	**15 Hours**
Need for Software Engineering, Professional Software Development, Software Engineering Ethics, Case Studies.	
Software Processes	
Models: Waterfall Model, Incremental Model and Spiral Model; Process activities	
Requirements Engineering	
Functional and non-functional requirements, Requirements engineering processes, Requirements Elicitation and Analysis, Requirements specification, Software requirements document, Requirements validation & management.	

UNIT-II

System Models	**15 Hours**
Context models, Interaction models, Structural models, Behavioral models.	
T Architectural Design	
Architectural design decisions. Architectural Views and patterns, Application architectures.	
Design and implementation	
Object oriented Design using UML.	
Agile Software Development	
Agile methods, Plan-driven and agile development, Extreme Programming, Agile project management.	

UNIT-III

Project Management	**10 Hours**
Risk management, Teamwork.	
Project Planning	
Software pricing, Plan-driven development, Project Scheduling.	
Quality Management	

Software quality, Reviews and inspections, Software measurement and metrics, Software standards.

Course Outcomes: At the end of the course student will be able to

1.	Recognise the basics of software system, component, process and Software Requirement Specification to meet desired needs within realistic constraints and outline the professional and ethical responsibility
2.	Describe the waterfall, incremental and iterative models and architectural design in implementing the software
3.	Make use of the techniques, skills, modern engineering design tools and agile methods necessary for engineering practice.
4.	Describe the methods for maintaining software system.
5.	Discuss project planning and management and illustrate the quality of software products

Course Outcomes Mapping with Program Outcomes

Program Outcomes→ **↓ Course Outcomes**	1	2	3	4	5	6	7	8	9	10	11	12
IS2503-1.1	-	3	1	-	-	-	-	2	-	-	-	-
IS2503-1.2	1	3	1	-	-	-	-	-	-	-	-	-
IS2503-1.3	1	1	3	-	-	-	-	-	-	-	-	-
IS2503-1.4	1	3	2	-	-	-	-	-	-	-	-	-
IS2503-1.5	1	2	2	-	-	-	-	-	-	-	-	-

1: Low 2: Medium 3: High

TEXTBOOKS:

1.	Ian Sommerville, “Software Engineering”, 9th Edition, Pearson Education, 2012.

REFERENCE BOOKS:

1.	Roger S. Pressman: “Software Engineering-A Practitioners approach”, 7th Edition, Tata McGraw Hill, 2017.
2.	Pankaj Jalote: “An Integrated Approach to Software Engineering”, Wiley, India, 2010.

E Books / MOOCs/ NPTEL

1.	http://agilemanifesto.org/
2.	http://www.jamesshore.com/Agile-Book/
3.	https://www.mooc-list.com/course/uml-class-diagrams-software-engineering-edx
4.	https://www.mooc-list.com/course/enterprise-software-lifecycle-management-edx

WEB TECHNOLOGIES

Course Code:	**IS2504-1**	**Course Type**	**OEC**
Teaching Hours/Week (L: T: P: S)	**3:0:0:0**	**Credits**	**03**
Total Teaching Hours	**40**	**CIE + SEE Marks**	**50+50**
Prerequisite	**CS1002-1**		

Teaching Department: Information Science & Engineering

Course Objectives:

1.	Illustrate the Semantic Structure of HTML and CSS
2.	Compose forms and tables using HTML and CSS
3.	Design Client-Side programs using JavaScript and Server-Side programs using PHP
4.	Illustrate the Database connectivity using PHP
5.	Examine JavaScript frameworks such as jQuery

UNIT-I

Introduction to HTML — **15 Hours**

HTML tags and simple HTML forms, web site structure, HTML table, Need for CSS, introduction to CSS, basic syntax and structure, using CSS, background images, colours and properties, manipulating texts, using fonts, borders and boxes, margins, padding lists, positioning using CSS, Selectors, The Cascade: How Styles Interact, The Box Model, CSS Text Styling.

UNIT-II

Client side Scripting — **15 Hours**

Introduction to JavaScript: JavaScript language – declaring variables, scope of variables functions, event handlers (on click, on submit etc.), Document Object Model, Form validations. Introduction to PHP: Declaring variables, data types, arrays, strings, operations, expressions, control structures, functions, Reading data from web form controls like Text Boxes, radio buttons, lists etc.,

UNIT-III

PHP Databases — **10 Hours**

Basic command with PHP examples, Connection to server, creating database, selecting a database, listing database, listing table names creating a table, inserting data, altering tables, queries, deleting database, deleting data and tables, File Handling in PHP, PHP Arrays and Superglobals, Arrays, $_GET and $_POST Superglobal Arrays, jQuery Introduction: What is jQuery, Adding jQuery in to your web pages, jQuery Syntax, jQuery Selectors, jQuery Events.

Course Outcomes: At the end of the course student will be able to

1.	Adapt HTML and CSS syntax and semantics to build web pages
2.	Construct and visually format tables and forms using HTML and CSS.
3.	Experiment with the usage of Event handling and Form validation using JavaScript.
4.	Understand the principles of object-oriented development using PHP and Database concepts.

5.	Inspect JavaScript frameworks like jQuery which facilitates developers to focus on core features.

Course Outcomes Mapping with Program Outcomes

Program Outcomes→ / ↓ Course Outcomes	1	2	3	4	5	6	7	8	9	10	11	12
IS2504-1.1	1	2	-	2	-	-	-	-	-	-	-	1
IS2504-1.2	1	-	-	2	-	-	-	-	-	-	-	1
IS2504-1.3	1	2	-	2	3	-	-	-	-	-	-	1
IS2504-1.4	1	2	-	2	3	-	-	-	-	-	-	1
IS2504-1.5	1	-	-	2	3	-	-	-	-	-	-	1

1: Low 2: Medium 3: High

TEXTBOOKS:

1.	Randy Connolly, Ricardo Hoar, "Fundamentals of Web Development", 1st Edition, Pearson Education India. (ISBN:978-9332575271).

E Books / MOOCs/ NPTEL

1.	nptel.ac.in/courses/106105084/11

GRAPH THEORY

Course Code:	**MA1501-1**	**Course Type**	**OEC**
Teaching Hours/Week (L: T: P: S)	**3:0:0:0**	**Credits**	**03**
Total Teaching Hours	**40**	**CIE + SEE Marks**	**50+50**

Teaching Department: Mathematics

Course Objectives:

1.	Explain subgraphs, bipartite graphs, isomorphic graphs etc. Apply the concept of trees and its properties
2.	Distinguish between Hamilton and Eulerian graph. Distinguish between planar and nonplanar graphs and apply their properties to solve problems.
3.	Represent a graph in terms of adjacency matrix, incidence matrix etc. and vice-versa.
4.	Find the shortest path between two vertices in a graph. Find minimal spanning tree.

UNIT-I

Introduction to graphs	**15 Hours**
Graphs and Graph Models, digraphs, Konigsberg bridge problem. Special Types of Graphs: Subgraphs-spanning and induced subgraphs, complete graph, Bipartite Graphs. Isomorphism of graphs. Complement of a graph and its properties. Connectivity-point and line connectivity. Trees and its properties. Euler and Hamilton graphs and their applications.	

UNIT-II

Planar graphs	**09 Hours**
Euler's polyhedron formula, outer planar graphs, applications	
Colorability	**07 Hours**
Chromatic number, five color theorem, chromatic polynomial, Applications of graph coloring.	
Matrix representation of graphs	
Adjacency matrix, incidence matrix, circuit matrix, cut set matrix, Path matrix.	

UNIT-III

Network Flows	**04 Hours**
Max -flow and Min-cut Theorem(statement), problems.	
Shortest paths in weighted graphs	
Dijkstra's algorithm to find shortest paths.	
Spanning trees	**05 Hours**
Algorithms to find a spanning tree, minimal spanning tree-Kruskal's & Prim's algorithm.	

Course Outcomes: At the end of the course student will be able to

1.	Distinguish between bipartite and complete bipartite graphs, identify whether two graphs are isomorphic, find subgraphs of a graph etc.
2.	Distinguish between Eulerian and Hamiltonian graphs.
3.	Identify whether a graph is planar and to find the chromatic polynomial of a graph.
4.	Representing graphs interms of Matrices.
5.	Apply algorithmic methods to find the shortest path between two given vertices. Use a suitable algorithm to find a minimal spanning tree.

Course Outcomes Mapping with Program Outcomes

Program Outcomes→ **↓ Course Outcomes**	1	2	3	4	5	6	7	8	9	10	11	12
MA1501-1.1	3	3	-	-	-	-	-	-	-	-	-	-
MA1501-1.2	2	1	-	-	-	-	-	-	-	-	-	-
MA1501-1.3	2	3	-	-	-	-	-	-	-	-	-	-
MA1501-1.4	3	2	-	-	-	-	-	-	-	-	-	-
MA1501-1.5	3	2	-	-	-	-	-	-	-	-	-	-

1: Low 2: Medium 3: High

TEXTBOOKS:

1. F. Harary, "Graph theory", Narosa Publishing House, 1988.

2. Narsing Deo, "Graph Theory with applications to Engg. and Comp. Sciences", PHI,1974.

3. Kenneth H. Rosen, "Discrete Mathematics and its applications", Tata McGraw Hill, VEdition-2003.

REFERENCE BOOKS:

1. D. B. West, "Introduction to Graph Theory", PHI,2001.

2. Chartrand and Zhang, "First Course in Graph Theory", 2012

E Books / MOOCs/ NPTEL

1. http://diestel-graph-theory.com.

2. https://nptel.ac.in/courses/111106102

NUMBER THEORY

Course Code:	**MA1502-1**	**Course Type**	**OEC**
Teaching Hours/Week (L: T: P: S)	**3:0:0:0**	**Credits**	**03**
Total Teaching Hours	**40**	**CIE + SEE Marks**	**50+50**

Teaching Department: Mathematics

Course Objectives:

1.	Understand the divisibility of integers, study of prime numbers and basic properties of congruences.
2.	Study Fermat's little theorem and understand Euler's function.
3.	Study the existence of primitive roots and quadratic residues.
4.	Study the cryptographic applications in number theory.

UNIT-I

Divisibility and the theory of congruences	**15 Hours**

Division algorithm, Euclid's algorithm for the greatest common divisor. Linear Diophantine equations. Prime numbers, fundamental theorem of arithmetic. Basic properties of congruences, Linear congruences and Chinese reminder theorem.

UNIT-II

	07 Hours

Fermat’s theorem, Wilson’s theorem, Euler’s Phi function, Euler’s theorem.

Primitive roots and Quadratic congruences	**08 Hours**

Order of an integer modulo n, primitive roots for primes, Euler’s criterion, Legendre symbol and its properties.

UNIT-III

Cryptography	**10 Hours**

Introduction to public key cryptography, RSA cryptosystem, an application of primitive roots to cryptography.

Course Outcomes: At the end of the course student will be able to

1.	Use divisibility and Greatest common divisor in Euclidean algorithm. Solve Diophantine equations. Identify prime factorization of an integers.
2.	Understand the properties of congruences. Use Chinese reminder theorem to find solution of system of linear congruences
3.	Use Fermat's Little Theorem and Wilson's Theorem. Use of Euler’s Phi function.
4.	Identify primitive roots of an integers. Apply Euler’s criterion and Legendre symbols.
5.	Code and decode numbers in the RSA cryptosystem.

Course Outcomes Mapping with Program Outcomes

Program Outcomes→ / ↓ Course Outcomes	1	2	3	4	5	6	7	8	9	10	11	12
MA1502-1.1	2	3	-	-	-	-	-	-	-	-	-	-
MA1502-1.2	2	3	-	-	-	-	-	-	-	-	-	-
MA1502-1.3	2	3	-	-	-	-	-	-	-	-	-	-
MA1502-1.4	2	3	-	-	-	-	-	-	-	-	-	-
MA1502-1.5	2	3	-	-	-	-	-	-	-	-	-	-

1: Low 2: Medium 3: High

TEXTBOOKS:

1.	D. Burton, "Elementary Number Theory", McGraw-Hill, 2005.
2.	Niven, H.S. Zuckerman & H.L. Montgomery, "Introduction to the Theory of Numbers", Wiley, 2000.

REFERENCE BOOKS:

1.	H. Davenport, "The Higher Arithmetic", Cambridge University Press, 2008.
2.	G. A. Jones & J. M. Jones, "Elementary Number Theory", Springer UTM, 2007.
3.	Thomas Koshy, "Elementary Number Theory with Applications", 2nd edition, Elsevier, 2007.
4.	William J. LeVeque, "Fundamentals of Number Theory".

E Books / MOOCs/ NPTEL

1.	http://refkol.ro/matek/mathbooks/ro.math.wikia.com%2520wiki%2520Fisiere_pdf_incarcate/ Elementary-Number-Theory.pdf
2.	https://nptel.ac.in/courses/111104138
3.	https://nptel.ac.in/courses/111103020

LINEAR ALGEBRA

Course Code:	**MA3501-1**	**Course Type**	**OEC**
Teaching Hours/Week (L: T: P: S)	**3:0:0:0**	**Credits**	**03**
Total Teaching Hours	**40**	**CIE + SEE Marks**	**50+50**
Prerequisite	**MA1001-1 and MA2009-1**		

Teaching Department: Mathematics

Course Objectives:

1.	Understand the concepts of vectors, bases.
2.	Determine the kernel, range, rank, and nullity of a linear transformation and apply them suitably in their field of study.
3.	Find the canonical forms and appraise its importance in various fields.
4.	Make use of Gram-Schmidt process to produce an orthonormal basis.
5.	Learn the concepts of singular value decomposition and PCA.

UNIT-I

Vector spaces	**08 Hours**
Vector spaces, subspaces, bases and dimensions, coordinate vecotrs, null spaces and column spaces of the matrices.	
Linear Transformations	**07 Hours**
Linear transformations, rank-nullity theorem, algebra of linear transformations, change of basis, linear operators, linear functionals, transpose of a linear transformation.	

UNIT-II

Canonical Forms	**08 Hours**
Review of characteristic values, similarity of matrices, Cayley Hamilton theorem, annihilating polynomials, invariant subspaces, Jordan and rational canonical forms.	
Inner Product Spaces	**07 Hours**
Inner products; inner product spaces; orthogonal sets and projections; Gram-Schmidt process; QR-factorization, Least-squares problems.	

UNIT-III

Symmetric Matrices and Quadratic Forms	**10 Hours**
Diagonalization, quadratic forms, constrained optimization, singular value decomposition and principal component analysis. Applications to linear recurrence relations.	

Course Outcomes: At the end of the course student will be able to

1.	Interpret vectors in two and three-dimensional spaces both algebraically and geometrically.
2.	Analyze the concept of a linear transformation as a mapping from one vector space to another and be able to calculate its matrix representation with respect to standard and nonstandard bases.
3.	Understand the concepts of Jordan and rational canonical forms.
4.	Make use of Gram-Schmidt process to produce an orthonormal basis and also able to use least square approximation method to obtain the solution of ill conditioned system.

5.	Apply techniques of constrained optimization singular value decomposition and PCA for problems arising in various engineering fields.

Course Outcomes Mapping with Program Outcomes

Program Outcomes→ / **↓ Course Outcomes**	1	2	3	4	5	6	7	8	9	10	11	12
MA3501-1.1	3	2	-	-	-	-	-	-	-	-	-	-
MA3501-1.2	2	2	-	-	-	-	-	-	-	-	-	-
MA3501-1.3	3	1	-	-	-	-	-	-	-	-	-	-
MA3501-1.4	3	2	-	-	-	-	-	-	-	-	-	-
MA3501-1.5	3	2	-	-	-	-	-	-	-	-	-	-

1: Low 2: Medium 3: High

TEXTBOOKS:

1.	Kenneth Hoffman and Ray Kunze, "Linear Algebra," 2nd edition, Pearson Education (Asia) Pte. Ltd, 2004.
2.	David C. Lay, “Linear Algebra and its Applications”,3rd edition, Pearson Education (Asia) Pte. Ltd, 2005.

REFERENCE BOOKS:

1.	M. Artin, "Algebra", Prentice Hall of India, 2004.
2.	Gilbert Strang, “Linear Algebra and its Applications”, 4th edition, Thomson Learning Asia, 2003.
3.	Bernard Kolman and David R. Hill, “Introductory Linear Algebra with Applications”, Pearson Education (Asia) Pte.Ltd, 7th edition ,2003.
4.	Sheldon Axler, “Linear Algebra Done Right”, Springer International Publication, Third Edition, 2015.

AUTOMOTIVE ENGINEERING

Course Code:	**ME1501-1**	**Course Type**	**OEC**
Teaching Hours/Week (L: T: P: S)	**3:0:0:0**	**Credits**	**03**
Total Teaching Hours	**40**	**CIE + SEE Marks**	**50+50**

Teaching Department: Mechanical Engineering

Course Objectives:

1.	Get an idea on the different components of an engine and its types with lubrication system.
2.	Understand the fuel supply system and ignition systems used in automobiles.
3.	Demonstrate the working of transmission system.
4.	Explain the importance of suspension system, steering geometry and drives in automobiles
5.	Know the concept of braking system, tyres and emission control.

UNIT-I

Engine Components and Cooling & Lubrication Systems	**08 Hours**

SI & CI engines, Cylinder arrangements and their relative merits, Liners, Piston, connecting rod, crankshaft, valves, valve actuating mechanisms, valve and port timing diagrams, Choice of materials for different engine co mponents, engine positioning, cooling requirements, methods of cooling, thermostat valves, different lubrication arrangements, crankshaft/flywheel position sensor, accelerator pedal sensors, engine coolant water temperature sensor.

Fuel Supply Systems for SI and CI Engines	**08 Hours**

Fuel mixture requirements for SI engines, types of carburetors, si mple carburetor, multi point and single point fuel injection systems, CRDI, fuel transfer pumps: AC Mechanical Pump, SU Electrical Pumps, injectors, Fuel gauge sensor, Throttle position sensor, Mass air flow sensors.

Ignition Systems : Battery Ignition systems, magneto Ignition system, Transistor assisted contacts. Electronic Ignition, Automatic Ignition advance systems, Lighting systems, Rain/Light sensors, starting device (Bendix drive)

Pedagogy: Chalk and talk method, Power Point Presentation

UNIT-II

Power Trains	**07 Hours**

Clutches - Single plate, multiplate and centrifugal clutches. Gear box: Necessity for gear ratios in transmission, Constant m esh gear box, Synchromesh gear box, principle of automatic transmission, Vehicle Speed Sensors, calculation of gear ratios, Types of transmission systems. No numerical.

Drive to Wheels	**08 Hours**

Propeller shaft, universal joints, Hotchkiss. and torque tube drives, differential, rear axle, steering geometry, camber, king pin inclination, included angle, castor, toe in & toe out, condition for exact steering, power steering, over steer, under steer & neutral steer, Steering angle sensors, numerical problems.

Suspension and Springs: Requirements, leaf spring, coil spring, Torsion bar suspension systems, independent suspension for front Wheel, Air suspension system. Collective

bargaining; Characteristics, Necessity, Forms Safety & Health; Industrial accidents, Safety Quality circle; Meaning, Structure
Pedagogy: Chalk and talk method, Power Point Presentation

UNIT-III

Brakes	**09 Hours**

Types of brakes, mechanical, compressed air, vacuum and hydraulic braking systems, construction and working of master and wheel cylinder, brake shoe arrangements, Disk brakes, Drum brakes.
Tyres: Desirable tyre properties, Types of tyres.
Automotive Emission: Automotive exhaust emissions, sources and emission control method: EGR, SCR, Emission Standards, Exhaust sensors.
Electric Vehicles.
Pedagogy Chalk and talk method, Power Point Presentation

Course Outcomes: At the end of the course student will be able to

1.	Describe and demonstrate the layout of an automobile and components of an automobile engine. Explain cooling and lubrication systems.
2.	Explain and demonstrate the fuel supply and Ignition systems for SI and CI engines.
3.	Describe and demonstrate the transmission system
4.	Explain and demonstrate the components of drive to wheel and suspension system, calculate the parameters of steering geometry.
5.	Describe and demonstrate automotive braking system. Explain types and construction of tyres and wheels. Explain the significance of automotive emissions and its controlling methods

Course Outcomes Mapping with Program Outcomes

Program Outcomes→ / **↓ Course Outcomes**	1	2	3	4	5	6	7	8	9	10	11	12
ME1501-1.1	3	1	-	-	-	1	-	-	3	1	-	1
ME1501-1.2	3	1	-	-	-	1	-	-	3	1	-	1
ME1501-1.3	3	1	1	-	-	1	-	-	3	1	-	1
ME1501-1.4	2	3	1	-	-	1	-	-	3	1	-	1
ME1501-1.5	3	1	1	-	-	1	1	1	3	1	-	1

1: Low 2: Medium 3: High

TEXTBOOKS:

1.	S. Srinivasan, "Automotive Mechanics", Tata McGraw Hill, 2003.
2.	Kirpal Singh, "Automobile Engineering", Vol I and II, 2013.
3.	A. K. Babu, "Automotive Electrical and Electronics", Khanna Publishers, 2nd edition, 2016.

REFERENCE BOOKS:

1.	R. B. Gupta, "Automobile Engineering", Satya Prakashan, 4th Edn., 1984 .
2.	Naran G, "Automobile Engineering", Khanna Publishers 2002

INDUSTRIAL POLLUTION CONTROL

Course Code:	**ME1502-1**	**Course Type**	**OEC**
Teaching Hours/Week (L: T: P: S)	**3:0:0:0**	**Credits**	**03**
Total Teaching Hours	**40**	**CIE + SEE Marks**	**50+50**

Teaching Department: Mechanical Engineering

Course Objectives:

1.	Know the Consequences of pollution, relationship between man and environment over the last few decades, necessity of modern awareness on pollution and how carbon audit can help in developing a carbon strategy.
2.	Identify the Importance of Meteorology in pollution control and global warming, various types of plume dispersions and its effect; analyze various levels of plume height for different pollutants.
3.	Distinguish Particulates and fly ash separation techniques such as cyclone separator, electrostatic precipitator efficiency calculations etc.
4.	Illustrate Formation, measurement and control techniques for Smoke and gaseous pollutants.
5.	Summarize the Effects of water, soil, plastics and odor pollution their control techniques, Different Pollution Control Acts, Legal aspects of pollution control and how these acts can help in bringing down the pollution rate.

UNIT-I

Introduction to Pollution — **08 Hours**

Man and the environment, types of pollution and its consequences, Changing environmental management concept, sustainable industrial growth, carbon audit, Ill effects of various pollutants, permissible concentration levels & AQI.

Meteorology — **08 Hours**

Meteorology, Wind rose, Lapse rate, plume dispersion studies & Numerical problems.
Pedagogy: Chalk and talk method, Power Point Presentation

UNIT-II

Separation techniques — **08 Hours**

Different types of Particulates, Need for Separation techniques, Sources of Particulates Matter Fly Ash Electrostatic precipitator (Problems) Theory of settling processes (Design Problems), Bag House fabric filter Cyclone separator Spray Tower Scrubbers & Venturi Scrubber

Smoke and gaseous pollutants: — **08 Hours**

Smoke- White, blue and black smoke, Sources of smoke, T,T,T-O Principle of smoke Measurement of stack smoke intensity using Ringlemann Chart and Smokescope &Bosch Smoke meter, Domestic and Industrial Incinerators-Design factors, Pollutant gaseous So2, Co, UBHC, Nox their ill effects and & control methods.
Pedagogy: Chalk and talk method, Power Point Presentation

UNIT-III

	08 Hours
Water, soil, noise, and odor pollution, their control methods, problems associated with nuclear reactors, Legal aspects of pollution control in India, brief details of Euro and BS standards Pedagogy: Chalk and talk method, Power Point Presentation	

Course Outcomes: At the end of the course student will be able to

1.	Identify the various types of pollutants and distinguish between them with regards to Particulate matters and AQI.
2.	Outline the instruments for Meteorological measurements, distinguish types of plume dispersions and its effect; analyze the concentration of various gaseous pollutants from T-Z diagrams
3.	Explain the Particulates and fly ash separation techniques, compare and Interpret their efficiency
4.	Illustrate Formation, measurement and control techniques for Smoke and gaseous pollutants
5.	Identify Effects of water, soil, plastics and odor pollution on environmental Pollution and explain the Legal aspects of pollution control.

Course Outcomes Mapping with Program Outcomes

Program Outcomes→ / **↓ Course Outcomes**	1	2	3	4	5	6	7	8	9	10	11	12
ME1502-1.1	1	-	-	1	-	3	3	2	1	2	-	3
ME1502-1.2	1	2	1	1	3	2	3	1	1	1	-	2
ME1502-1.3	1	2	2	1	1	2	3	1	1	1	-	1
ME1502-1.4	1	1	1	1	1	2	3	1	1	1	-	2
ME1502-1.5	1	-	-	1	-	2	3	1	1	1	-	3

1: Low 2: Medium 3: High

TEXTBOOKS:

1.	“Environmental Pollution Control Engineering", Wiley Eastern Ltd.,
2.	Gilbert M Masters, “Introduction to Environmental Engineering & Science”, PHI,1995
3.	C. S Rao, “Environmental Pollution Control Engineering", New Age Int.

REFERENCE BOOKS:

1.	Henry C. Perkins, “Air Pollution”, Mc-Graw Hill, 1974.
2.	W. L. Faith, “Air Pollution control”, John Wiley

E Books / MOOCs/ NPTEL

1.	http://nptel.ac.in/courses/105106119/36

SUSTAINABLE DEVELOPMENT GOALS

Course Code:	**ME1503-1**	**Course Type**	**OEC**
Teaching Hours/Week (L: T: P: S)	**3:0:0:0**	**Credits**	**03**
Total Teaching Hours	**40**	**CIE + SEE Marks**	**50+50**

Teaching Department: Mechanical Engineering

Course Objectives:

1.	To provide the knowledge, skills, attitudes and values necessary to address sustainable development challenges
2.	Address the global challenges including poverty, inequality, climate change, environmental degradation, peace and justice.
3.	To learn more and take action.
4.	Addresses critical global challenges put forth by UN.
5.	Analyze how sustainable development can be achieved in practice.

UNIT-I

08 Hours

The origin, development and idea of the SDGs History and origins of the Sustainable Development Goals. What are the SDGs? What are their aims, methodology and perspectives? How are they related to the Millennium Development Goals?

SDGs and Society — **08 Hours**

Ensuring resilience and primary needs in society In-depth discussion and analysis of goals related to poverty, hunger, health & well-being and education

Pedagogy: Chalk and talk method, Power Point Presentation

UNIT-II

SDGs and Society — **14 Hours**

Strengthening Institutions for Sustainability In-depth discussion and analysis of goals related to gender equality, affordable and clean energy, sustainable cities & communities, and peace, justice & strong institutions

SDGs and the Economy: Shaping a Sustainable Economy In-depth discussion and analysis of goals related to work & economic growth, industry, innovation & infrastructure, inequalities, responsible production & consumption

Pedagogy: Chalk and talk method, Power Point Presentation

UNIT-III

SDGs and the Biosphere — **10 Hours**

Development within Planetary Boundaries In-depth discussion and analysis of goals related to clean water, climate, life below water and life on land

Realizing the SDGs: Implementation through Global Partnerships In-depth discussion and analysis of SDG 17 which aims to implement the SDGs through partnerships, finance, technology and the development of coherence between policies.

Pedagogy: Chalk and talk method, Power Point Presentation

Course Outcomes: At the end of the course student will be able to

1.	Summarize the UN‟s Sustainable Development Goals and how their aims, methodology and perspectives.
2.	Analyze the major issues affecting sustainable development and how sustainable development can be achieved in practice.
3.	Identify and apply methods for assessing the achievement/possibilities of sustainable development in Nitte gram panchayath.
4.	Evaluate the implications of overuse of resources, population growth and economic growth. sustainability & Explore the challenges the society faces in making transition to renewable resource use.
5.	Create skills that will enable students to understand attitudes on individuals, society and their role regarding causes and solutions in the field of sustainable development.

Course Outcomes Mapping with Program Outcomes

Program Outcomes→ / **↓ Course Outcomes**	1	2	3	4	5	6	7	8	9	10	11	12
ME1503-1.1	1	2	1	1	1	3	3	1	1	1	-	2
ME1503-1.2	2	2	1	1	1	3	3	2	1	1	-	1
ME1503-1.3	3	2	2	1	1	3	3	2	3	1	-	1
ME1503-1.4	3	2	3	1	1	3	3	2	1	1	-	1
ME1503-1.5	1	2	2	1	1	3	3	2	2	2	-	1

1: Low 2: Medium 3: High

TEXTBOOKS:

1.	Sachs, Jeffrey D. "The age of sustainable development" Columbia University Press, 2015
2.	Gagnon, B., Leduc, R., and Savard, L., "Sustainable development in engineering: a review of principles and definition of a conceptual framework", Cahier de recherche / Working Paper 08-18, 2008.

REFERENCE BOOKS:

1.	Elliott, Jennifer, "An introduction to sustainable development", Routledge, 2012.

E Books / MOOCs/ NPTEL

1.	https://www.un.org/sustainabledevelopment/poverty/

TECHNOLOGICAL INNOVATION

Course Code:	**ME1504-1**	**Course Type**	**OEC**
Teaching Hours/Week (L: T: P: S)	**3:0:0:0**	**Credits**	**03**
Total Teaching Hours	**40**	**CIE + SEE Marks**	**50+50**

Teaching Department: Mechanical Engineering

Course Objectives:

1.	Understand basics of operations management and Quality.
2.	Define the concept of technological innovation.
3.	Discuss Innovation management and the difference between Invention and Innovation.
4.	Appreciate the importance of Innovation as a management process and Innovation management techniques.
5.	Discuss the Innovation system, Understand the importance of Technology management and Transfer and basics of Technological Forecasting.

UNIT-I

Production and Operations Management and Introduction to Quality Concepts — **04 Hours**

Production and Operations Management: Introduction - Functions within business organizations - the operation management function - Classification of production systems.
Introduction to Quality Concepts: The Meaning of Quality and Quality Improvement - Key dimensions of Quality - Concept of cost of quality - Customers' perception of quality.

Introduction to Technological Innovation — **09 Hours**

Basic Concepts and Definitions: Technology - Technology Management – Invention – Creativity – Innovation - The Concept of Technological Innovation - Innovation Posture, Propensity and Performance - Innovation Measurement - Key factors linking creativity and innovation – Classifications of Innovations – Innovation Process.

Startup Idea Pitching — **03 Hours**

UNIT-II

Introduction to Innovation Management and Innovation & Competitiveness — **07 Hours**

Introduction to Innovation Management: Innovation Management Through Management of Knowledge and Education – Types of Learning - Difference Between Innovation and Invention - Types and Characteristics of Innovation.
Innovation and Competitiveness: Case Study – Barriers for Innovation and Competitiveness

Innovation as a Management Process — **08 Hours**

Activities to enhance companies' capacity for innovation – Management of Technological Innovation: Corporate Perspective, National Perspective, Theoretical Perspective and Individual Perspective - Challenges in Technological Innovation Management - Case Study in Technological Innovation Management - Innovation Management Techniques (IMTs).

UNIT-III

Innovation Systems and Technology Management & Transfer — **04 Hours**

Innovation Systems: The Concept of Innovation Systems - Innovation Systems: Sectoral, Regional, National.
Technology Management and Transfer: Technology Transfer - Impacts of MNCs in technology transfer

Introduction to Technological Forecasting	**05 Hours**
Introduction - Applications & Limitations of Technological Forecasting – Technology Forecasting Techniques – Exploratory Forecasting – Normative Forecasting – Delphi Technique – Problems of Technological Forecasting	

Course Outcomes: At the end of the course student will be able to

1.	Define operations management and quality.
2.	Describe technological innovation and its key features for business.
3.	Discuss innovation management and the difference between invention and innovation.
4.	Explain innovation as a management process, its management and perspectives. Understand Innovation management techniques.
5.	Explain innovation systems, technology management transfer and basics of technological forecasting.

Course Outcomes Mapping with Program Outcomes

Program Outcomes→ / **↓ Course Outcomes**	1	2	3	4	5	6	7	8	9	10	11	12
ME1504-1.1	3	2	-	-	-	1	1	-	1	-	-	1
ME1504-1.2	3	2	-	-	-	1	1	-	1	-	-	1
ME1504-1.3	2	2	-	-	-	1	1	-	1	-	-	1
ME1504-1.4	2	2	-	-	-	1	1	-	1	-	-	1
ME1504-1.5	3	2	-	-	-	1	1	-	1	-	-	1

1: Low 2: Medium 3: High

TEXTBOOKS:

1.	Carayannis, Elias G., Samara, Elpida T., Bakouros, Yannis L., “Innovation and Entrepreneurship Theory, Policy and Practice”, Springer, 2015.

REFERENCE BOOKS:

1.	Dick Whittington, “Digital Innovation and Entrepreneurship”, Cambridge University Press, 2018.

E Books / MOOCs/ NPTEL

1.	https://krishi.icar.gov.in/jspui/bitstream/123456789/46063/1/21_Technological%20forecasting.pdf dtd 12/06/2022
2.	http://www.oipec.eu/wp-content/uploads/2017/07/Introduction-to-Technology-Forecasting.pdf dtd 12/06/2022

HUMAN RESOURCE MANAGEMENT			
Course Code:	**MG1501-1**	**Course Type**	**OEC**

Teaching Hours/Week (L: T: P: S)	**3:0:0:0**	**Credits**	**03**
Total Teaching Hours	**40**	**CIE + SEE Marks**	**50+50**

Teaching Department: Mechanical Engineering

Course Objectives:

1.	To develop a meaningful understanding of HRM theory, functions and practices.
2.	To understand concepts and skills recruitment.
3.	To understand the concepts of training and development.
4.	To deal with employees' grievances, safety and health types of organizations.
5.	To understand the concepts of e-HRM.

UNIT-I

Human Resource Management & HRP	**08 Hours**
Introduction, meaning, nature, scope of HRM. Major functions of HRM, Personnel Management vs Human Resource Management, job design, job evaluation, job analysis, job specification, job enlargement, job enrichment. Role of HR Manager.HR Planning. Process HRP.	
Recruitment	**08 Hours**
Definition, Sources and Methods of Recruitment Selection: Definition and Process of Selection. Cost benefit analysis of selection. Placement: Meaning, Induction/Orientation, Internal Mobility, Transfer, Promotion, Demotion and Employee Separation. Performance Appraisal methods. Pedagogy: Chalk and talk method, Power Point Presentation	

UNIT-II

Training and development	**07 Hours**
Training v/s development, stages in training, Training Methods, Executive Development, Methods and Development of Management Development, Career and Succession Planning.	
Compensation	**08 Hours**
Employee remuneration, rewards, Wage and Salary Administration, Bonus, fringe benefits. Internal Mobility, External Mobility, Trade union Act (Amendment) 2001. Employee Grievances: Employee Grievance procedure. Discipline procedure Collective bargaining; Characteristics, Necessity, Forms Safety & Health; Industrial accidents, Safety Quality circle; Meaning, Structure Pedagogy: Chalk and talk method, Power Point Presentation	

UNIT-III

IHRM and e-HRM	**09 Hours**
Managing IHRM. e-HR Activities, Global recruitment, selection, expatriates. Industrial conflict –Causes, Types, Prevention and Settlement. Aspects of e-HRM,e-Job design & Analysis, Ethical issues in employment Pedagogy: Chalk and talk method, Power Point Presentation	

Course Outcomes: At the end of the course student will be able to

1.	Describe the basic concepts of HRM & HRP.
2.	Elucidate the HRM functions of recruitment, selections, and appraisal.
3.	Apply the training, development and compensation methods in HRD.

4.	Identify the employee grievances to spell out the remedial measures.
5.	Infer the concepts of e-HRM and I-HRM.

Course Outcomes Mapping with Program Outcomes

Program Outcomes→ / ↓ Course Outcomes	1	2	3	4	5	6	7	8	9	10	11	12
MG1501-1-1.1	3	-	-	-	-	1	-	-	1	1	-	1
MG1501-1-1.2	3	-	-	-	-	1	-	-	1	1	-	1
MG1501-1-1.3	3	-	-	-	-	1	-	-	1	1	-	1
MG1501-1-1.4	3	-	-	-	-	1	-	-	1	1	-	1
MG1501-1-1.5	3	-	-	-	-	1	-	-	1	1	-	1

1: Low 2: Medium 3: High

TEXTBOOKS:

1. P Courseba Rao, "Essentials of Human Resource Management & Industrial Relations", Third Revised Edition.

REFERENCE BOOKS:

1. John M. Ivancevich, "Human Resource Management", 10/e, McGraw Hill.
2. Flippo, "Human Resource Management".

E Books / MOOCs/ NPTEL

1. http://edx.nimt.ac.in/courses/course-v1:nimtX+PGDM1212+2017_H1/about

MANAGEMENT ACCOUNTING AND CONTROL SYSTEM

Course Code:	**MG1502-1**	**Course Type**	**OEC**
Teaching Hours/Week (L: T: P: S)	**3:0:0:0**	**Credits**	**03**
Total Teaching Hours	**40**	**CIE + SEE Marks**	**50+50**

Teaching Department: Management

Course Objectives:

1.	Apply Cost Accounting concepts and techniques in the decision making process.
2.	Make decisions such as pricing, special order pricing, make-or-buy and elimination of a part of the company or replacement of equipment.
3.	Understand the relevance of different types of costs in the decision making process such as relevant costs, sunk costs or controllable costs.
4.	Understand fundamental concepts in Financial, Cost & Management Accounting.
5.	Develop analytical skills associated with the preparation and interpretation of Financial Statement

UNIT-I

Introduction to Cost and Management Accounting and Marginal Costing	**07 Hours**

Cost Accounting – Meaning, Objectives and Scope, Management Accounting – Meaning, Objectives and Scope, Tools and Techniques of Management Accounting, Relationship of Cost Accounting, Financial Accounting, Management Accounting and Financial Management, Conflicts in Profit versus Value Maximization Principle, Role of Management Accountant in Decision Making.

Marginal Costing	**08 Hours**

Meaning, Advantages, Limitations and Applications. Breakeven Analysis, Cost Volume Profit Analysis, P/V Ratio and its Significance, Margin of Safety, Absorption Costing: System of Profit Reporting and Stock Valuation, Difference between Marginal Costing and Absorption Costing, Income Measurement under Marginal Costing and Absorption Costing. (Practical Problems)

UNIT II

Standard Costing and Budgetary Control	**07 Hours**

Standard Costing – Definition, Significance and Applications, Various Types of Standards, Installation of Standard Costing System-for Material, Labour, and Overhead. Variance Analysis for Materials, Labour and Overheads, Accounting Treatment of Variances. Benchmarking for Setting of Standards, Variance Reporting to Management. (Practical Problems)

Budgetary Control	**08 Hours**

Budget Concept, Manual, Fixed and Flexible Budgets, Preparation and Monitoring of Various Types of Budgets, Budgetary Control System- Advantages, Limitations and Installation. Zero Base Budgeting, Programme and Performance Budgeting. (Practical Problems)

UNIT III

Fund Flow and Cash Flow Statement	**05 Hours**

Fund Flow Statement Analysis – Definition, Features, Steps for Preparation of Fund Flow Statement.

Cash Flow Statement Analysis	**05 Hours**

Classification, Preparation of Cash Flow Statement, Uses of Cash Flow statement, Difference between Cash Flow and Fund Flow Statement. (Practical Problems)

Course Outcomes: At the end of the course student will be able to

1.	Describe the Cost Accounting concepts and techniques in the decision making process.
2.	Elucidate the Make decisions such as pricing, special order pricing, make-or-buy and elimination of a part of the company or replacement of equipment.
3.	Apply the relevance of different types of costs in the decision making process such as relevant costs, sunk costs or controllable costs.
4.	Identify fundamental concepts in Financial, Cost & Management Accounting.
5.	Infer the analytical skills associated with the preparation and interpretation of Financial Statement

Course Outcomes Mapping with Program Outcomes

Program Outcomes→ / **↓ Course Outcomes**	1	2	3	4	5	6	7	8	9	10	11	12
MG1502-1-1.1	3	-	-	-	-	1	-	-	1	1	-	1
MG1502-1-1.2	3	-	-	-	-	1	-	-	1	1	-	1
MG1502-1-1.3	3	-	-	-	-	1	-	-	1	1	-	1
MG1502-1-1.4	3	-	-	-	-	1	-	-	1	1	-	1
MG1502-1-1.5	3	-	-	-	-	1	-	-	1	1	-	1

1: Low 2: Medium 3: High

TEXTBOOKS:

1.	M.Y. Khan and P.K. Jain. “Management Accounting”, McGraw-Hill Education
2.	Robert N. Anthony, “Management Accounting”, Richard Dirwin.
3.	I.M. Pandey , “Management Accounting”, Vikas Publishing House.
4.	Paresh shaw, “Management Accounting”, Oxford University Press.
5.	A. Murthy and S. Gurusamy , “Management Accounting”, McGraw Hill.
6.	NM Singhvi and Ruzbeh J. Bodhanwala, “Management Accounting”, PHI learning Pvt. Ltd.

OPERATIONS AND QUALITY MANAGEMENT

Course Code:	**MG1503-1**	**Course Type**	**OEC**
Teaching Hours/Week (L: T: P: S)	**3:0:0:0**	**Credits**	**03**
Total Teaching Hours	**40**	**CIE + SEE Marks**	**50+50**

Teaching Department: Management

Course Objectives:

1.	Define production/operations management. Differentiate between Production and service system and types of production systems Discuss continuous and intermittent production systems with their advantages and disadvantages. Discuss CRM and ERP systems.
2.	Solve problems on fundamentals of statistics and normal distribution. Draw and Analyze variable process control charts and determine process capability.
3.	Discuss Total Quality Management tools and methods. Calculate reliability of series and parallel systems using the information on failure rate and time.
4.	Solve decision-making problems using break even analysis and decision tree methods. Apply the concepts of Design and System capacity. Solve problems on faculty location using break even analysis and transportation method. Solve problems related to product and process layouts.
5.	Use concepts of replacement theory to solve problems of replacing items that fail gradually and suddenly.

UNIT-I

Production and Operations Management — **06 Hours**

Introduction, Functions within business organizations, the operation management function, Classification of production systems, Productivity, factors affecting productivity, Introduction to Customer Relationship Management (CRM) and Enterprise Resource Planning (ERP).

Philosophy of statistical process control and modeling process quality — **11 Hours**

Normal distribution tables, Finding the Z score, Central limit theorem, Chance and assignable causes of variation, Statistical Basis of the Control Charts (basic principles, choices of control limits, significance of control limits, warning limits)

Control charts for variables: Control Charts for X-Bar and R- Charts, Type I and Type II errors, Simple Numerical Problems,

Process capability: The foundation of process capability, Natural Tolerance limits, c_p – process capability index, c_{pk}, p_p – process performance index, summary of process measures. Numerical problems. Concept of Six sigma.

Pedagogy: Chalk and talk method, Power Point Presentation

UNIT II

Quality Concepts and Reliability — **06 Hours**

Introduction to Quality Concepts: The Meaning of Quality and Quality Improvement, Key dimensions of Quality, Concept of cost of quality. Customers' perception of quality.

TOTAL Quality Management: Definition, Principles of TQM, Gurus of TQM, Benefits of TQM.

Managing Quality: Quality circles, Continuous Improvement- Juran's Trilogy, PDSA cycle, Kaizen, 7 QC tools.

Introduction to reliability, Mean time to failure, Mean time between failures, Bath tub curve, Reliability of series and parallel systems, Numerical problems on the above topics.

Operations Management activities	**12 Hours**

Decision Making: The decision process, characteristics of operations decisions, use of models - decision making environments. Break even Analysis, Decision trees.
Capacity Planning: Importance of capacity decisions, defining and measuring capacity, determinants of effective capacity. Design, System an actual capacity. System efficiency and utilization. Determination of Equipment requirement for a single stage production processes. Numerical problems on the above.
Facilities location planning: Need for location decisions, nature of locations decisions, general procedure for making locations decisions, Use of Breakeven analysis and Transportation algorithms for making location decisions.
Facilities layout planning: Need for layout decisions. Minimizing material handling cost in process ayout using Load distance analysis, Simple line balancing problems in product layout.

UNIT III

Replacement Theory	**05 Hours**

Replacement policy for equipment which deteriorates gradually. Replacement of items that fail suddenly.
Pedagogy: Chalk and talk method, Power Point

Course Outcomes: At the end of the course student will be able to

1.	Define production/operations management. Differentiate between Production and service system and types of production systems Discuss continuous and intermittent production systems with their advantages and disadvantages. Discuss CRM and ERP systems.
2.	Solve problems on fundamentals of statistics and normal distribution. Draw and Analyze variable process control charts and determine process capability.
3.	Discuss Total Quality Management tools and methods. Calculate reliability of series and parallel systems using the information on failure rate and time.
4.	Solve decision-making problems using break even analysis and decision tree methods. Apply the concepts of Design and System capacity. Solve problems on faculty location using break even analysis and transportation method. Solve problems related to product and process layouts.
5.	Use concepts of replacement theory to solve problems of replacing items that fail gradually and suddenly.

Course Outcomes Mapping with Program Outcomes

Program Outcomes→ **↓ Course Outcomes**	1	2	3	4	5	6	7	8	9	10	11	12
MG1503-1-1.1	2	1	-	-	-	-	-	-	-	-	2	-
MG1503-1-1.2	2	2	-	-	-	-	-	-	-	-	2	-
MG1503-1-1.3	1	1	-	-	-	-	-	-	-	-	2	-
MG1503-1-1.4	3	2	-	-	-	-	-	-	-	-	3	-
MG1503-1-1.5	1	1	-	-	-	-	-	-	-	-	1	-

1: Low 2: Medium 3: High

TEXTBOOKS:	
1.	Joseph G Monks, "Production / Operations Management", McGraw Hill Books
2.	William J Stevenson, "Production and Operations Management", Tata McGraw Hill, 8th Edition.
3.	RC Gupta, "Statistical Quality Control", Khanna Publishers, New Delhi, 2005.
4.	N.D. Vohra, "Quantitative Techniques in Management", Tata McGraw Hill, 2015
REFERENCE BOOKS:	
1.	E.L. Grant and R.S. Leavenworth, **"**Statistical Quality Control", 7th edition, McGraw-Hill publisher, 2004.
2.	Prem Kumar Gupta, D S. Hira, "Operations Research", S Chand Publications, New Delhi, 2nd edition 2008, Prentice Hall.
3.	W S Messina**, "**Statistical Quality Control for Manufacturing Managers", Wiley & Sons, Inc. New York, 1987
4.	Montgomery, Douglas, "Statistical Quality Control**",** 5th Edition, John Wiley & Sons, Inc. 2005, Hoboken, NJ.
5.	Jerry Banks, "Principles of Quality Control", Wiley & Sons, Inc. New York.

ORGANIZATIONAL BEHAVIOUR

Course Code:	**MG1504-1**	**Course Type**	**OEC**
Teaching Hours/Week (L: T: P: S)	**3:0:0:0**	**Credits**	**03**
Total Teaching Hours	**40**	**CIE + SEE Marks**	**50+50**

Teaching Department: Management

Course Objectives:

1.	Describe the Nature and Characteristics, Determinants and Approaches of Organizational Behaviour. Describe the concepts of Perception, Attitudes and values and their implications.
2.	Describe the concepts of learning and motivation along with their managerial implications.
3.	Describe the concepts of Leadership along with their managerial implications.
4.	Discuss the concepts of group dynamics and conflict management along with their implications.
5.	Discuss the concepts of Organization culture and change and conflict management along with their implications.

UNIT-I

15 Hours

Introduction: Conceptual Foundation of Organisational Behaviour; Nature and Characteristics; Determinants; Contributing Disciplines; Challenges and Opportunities for Organisational Behaviour, Models and Approaches of Organizational Behaviour, OB and Emotional Intelligence.

Perception, Attitude, and Values: Nature, Process, Importance, Factors Influencing Perception; Attribution Theory of Perception; Issues Involved in Perception: Selective Perception, Halo Effect, Contrast Effect, Projection, Stereotyping; Concept of Pygmalion Effect; an overview of Emotions and feelings, Values, Beliefs and Attitudes with Managerial Implications.

Learning: Concept; Theories of Learning: Conditioning, Social Learning, Managerial Implication of Learning Theories. Reinforcement.

Motivation: Concept, Major Theories and Process of Motivation: Maslow's Need-Hierarchy Theory; Herzberg's Motivation-Hygiene Theory; McGregor's Theory X and Theory Y; Goal-Setting Theory; ERG Theory; Vroom's Expectancy Theory; Equity Theory; Managerial implications of Various Theories.

UNIT II

15 Hours

Leadership: Concept and Functions; Style and Theories of Leadership: Traits, Behavioural and Situational/ Contingency Groups of Theories; Inspirational approaches to Leadership; Charismatic Leadership, Transformational Leadership, and Transactional Leadership, Contemporary Leadership Roles; Challenges to the Leadership Construct; Substitutes and Neutralizers to Leadership.

Group Behaviour: Groups: Concept and Classification; Stages of Group Development; Group Structure; Roles and Norms; Premise and Issues; Group Decision-Making: Group vs Individual;

Groupthink and Groups Shift; Group Decision Making Techniques and Process.

Conflict Management: Concept; Causes; Types; Stages; Effects; Management of Conflicts.

UNIT III

10 Hours

Organizational Culture: Concept; Dominant Culture; Strong vs Weak Cultures ; Creating and Sustaining Culture; Employees Learning of The Culture; Creating a Customer-Responsive Culture.
Organizational Changes: Concept and Forces for Change; Managing Planned Changes; Resistance to Change; Approaches to Manage Organizational Change; Organizational Development;
Culture-Boundedness of Managing the Change.

Course Outcomes: At the end of the course student will be able to

1.	Describe the Nature and Characteristics, Determinants and Approaches of Organizational Behaviour. Describe the concepts of Perception, Attitudes and values and their implications.
2.	Describe the concepts of learning and motivation along with their managerial implications.
3.	Describe the concepts of Leadership along with their managerial implications.
4.	Discuss the concepts of group dynamics and conflict management along with their implications.
5.	Discuss the concepts of Organization culture and change and conflict management along with their implications.

Course Outcomes Mapping with Program Outcomes

Program Outcomes→ / **↓ Course Outcomes**	1	2	3	4	5	6	7	8	9	10	11	12
MG1504-1-1.1	2	-	-	-	-	-	-	-	3	1	-	-
MG1504-1-1.2	2	-	-	-	-	-	-	-	3	1	-	-
MG1504-1-1.3	1	-	-	-	-	-	-	-	3	1	-	-
MG1504-1-1.4	3	-	-	-	-	-	-	-	3	1	-	-
MG1504-1-1.5	1	-	-	-	-	-	-	-	-	1	-	-

1: Low 2: Medium 3: High

TEXTBOOKS:

1.	Robbins, SP Stephen P, Timothy Judge and Nehasika Vohra, "Organisational Behaviour", 12th or 16th edition, Pearson Education, 2011.
2.	Fred Luthans, "Organisational Behaviour", 11th edition, Mc Graw Hill, 2009.

REFERENCE BOOKS:

1.	W. Newstrom, John, "Organisational Behaviour", 10th edition, Tata Mc Graw –Hill 2009.
2.	Paul Heresy, Kenneth H. Blanchard, and Dewey E. Johnson, "Management of Organisational Behaviour", Leading Human Resources, 2008.
3.	Dr S S Khanka, "Organisational Behaviour", S. Chand & Co, New Delhi, 2008.
4.	Sanghi Seema, "Organisational Behaviour", Pearson, 2011.

TAXATION FOR ENGINEERS

Course Code:	**MG1505-1**	**Course Type**	**OEC**
Teaching Hours/Week (L: T: P: S)	**3:0:0:0**	**Credits**	**03**
Total Teaching Hours	**40**	**CIE + SEE Marks**	**50+50**

Teaching Department: Management

Course Objectives:

1.	To make students understand the overview of Income Tax Law in India.
2.	To make students understand the basic concepts of income tax such as residential status, tax incidence.
3.	To make students understand the income tax provisions involved in determination of income from salary, House property, business and profession, capital gain and other sources.
4.	To help students understand the determination of tax liability Individual assessees.
5.	To make students understand the deductions u/s 80.

UNIT-I

Basic concepts and Explanation under various Heads of Income	**15 Hours**

Basic concepts: Assessment Year, Previous Year, Person, Assessee, Income, Charges on Income, Gross Total Income, Capital and Revenue Receipts, Residential status, Connotation of income, Deemed to accrue or arise in India, Incidence of tax, Tax Planning, Tax Evasion, Tax Management. (Problems on Residential Status of Individual assessee)

Explanation under various Heads of Income: Income from Salary (theory, basic and full-fledged problems on allowances, perquisites and retirement benefits)

UNIT II

Income under the head Profit and gains of Business or Professions and Income under Capital Gain	**15 Hours**

Income under the head Profit and gains of Business or Professions and its computation - basis - Method of accounting - Scheme of business deductions/ allowance - Deemed profits - maintenance of books, (Problems on computation of Income from Business/ Profession of Individual assessee)

Income under Capital Gain: Basis of charge, Transfer of capital asset, inclusion & exclusion from Capital Asset, Capital Gain, Computation of Capital Gains (theory & problems), Exemptions/deductions from capital gains

UNIT III

Income from House Property and Other Sources	**10 Hours**

Income from House Property - Basic problems on House Property
Income from Other Sources (theory only)
Deductions under section 80C to 80U (No problems - Provisions only)

Course Outcomes: At the end of the course student will be able to

1.	Exhibit an understanding of the Income Tax Law in India.
2.	Identify the nature of Incomes and their tax incidence.
3.	Demonstrate how to determine the income from salary, house property, business and profession, capital gain.

4.	Demonstrate the determination of tax liability of Individual assessees.
5.	Exhibit a clear understanding of various provisions of deductions u/s 80.

Course Outcomes Mapping with Program Outcomes

Program Outcomes→ / **↓ Course Outcomes**	1	2	3	4	5	6	7	8	9	10	11	12
MG1505-1-1.1	2	-	-	-	-	1	-	-	1	-	2	1
MG1505-1-1.2	2	-	-	-	-	1	-	-	1	-	2	1
MG1505-1-1.3	3	-	-	-	-	1	-	-	1	-	2	1
MG1505-1-1.4	3	-	-	-	-	1	-	-	1	-	2	1
MG1505-1-1.5	3	-	-	-	-	1	-	-	1	-	2	1

1: Low 2: Medium 3: High

REFERENCE BOOKS:

1.	Vinod Singhania, "Students Guide to Income Tax", Taxman Publications.
2.	Mehrotra & Goyal, "Direct Tax", Sahitya Bhavan.
3.	Lal & Vashisht, "Direct Tax", Pearson Ed. 28E.
4.	V S Datey, "Indirect Taxes", Taxman Publications.
5.	Vinod Singhania, "Direct Taxes", Taxman Publications.
6.	T N Manoharan, "Students Guide to Income Tax", Snow White.
7.	Kul Bushan, "How to deal with VAT", Pearson Education/PHI, 1/e.
8.	Mahesh Chandra & Shukla , "Income Tax Law & Practice", Pragathi Publications.
9.	Dr.Pillai, "VAT", Jaico Publications.

WORKING CAPITAL MANAGEMENT

Course Code:	**MG1506-1**	**Course Type**	**OEC**
Teaching Hours/Week (L: T: P: S)	**3:0:0:0**	**Credits**	**03**
Total Teaching Hours	**40**	**CIE + SEE Marks**	**50+50**

Need of the Course: The course will enable the student to manage activities in the area of working capital in an enterprise and help the students to do advance study in the field of financial-management through detailed analysis of financial statements, liquidity crises, cash optimization, credit analysis etc. The student will learn how to apply sound techniques for managing inventory.

Description of the Course: Every business needs adequate liquid resources in order to maintain day-to-day cash flow. It needs enough cash to pay wages and salaries as they fall due and to pay creditors if it is to keep its workforce and ensure its supplies. Maintaining adequate working capital is not just important in the short-term. Sufficient liquidity must be maintained in order to ensure the survival of the business in the long-term as well. Even a profitable business may fail if it doesn’t have adequate cash flow to meet its liabilities as they fall due.

Teaching Department: Management

Course Objectives:

1.	Discuss the importance of working capital management.
2.	Evaluate working capital requirement.
3.	Assess the challenges faced in managing working capital in domestic and international operations.
4.	Plan for financing working capital requirement.

UNIT-I

Working Capital Decisions, Working Capital Management and Sources of Working Capital	**15 Hours**

Working Capital Decisions: Meaning, Concepts, components Importance & types of working Capital.
Working Capital Management: Meaning, objectives, Principles, Importance of adequate working capital & consequences of inadequate working capital, Dangers of excessive working capital, determinants of working capital - operating cycle and Cash cycle. Approaches to determine an appropriate financing mix, Estimation of working capital requirements (problems) important working capital ratios.
Sources of Working Capital: Financing of long term working capital & short term working capital. Factoring - Meaning mechanism, Functions, types, merits & demerits.

UNIT II

Liquidity Management and Receivable Management	**15 Hours**

Liquidity Management: Cash Management - Meaning - Objectives of Cash Management - Nature of Cash - Motives of holding cash - Cash Management planning aspects - Cash Budgets (Problems), Cash Management control aspects - Concentration banking - Lock box system - Playing the float - Cash Management models - William J Baumol Model - Miller-Orr Model (Problems using these models)

Receivable Management: Definition, Objectives, cost and benefits of receivable. Credit policy & its variables. Types of Credit policy & their merits & demerits, Factors influencing the size of investment in receivables. Control of receivables. Framing optimum credit policy & Average collection period (Problems)

UNIT III

Inventory Management	**10 Hours**

Meaning of Inventory - Need/Purpose of holding inventory - Benefits of holding inventory - Risk and cost of holding inventory - Management of Inventory - Objectives of Inventory Management - Techniques of Inventory Management - Economic Order Quantity (EOQ) - Determination of Stock levels - ABC analysis - Just in Time (JIT).

Course Outcomes: At the end of the course student will be able to

1.	Understand the meaning of working capital
2.	Realize the importance of management of working capital in an organization
3.	Learn about some key liquidity ratios used to understand more about a business' working capital position
4.	Understand various techniques used to manage working capital.
5.	Be aware of the techniques of cash, inventory and receivables management.

Course Outcomes Mapping with Program Outcomes

Program Outcomes→ **↓ Course Outcomes**	1	2	3	4	5	6	7	8	9	10	11	12
MG1506-1-1.1	2	-	-	-	-	1	-	-	-	1	2	1
MG1506-1-1.2	2	-	-	-	-	1	-	-	-	1	2	1
MG1506-1-1.3	2	-	-	-	-	1	-	-	-	1	2	1
MG1506-1-1.4	2	-	-	-	-	1	-	-	-	1	2	1
MG1506-1-1.5	2	-	-	-	-	1	-	-	-	1	2	1

1: Low 2: Medium 3: High

REFERENCE BOOKS:

1.	Sekhar Satya G.V., "Working Capital Management", 1/e; New Delhi: Wiley, 2014.
2.	Bhalla V. K., "Working Capital Management", 1/e; New Delhi: S. Chand Publishing, 2014.
3.	Sagner James S., "Working Capital Management, Applications and Cases", 1/e, New Delhi: Wiley, 2015.

ENGINEERING ECONOMICS & FINANCIAL MANAGEMENT

Course Code:	**MG1507-1**	**Course Type**	**OEC**
Teaching Hours/Week (L: T: P: S)	**3:0:0:0**	**Credits**	**03**
Total Teaching Hours	**40**	**CIE + SEE Marks**	**50+50**

Teaching Department: Mechanical Engineering

Course Objectives:

1.	Analyse the time value of money.
2.	Evaluate the worth of creations, by comparing the alternatives visa, vis the cost (cost-benefit analysis).
3.	Take decisions with the limited resources, the relevant course of action, with the help of suitable tools.
4.	Determine the depreciated values of assets and also cost involved in each operation, a product should undergo with an aim to fix suitable selling price for the products.
5.	Know the fundamentals of Financial Management.

UNIT-I

Fundamental economic concepts	**07 Hours**
Consumer goods, Producer goods, Factors of production, Economy of organization, Demand theory, Law of demand, Exceptions to law of demand, Law of supply, Determinants of supply, Law of increasing returns and law of diminishing returns(No exercises)	
Interest	**07 Hours**
Rate of interest, Determining rate of interest, Time value of money, Simple interest, Compound interest, Nominal and effective interest rate, Equivalence involving interest, Interest formulae [single payment, uniform series and arithmetic gradient only], problems using interest formulae [discrete compounding only].	

UNIT II

Economic Analysis of Alternatives	**09 Hours**
Analysis based on: Present Worth [equal life and unequal life situations], Future Worth, Equivalent Annual Worth, Exercises. Analysis based on Rate of Return, Exercises.	
Depreciation	**04 Hours**
Causes of depreciation, Depletion, Methods of depreciation [Straight line, Declining balance, Double declining balance] Exercises.	
Estimating and Costing	**03 Hours**
Components of cost [Material cost, Labour cost, Overhead expenses, Prime cost, Factory cost, Total cost], Determination of selling price of a product, Exercises.	

UNIT III

Financial management	**05 Hours**
Terminologies used in accounting, Journal and ledger, Profit and loss statement, Balance sheet, Understanding basic financial ratios, Simple exercises.	
Working Capital Management	**05 Hours**

Factors influencing working capital requirement, determination of operating cycle and working capital.
Capital Budgeting: Risk analysis in Capital Budgeting

Course Outcomes: At the end of the course student will be able to

1.	Explain the fundamental economic concepts.
2.	Use simple interest and compound interest to determine compounded and discounted amount.
3.	Compare the alternatives using Present Worth, Equivalent Annual Worth, Future Worth and IRR methods.
4.	Calculate the depreciated amount of a given assets using Straight line, Declining balance, Double declining g balance method. Estimate the selling price of given product.
5.	Prepare Balance Sheet & Profit and Loss account for given data of a firm. Estimate working capital. Explain capital budgeting.

Course Outcomes Mapping with Program Outcomes

Program Outcomes→ / **↓ Course Outcomes**	1	2	3	4	5	6	7	8	9	10	11	12
MG1507-1.1	3	1	-	-	-	1	-	-	1	1	-	1
MG1507-1.2	2	3	-	-	-	1	-	-	1	1	-	1
MG1507-1.3	2	3	-	-	-	1	-	-	1	1	-	1
MG1507-1.4	2	3	-	-	-	1	-	-	1	1	-	1
MG1507-1.5	2	3	-	-	-	1	-	-	1	1	-	1

1: Low 2: Medium 3: High

TEXTBOOKS:

1.	Riggs J.L., "Engineering Economics", 4th edition, Tata McGraw-Hill, 2004.
2.	Banga and Sharma, "Mechanical Estimating and Costing", 16th edition, Khanna Publishers, 2012.
3.	I M Pandey, "Financial Management", Vikas Publishing House, 2002.

REFERENCE BOOKS:

1.	E Paul Degarmo, "Engineering Economy", Macmillan Publishing, 2001.
2.	Gerald J Thuesen & W J Fabrycky, "Engineering Economy", Prentice Hall of India, 9th ed.
3.	Tarachand, "Engineering Economics", Nemchand & Bros, 1996.

E Books / MOOCs/ NPTEL

1.	http://nptel.ac.in/courses/112107209/

NANOTECHNOLOGY

Course Code:	**PH2501 -1**	**Course Type**	**OEC**
Teaching Hours/Week (L: T: P: S)	**3:0:0:0**	**Credits**	**03**
Total Teaching Hours	**40**	**CIE + SEE Marks**	**50+50**
Prerequisite	**PH1001 -1**		

Teaching Department: PHYSICS

Course Objectives:

1.	To understand the basic scientific concepts of nanoscience, properties of nano materials, synthesis and fabrication of nano materials.
2.	To understand the various characterization techniques of nano materials.
3.	Study of carbon nano technology and its characterizations.
4.	To understand the applications of nano technology in various science, engineering and technology fields.

UNIT-I

Properties of Materials	**07 Hours**
Introduction: History of nano science, definition of nano meter, nanomaterials, nano technology. Classification of nano materials. Crystal symmetries, crystal directions, crystal planes, Band structure. Properties Of Materials: Mechanical properties, electrical properties, dielectric properties, thermal properties, magnetic properties, opto electronic properties. Effect of size reduction on properties, electronic structure of nano materials.	
Synthesis and Fabrication	**08 Hours**
Synthesis of bulk polycrystalline samples, growth of single crystals, Synthesis techniques for preparation of nano particle – Bottom Up Approach – sol gel synthesis, hydro thermal growth, thin film growth, PVD and CVD; Top Down Approach – Ball milling, micro fabrication, lithography, Requirements for realizing semiconductor nano structure, growth techniques for nano structures.	

UNIT-II

Characterization Techniques	**15 Hours**
X-Ray diffraction and Scherrer method, scanning electron microscopy, transmission electron microscopy (TEM), scanning probe microscopy (SEM), atomic force microscopy (AFM), piezoresponse microscopy, X-ray photoelectron spectroscopy, XANES and XAFS, angle resolved photoemission spectroscopy, diffuse reflectance spectra, photoluminescence spectra, UV-VIS-IR Spectrophotometers, Magnetic and electrical measurements and Infrared/ Raman, EPR and NMR	

UNIT-III

Carbon Nano Technology	**05 Hours**
Characterization of carbon allotropes, synthesis of diamond – nucleation of diamond, growth and morphology. Applications of nano crystalling diamond films, grapheme, and applications of carbon nano tubes.	
Applications of Nano Technology	**05 Hours**

Applications in material science, biology and medicine, surface science, energy and environment. Applications of nano structured thin films, applications of quantum dots.

Course Outcomes: At the end of the course student will be able to

1.	Ability to choose the appropriate nano material to meet the requirerment of a particular application.
2.	Identify the essential concepts used in nanotechnology.
3.	Identify the materials, properties, synthesis and fabrication of nanomaterials.
4.	Understand the various characterization techniques of nano materials.
5.	Applications of nanomaterials in various fields

Course Outcomes Mapping with Program Outcomes

Program Outcomes→ **↓ Course Outcomes**	1	2	3	4	5	6	7	8	9	10	11	12
PH2501-1.1	3	3	-	-	-	-	-	-	-	-	-	-
PH2501-1.2	3	3	-	-	-	-	-	-	-	-	-	-
PH2501-1.3	3	3	-	-	-	-	-	-	-	-	-	-
PH2501-1.4	3	3	-	-	-	-	-	-	-	-	-	-
PH2501-1.5	3	3	-	-	-	-	-	-	-	-	-	-

1: Low 2: Medium 3: High

TEXTBOOKS:

1.	M.S. Ramachandra Rao, Shubra Singh, "Nano science and nano technology", Wiley publishers.

REFERENCE BOOKS:

1.	Charles P. Poole, Jr. Frank J. Owens, "Introduction to Nano Technology", Wiley publishers.
2.	Jermy J Ramsden, "Nanotechnology", Elsevier publishers.
3.	A. K. Bandyopadhyay, "Nano Materials", New Age publishers.
4.	T. Pradeep, "Nano Essentials", TMH.
5.	M. A. Shah, "Nanotechnology the Science of Small", Wiley publishers.
6.	Phani Kumar, "Principles of Nanotechnology", Scitech.

E Books / MOOCs/ NPTEL

1.	https://youtu.be/ebO38bbq0_4
2.	https://youtu.be/0MzIh7wkgMs

OPTOELECTRONIC DEVICES

Course Code:	**PH2502-1**	**Course Type**	**OEC**
Teaching Hours/Week (L: T: P: S)	**3:0:0:0**	**Credits**	**03**
Total Teaching Hours	**40**	**CIE + SEE Marks**	**50+50**
Prerequisite	**PH1001 -1**		

Teaching Department: PHYSICS

Course Objectives:

1.	To understand the basic principles of construction, working and applications of various optoelectronic devices.
2.	Study of sources of radiation like lasers and LED, their specific properties and hence their use for applications.
3.	Study of radiation detectors like semiconductor detector, diode as detector and photo multiplier.
4.	Understanding the fabrication and applications of optical fibers, optical modulators and waveguides for optical communication

UNIT-I

Optical processes in Semiconductor, Display devices & Optical fibers	**15 Hours**

Elements of optical phenomena in Semiconductors- fundamentals of Fermi-Dirac distribution, band structure, direct and indirect band gap semiconductors, generation-recombination mechanisms, absorption and emission processes.
Display devices- cathode ray tube, liquid crystal display, charge coupled devices, plasma display.
Optical fibers- types of fibers, modes of propagation, attenuation and losses, optical fiber communication system, advantages.

UNIT-II

Optical Sources and Detectors	**15 Hours**

Lasers- basic principles, optical resonator-types, modes and quality factor, practical lasers- Nd-YAG, CO2, Excimer laser, Semiconductor laser- basic structure, laser action, heterojunction laser, quantum well laser, applications.
Light emitting diode- electroluminescence in p-n junction, LED characteristics, efficiency and responsivity, Heterojunction LED, Surface-Emitting LED and Edge emitting LED.
Photo detectors- photo conductor detector, junction photo diode, p-i-n photo diode, avalanche photo diode. Photo multiplier tube.

UNIT-III

Integrated Optics and Modulators	**10 Hours**

Modulation of light- Analog and digital modulation, Direct modulation - using LED and Semiconductor diode laser (SDL). External modulation - Electro-optic modulators (Pockels effect), Electro-absorption modulators. Acousto-optic modulation. Waveguides- device structure, waveguide devices – waveguide lenses, light bending devices, optical power dividers, directional couplers, waveguide polarizer, wavelength multiplexers and demultiplexers. Waveguide coupling. Optoelectronic integrated circuit

Course Outcomes: At the end of the course student will be able to

1.	Ability to choose the appropriate device to meet the requirement of a particular application.
2.	Making modifications to device structures by understanding the factors affecting their performance.
3.	Attempting better efficiency and utility through an understanding of the principles of performance.
4.	Use the technical knowledge acquired to troubleshoot and rectify devices and circuits.
5.	Explore the possibility of designing devices with better characteristics.

Course Outcomes Mapping with Program Outcomes

Program Outcomes→ **↓ Course Outcomes**	1	2	3	4	5	6	7	8	9	10	11	12
PH2502-1.1	3	3	-	-	-	-	-	-	-	-	-	-
PH2502-1.2	3	3	-	-	-	-	-	-	-	-	-	-
PH2502-1.3	3	3	-	-	-	-	-	-	-	-	-	-
PH2502-1.4	3	3	-	-	-	-	-	-	-	-	-	-
PH2502-1.5	3	3	-	-	-	-	-	-	-	-	-	-

1: Low 2: Medium 3: High

TEXTBOOKS:

1.	P.R.Sasikumar, "Photonics – an introduction", PHI Learning Pvt. Ltd.,New Delhi, 2012 edition.
2.	Pallab Bhattacharya, "Semiconductor Opto Electronic Devices", Prentice Hall of India Pvt., Ltd., New Delhi, 2006.

REFERENCE BOOKS:

1.	J.Wilson and J.Haukes, "Opto electronics- an introduction", Prentice Hall of India, New Delhi.
2.	Jasprit Singh, '"Opto electronics- an introduction to Materials and Devices", McGraw Hill international ed., 1998.
3.	A.Ghatak and Thyagarajan, "Introduction to opto electronics", New Age International Publication.

E Books / MOOCs/ NPTEL

1.	http://nptel.ac.in/courses/115102026/

AUTONOMOUS MOBILE ROBOTS

Course Code:	**RI2501-1**	**Course Type**	**OEC**
Teaching Hours/Week (L: T: P: S)	**3:0:0:0**	**Credits**	**03**
Total Teaching Hours	**40**	**CIE + SEE Marks**	**50+50**
Prerequisite	**EC 1001-1, ME 1003-1**		

Teaching Department: Robotics and Artificial Intelligence

Course Objectives:

1.	Explain different types of locomotion in mobile robots to obtain a required task.
2.	Understand the different types of kinematics and dynamics involved in a mobile robot.
3.	Study the different types of sensors used in an autonomous mobile robot.
4.	Understand the different types of algorithms to identify the position of the mobile robot.
5.	Understand the various algorithms for planning and navigation of the mobile robot.

UNIT-I

Robot locomotion	**07 Hours**
Types of locomotion, hopping robots, legged robots, wheeled robots, stability, maneuverability, and controllability.	
Mobile robot kinematics and dynamics	**09 Hours**
Forward and inverse kinematics, holonomic and nonholonomic constraints, kinematic models of simple car and legged robots, dynamics simulation of mobile robots.	

UNIT-II

Perception	**07 Hours**
Proprioceptive/Exteroceptive and passive/active sensors, performance measures of sensors, sensors for mobile robots like global positioning system (GPS), Doppler effect-based sensors, vision-based sensors, uncertainty in sensing, filtering.	
Localization	**07 Hours**
Odometric position estimation, belief representation, probabilistic mapping, Markov localization, Bayesian localization, Kalman localization, and positioning beacon systems.	

UNIT-III

Introduction to planning and navigation	**10 Hours**
Path planning algorithms based on A-star, Dijkstra, Voronoi diagrams, probabilistic roadmaps (PRM), rapidly exploring random trees (RRT), Markov Decision Processes (MDP), stochastic dynamic programming (SDP).	

Course Outcomes: At the end of the course student will be able to

1.	Explain different types of locomotion in mobile robots to obtain a required task.
2.	Identify the different types of kinematics and dynamics involved in a mobile robot.
3.	Apply the different types of sensors used in an autonomous mobile robot.
4.	Apply the different types of algorithms to identify the position of the mobile robot.
5.	Apply the various algorithms for planning and navigation of the mobile robot to reach the destination.

Course Outcomes Mapping with Program Outcomes

Program Outcomes→ / ↓ Course Outcomes	1	2	3	4	5	6	7	8	9	10	11	12
RI2501-1.1	3	3	3	3	2	1	-	-	-	-	-	3
RI2501-1.2	3	3	3	3	2	1	-	-	-	-	-	3
RI2501-1.3	3	3	3	3	2	1	-	-	-	-	-	3
RI2501-1.4	3	3	3	3	2	1	-	-	-	-	-	3
RI2501-1.5	3	3	3	3	2	1	-	-	-	-	-	3

1: Low 2: Medium 3: High

TEXTBOOKS:

1. R. Siegwart, I. R. Nourbakhsh, “Introduction to Autonomous Mobile Robots”, The MIT Press, 2011.
2. Peter Corke, "Robotics, Vision and Control: Fundamental Algorithms in MATLAB", Springer Tracts in Advanced Robotics, 2011.
3. S. M. LaValle, “Planning Algorithms”, Cambridge University Press, 2006. (Available online http://planning.cs.uiuc.edu/)

REFERENCE BOOKS:

1. Thrun, S., Burgard, W., and Fox, D., "Probabilistic Robotics". MIT Press, Cambridge, MA, 2005.
2. Melgar, E. R., Diez, C. C., "Arduino, and Kinect Projects: Design, Build, Blow Their Minds", 2012.
3. H. Choset, K. M. Lynch, S. Hutchinson, G. Kantor, W. Burgard, L. E. Kavraki, and S. Thrun, "Principles of Robot Motion: Theory, Algorithms, and Implementations", PHI Ltd., 2005.

E Books / MOOCs/ NPTEL

1. https://archive.nptel.ac.in/courses/112/106/112106298/
2. https://www.edx.org/course/autonomous-mobile-robots

MEDICAL ROBOTICS

(For All except AI)

Course Code:	**RI2502-1**	**Course Type**	**PEC**
Teaching Hours/Week (L: T: P: S)	**3:0:0:0**	**Credits**	**03**
Total Teaching Hours	**40**	**CIE + SEE Marks**	**50+50**
Prerequisite	**PH 1001-1, IS 1001-1, CY 1001-1**		

Teaching Department: Robotics and Artificial Intelligence

Course Objectives:

1.	Understand the types of medical robots used in the field of healthcare.
2.	Explain the various localization and tracking sensors
3.	Understand the applications of surgical robots with the help of few case studies
4.	Understand Rehabilitation of limbs and brain machine interface with the help of few case studies
5.	Understand the design methodology of medical robots.

UNIT-I

Introduction — **07 Hours**

Types of medical robots - Navigation - Motion Replication - Imaging - Rehabilitation and Prosthetics - State of art of robotics in the field of healthcare. Localization And Tracking

Position sensors requirements — **09 Hours**

Tracking - Mechanical linkages - Optical - Sound-based - Electromagnetic -Impedance-based - In-bore MRI tracking - Video matching - Fiber optic tracking

UNIT-II

Control Modes Radiosurgery — **07 Hours**

Orthopedic Surgery - Urologic Surgery and Robotic Imaging - Cardiac Surgery – Neurosurgery – case studies.

Rehabilitation — **07 Hours**

Rehabilitation for Limbs - Brain-Machine Interfaces - Steerable Needles – case studies.

UNIT-III

Design of Medical Robots — **10 Hours**

Characterization of gestures to the design of robots- Design methodologies- Technological choices - Security

Course Outcomes: At the end of the course student will be able to

1.	Describe the types of medical robots and the concepts of navigation and motion replication.
2.	Describe about the sensors used for localization and tracking
3.	Explain the applications of surgical robots
4.	Explain the concepts in Rehabilitation of limbs and brain machine interface
5.	Classify the types of assistive robots and analyze the design characteristics, methodology and technological choices for medical robots.

Course Outcomes Mapping with Program Outcomes

Program Outcomes→ / ↓ Course Outcomes	1	2	3	4	5	6	7	8	9	10	11	12
RI2502-1.1	3	-	1	-	-	-	-	-	-	-	-	1
RI2502-1.2	3	-	1	-	-	-	-	-	-	-	-	1
RI2502-1.3	3	-	1	-	-	-	-	-	-	-	-	1
RI2502-1.4	3	-	1	-	-	-	-	-	-	-	-	1
RI2502-1.5	3	-	3	-	-	-	-	-	-	-	-	1

1: Low 2: Medium 3: High

TEXTBOOKS:

1.	Mark W. Spong, Seth Hutchinson, and M. Vidyasagar, "Robot Modeling and Control", Wiley Publishers, 2006.
2.	Paula Gomes, "Medical robotics- Minimally, Invasive surgery", Woodhead, 2012.
3.	Achim Schweikard, Floris Ernst, "Medical Robotics", Springer, 2015.

REFERENCE BOOKS:

1.	Jocelyne Troccaz, "Medical Robotics", Wiley-ISTE, 2012.
2.	Vanja Bonzovic, "Medical Robotics", I-tech Education publishing Austria, 2008.
3.	Daniel Faust, "Medical Robotics", Rosen Publishers, 2016.
4.	Jocelyne Troccaz, "Medical Robotics", Wiley, 2013.

E Books / MOOCs/ NPTEL

1.	https://www.futurelearn.com/courses/medtech-ai-and-medical-robots
2.	https://web.stanford.edu/class/me328/

PLC CONTROL OF HYDRAULIC AND PNEUMATIC CIRCUITS

(For All except AI)

Course Code:	**RI2503-1**	**Course Type**	**OEC**
Teaching Hours/Week (L: T: P: S)	**3:0:0:0**	**Credits**	**03**
Total Teaching Hours	**40**	**CIE + SEE Marks**	**50+50**
Prerequisite	**EE 1001-1, EC 1001-1**		

Teaching Department: Robotics and Artificial Intelligence

Course Objectives:

1.	To understand the fundamentals of fluid power transmission systems
2.	To design various hydraulic system components.
3.	To design various pneumatic system components.
4.	Learn various types of hydraulic and pneumatic power circuits.
5.	Learn various types of applications in fluid power circuits using PLC.

UNIT-I

Fluid power systems and fundamentals — **06 Hours**

Introduction to fluid power, Advantages of fluid power, Application of fluid power system. Types of fluid power systems, General types of fluids - Properties of hydraulic fluids -Fluid power symbols. Basics of Hydraulics-Applications of Pascal's Law

Hydraulic system components — **05 Hours**

Sources of Hydraulic Power: Pumping theory - Pump classification - construction and working of pumps - Variable displacement pumps, pump performance. Actuators: Linear hydraulic actuators-Single acting and double acting cylinders, Rotary actuators - Fluid motors.

Control Components — **04 Hours**

Direction control valve - Valve terminology - Various center positions. Shuttle valve - check valve - pressure control valve - pressure reducing valve, sequence valve. Flow control valves - Fixed and adjustable Safety valves.

UNIT-II

Pneumatic system components — **07 Hours**

Pneumatic Components: Properties of air. Compressors. FRL Unit -Air control valves, Quick exhaust valves and pneumatic actuators- cylinders, air motors. Basics of low-cost automation

Fluidics & Pneumatic circuit design — **08 Hours**

Fluidics - Introduction to fluidic devices, simple circuits. Introduction to Electrohydraulic Pneumatic logic circuits, PLC applications in fluid power control, Sequential circuit design for simple applications using classic, cascade, logic with Karnaugh- Veitch Mapping and combinational circuit design methods.

UNIT-III

Fluid power circuits — **10 Hours**

Electrical control of pneumatic and hydraulic circuits-use of relays, timers, counters, Ladder diagram. Programmable logic control of Hydraulics Pneumatics circuits, PLC ladder diagram for various circuits, motion controllers, use of field busses in circuits. Electronic drive circuits for various Motors.

Course Outcomes: At the end of the course student will be able to

1.	Compare the basics of hydraulics to the performance of fluid power systems
2.	Explain the working principle of hydraulic systems including pumps and control components.
3.	Explain the working principle of pneumatic systems and their components.
4.	Design various types of Electrohydraulic and electro pneumatic circuits
5.	Design various types of applications in fluid power circuits using PLC.

Course Outcomes Mapping with Program Outcomes

Program Outcomes→ / **↓ Course Outcomes**	1	2	3	4	5	6	7	8	9	10	11	12
RI2503-1.1	3	2	3	2	3	-	-	-	-	-	-	3
RI2503-1.2	3	2	3	2	3	-	-	-	-	-	-	3
RI2503-1.3	3	2	3	2	3	-	-	-	-	-	-	3
RI2503-1.4	3	2	3	2	3	-	-	-	-	-	-	3
RI2503-1.5	3	2	3	2	3	-	-	-	-	-	-	3

1: Low 2: Medium 3: High

TEXTBOOKS:

1.	Majumdar S.R., "Pneumatic systems - Principles and maintenance", Tata McGraw Hill, 2008.
2.	Anthony Esposito, "Fluid Power with Applications", Pearson Education 2009.

REFERENCE BOOKS:

1.	Majumdar S.R., "Oil Hydraulics", Tata McGraw-Hill, 2000.
2.	Harry L. Stevart D. B, "Practical guide to fluid power", Taraoeala sons and Port Ltd.Broadey, 2010.
3.	Michael J, Prinches and Ashby J. G, "Power Hydraulics", Prentice Hall, 2011.
4.	Dudelyt, A. Pease and John T. Pippenger, "Basic Fluid Power", Prentice Hall, 2011.

E Books / MOOCs/ NPTEL

1.	https://nptel.ac.in/courses/108/105/108105088/
2.	https://plc-coep.vlabs.ac.in/List%20of%20experiments.html?domain=Electrical%20Engineering
3.	http://vlabs.iitb.ac.in/vlabs-dev/vlab_bootcamp/bootcamp/COEP_KNOWLEDGE_SEEKERS/labs/exp1/theory.html