College Calendar 2021-22

Department of Electrical & Electronics Engineering

Syllabus of 3rd Year
V & VI SEMESTER
Department of
Electrical & Electronics Engineering

College Calendar 2021-22
मातेव रक्षणति पितेव हिते नियुक्तते
काजेव चापि रमयत्यपनीय खेदमू।
लक्ष्मी तनोति वितनोति च दिश्रु कीति
किं किं न साधयति कल्यावलेव विद्या॥

विद्या माता की तरह पालन करती है, बाप के तरह हितकर मार्ग में ही ले लेता है। पत्नी
की तरह हमारा दुःख दूर करता है। मन को संतोष देता है, धन देती है, दिश्रों में कीति प्रेमताई
है। कल्यावली की तरह वह सब कामनाए नौ नौरी करती है।

Do you know in how many ways the 'Knowledge' serves his master? Like mother it protects, like father it teaches and guides, like wife, provides all
kinds of happiness after destroying all sorrows, it brings wealth from every
corner and spreads the fame in all direction. Like 'Kalpalatha' knowledge
offers everything to human being whatever he wishes.
COLLEGE CALENDAR
2021-22
(V & VI Semester)
Vision Statement

Pursuing Excellence, Empowering people, Partnering in Community Development

Mission Statement

To develop N.M.A.M. Institute of Technology, Nitte, as Centre of Excellence by imparting 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 Memorium

Late Nitte Mahalinga Adyanthaya
Our Founder

Late Justice K. S. Hegde
1909-1990
SRI N. VINAYA HEGDE
President, Nitte Education Trust
Chancellor, Nitte (Deemed to be University), Mangaluru
<table>
<thead>
<tr>
<th>Sl.No.</th>
<th>Name of the Faculty</th>
<th>Designation</th>
</tr>
</thead>
<tbody>
<tr>
<td>1.</td>
<td>Dr. Niranjan N. Chiplunkar</td>
<td>Principal</td>
</tr>
<tr>
<td>2.</td>
<td>Mr. Yogesh Hegde</td>
<td>Registrar</td>
</tr>
<tr>
<td>3.</td>
<td>Dr. Shrinivasa Rao B. R.</td>
<td>Vice Principal / Controller of Examinations / Professor</td>
</tr>
<tr>
<td>4.</td>
<td>Dr. I. Ramesh Mithanthaya</td>
<td>Vice Principal / Dean (Academics) / Professor</td>
</tr>
<tr>
<td>5.</td>
<td>Dr. Sudesh Bekal</td>
<td>Dean (R&amp;D)/Professor</td>
</tr>
<tr>
<td>6.</td>
<td>Dr. Rajesh Shetty K.</td>
<td>Dean (Admissions) / Professor</td>
</tr>
<tr>
<td>7.</td>
<td>Dr. Subrahmanya Bhat K.</td>
<td>Dean (Student Welfare) / Professor</td>
</tr>
<tr>
<td>8.</td>
<td>Dr. Nagesh Prabhu</td>
<td>PG Coordinator/Professor</td>
</tr>
<tr>
<td>9.</td>
<td>Dr. Srinath Shetty K.</td>
<td>Resident Engineer/Professor</td>
</tr>
</tbody>
</table>

**HEADS OF DEPARTMENTS**

1. Prof. Shalini K. Sharma Counseling, Welfare, Training & Placement
2. Dr. Arun Kumar Bhat Civil Engg.
3. Dr. Jyothi Shetty Computer Science & Engg.
5. Dr. Srinivas Pai P. Mechanical Engg.
6. Dr. KV SSSS Sairam Electronics & Communication Engg.
7. Dr. Suryanarayana K. Electrical & Electronics Engg.
8. Dr. Ujwal P. Biotechnology Engg.
10. Dr. Sharada Uday Shenoy Artificial Intelligence & Machine Learning Engg.
12. Dr. Kumudakshi Mathematics
13. Dr. Shobha R. Prabhu Physics
14. Dr. Shivaprasad Shetty M. Chemistry
15. Mrs. Rashmi D. Hegde Humanities
16. Dr. Surendra Shetty MCA

**INCHARGE OF INSTITUTION’S RESPONSIBILITIES**

1. Dr. Gururaj Upadhyaya Workshop Supdt.
2. Dr. Narasimha Bailkeri 1st year Coordinator
3. Dr. Venkatesh Kamath Deputy Controller of Examination
4. Dr. Janardhan Nayak Co-ordinator, Red Cross Unit
5. Mr. Srinivas Nekkar NSS Co-ordinator
6. Mr. Krishnaraja Joisa Public Relations Officer
7. Dr. Jnaneshwar Pai Maroor Co-ordinator, Alumni
8. Sri. Shekar Poojari Student Welfare Officer
9. Dr. Shivaprasad Shetty M. NCC Officer

ENTREPRENEURSHIP DEVELOPMENT CELL
1. Dr. Ramakrishna B. Professor/EDC- Incharge
2. Mrs. Geetha Poojarthi Co-ordinator

DEPARTMENT OF TRAINING & PLACEMENT
1. Mr. Bharath G. Kumar Lead Placements

DEPARTMENT OF MATHEMATICS
1. Dr. Shashirekha B. Rai Professor
2. Dr. P. Shankaran Professor
3. Dr. Kumudakshi Asso. Professor/ HoD
4. Dr. Sharad M. Hegde Asst. Professor Gd III
5. Dr. Vasanth K. R. Asst. Professor Gd III
6. Mrs. Ambika N. Asst. Professor Gd I
7. Mrs. Vinaya Acharya Asst. Professor Gd I
8. Mrs. Anitha D. Bayar Asst. Professor
9. Mrs. Bhavya K. Asst. Professor
10. Ms. Chaithra K. Asst. Professor
12. Mrs. Sharmila Asst. Professor
13. Mrs. Anjana Pai K. Asst. Professor
14. Mrs. Soumya Asst. Professor
15. Mrs. Smitha G. V. Asst. Professor

DEPARTMENT OF PHYSICS
1. Dr. K. B. Vijaya Kumar Professor
2. Dr. Sathyajith K. T. Asso. Professor
3. Dr. Manjunath K. B. Asso. Professor
4. Dr. Shobha R. Prabhu Asso. Professor / HoD
5. Dr. Nagaraja B. S. Asst. Professor Gd III
6. Dr. Raghavendra Bairy Asst. Professor Gd III
7. Dr. Shyam Prasad K. Asst. Professor Gd III
DEPARTMENT OF CHEMISTRY
1. Dr. Janardhana Nayak Professor
2. Dr. Ramesh Bhat Asso. Professor
3. Dr. Shivaprasad Shetty M. Asst. Professor Gd III/HoD
4. Dr. Aarti S. Bhat Asst. Professor Gd III
5. Dr. Subrahmanyas Ishwar Bhat Asst. Professor Gd III
6. Mr. Sarvajith M. S. Asst. Professor

DEPARTMENT OF HUMANITIES
1. Dr. Ramakrishna B. Professor
2. Mrs. Rashmi D. Hegde Asso. Professor/HoD
3. Dr. Vishwanatha Asso. Professor
4. Dr. Jnaneshwar Pai Maroor Asst. Professor Gd III
5. Dr. Joy Elvine Martis Asst. Professor Gd III
6. Mrs. Shyla D. Mendonca Asst. Professor Gd II
7. Ms. Sonia Lobo Asst. Professor Gd I
8. Mr. Srinivas Nekkar Asst. Professor
9. Mrs. Sudeeksha S. Pai Asst. Professor

OFFICE SECTION HEADS
1. Mr. Keshava Mugeraya Sr. Supdt., Academic Section/Purchase In-Charge
2. Mrs. Suneetha R. Shetty Sr. Supdt., Administrative Section
3. Mr. Suresh Achar Sr. Supdt., Stores
4. Mrs. Jayashree Sr. Programmer
5. Mrs. Shailaja V. Shetty Supdt., Accounts Section
6. Sri. Sudhakar K. Incharge Librarian

SECURITY DEPARTMENT
1. Mr. Hirianna Suvarra S. Security Supervisor

SPORTS DEPARTMENT
1. Sri. Shyam Sundar M. P.E.D
2. Sri. Ganesh Poojary P.E.D
3. Ms. Sowjanya M. P.E.I
4. Mr. Ravi Prakash C. Anpur Basket Ball Coach
### HOSTEL WARDENS

1. Dr. Veena Devi S.V  
   Chief Warden, NET Ladies Hostels, Nitte
2. Dr. Vishwanatha  
   Chief Warden, NET Gents Hostels, Nitte

### HOSTEL SUPERINTENDENT / MANAGER

1. Mr. John D’Souza  
   Sr. Manager, Gents Main Hostel
2. Mr. Francis D’Souza  
   Hostel Manager, Gents Main Hostel
3. Mr. Rajesh Ballal  
   Supervisor, Gents PG Hostel
4. Mrs. Gayathri Kamath  
   Supdt. Ladies PG Hostel
5. Mrs. Chethana Sharma  
   Supdt. Ladies Main Hostel
6. Mrs. Hema S. Hegde  
   Supdt., Hostel Office
REGULATIONS
2021-22
(Applicable for admission batch 2018-19 onwards)

COMMON TO ALL B.E. (CREDIT SYSTEM)
DEGREE PROGRAMMES
CONTENTS

REGULATIONS

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7. WITHDRAWAL FROM THE PROGRAMME
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10. COMMUNICATION OF GRADES
11. VERTICAL PROGRESSION
12. AWARD OF CLASS
13. APPEAL FOR REVIEW OF GRADES
14. AWARD OF DEGREE
15. GRADUATION REQUIREMENTS AND CONVOCATION
16. AWARD OF PRIZES, MEDALS, CLASS AND RANKS
17. CONDUCT AND DISCIPLINE
18. EARNING OF ACTIVITY POINTS FOR THE AWARD OF DEGREE
19. LISTS OF MAJOR SCHOLARSHIPS
1. INTRODUCTION

1.1 The general regulations are common to all B.E. (Credit System) Degree Programmes conducted at the NMAMIT, Nitte Campus and shall be called “NMAMIT Regulations”.

1.2 The provisions contained in this set of regulations govern the policies and procedures on the Registration of students, imparting Instructions of course, conduct of the examination and evaluation and certification of student's performance and all amendments related to the said Degree programme(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 BE Degree program (of VTU) along with all the amendments thereto, and shall be binding on all students undergoing the Graduate Degree Programme(s) (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 stake holders (The Students, Faculty, Staff of Departments of NMAMIT, Nitte). The decision of the Academic Council/ Governing Council shall be final and binding.

1.4 In order to guarantee fairness and justice to the parties concerned in view of 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 NMAMIT courses for appropriate action, irrespective of whether a reference is made here in this set of Regulations or otherwise.

1.6 The course shall be called Bachelor of Engineering course abbreviated as B.E. (Subject of specialization) – Credit System.

1.7 DURATION OF THE COURSE

(a) The course shall extend over a period of total duration of 4 years.
(b) 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 Three; Two being Main semesters (odd, even) and one being a supplementary semester; after 2 main semesters.  
(Note: Supplementary semester is primarily to assist weak and/ or failed students through make up courses. However, Autonomous Colleges may use this semester 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 19 Weeks;  |
|                              | Supplementary Semester 8 Weeks           |

| 3. Academic Activities        | Main Semester                          |
| (Weeks):                      | Registration of Courses & Course Work   |
|                              | (16.0)                                 |
|                              | Examination Preparation and Examination |
|                              | (3.0)                                  |
| Total (19)                    | Supplementary Semester                 |
| Registration of Courses &    | (5.0)                                  |
| Course Work                  | Examination Preparation and Examination |
| Total (8)                     | (3.0)                                  |
| Declaration of results: 2    | 2 weeks from the date of last examination |
| weeks from the date of last  |                                        |
| examination                   |                                        |
| Inter- Semester Recess:      |                                        |
| After each Main Semester (2) |                                        |
| Total Vacation: 10 weeks     | (for those who do not register for      |
|                               | supplementary semester) and 4 weeks     |
|                               | (for those who register for supplementary |
|                               | semester)                              |

(Note: In each semester, there will be provision for students for Registration of courses at the beginning, dropping of courses in the middle and withdrawal from courses towards the end, under the advice of faculty member. These facilities are expected to enhance the learning capabilities of students, minimizing their chances of failure in courses registered and also ensure 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 Bachelor Degree.

The calendar of events in respect of the course shall be fixed by the Senate from time to time, but preferably in line with the academic calendar of the VTU.
2. DEGREE PROGRAMMES

2.1 Undergraduate B.E. Degree Programmes are offered in the following disciplines by the respective programme hosting departments listed below:

i) Biotechnology Engineering (BT)
ii) Civil Engineering (CV)
iii) Computer Science & Engineering (CS)
iv) Electronics & Communications Engineering (EC)
v) Electrical & Electronics Engineering (EE)
vi) Information Science & Engineering (IS)
vii) Mechanical Engineering (ME)
viii) Artificial Intelligence and Machine Learning Engg. (AM)*
ix) Computer and communication Engineering (CC)*
x) Robotics and Artificial Intelligence Engineering (RA)*

Other teaching departments are –

i) Mathematics (MA)
ii) Physics (PH)
iii) Chemistry (CY)
iv) Humanities, Social Sciences and Management (HU)

2.2 The provisions of these Regulations shall be applicable to any new discipline* that may be introduced from time to time and appended to the above list.

3. REGISTRATION

3.1 Every student after consulting his Faculty Advisor in parent department shall register approved courses (core and elective) to earn credits for meeting the requirements of 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 have to pay a late fee. Such courses together with their grade and credits earned will be included in the grade card issued by the college at the end of each semester, like odd, even, supplementary and it forms the basis for determining the student’s performance in that semester.

3.2 Lower and Upper Limits for Course Credits Registered in a Semester Course Credit Assignment

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

Lecture / Tutorials / Practical:

i) One hour Lecture per week is assigned one Credit.
ii) 2-hour Tutorial session per week is assigned 1.0 Credit.
iii) 2-hour Lab. session 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

<table>
<thead>
<tr>
<th>No. of Courses</th>
<th>Credits / Course</th>
<th>Total Credits</th>
<th>Contact Hours per Week</th>
</tr>
</thead>
<tbody>
<tr>
<td>2 Lecture Courses</td>
<td>3:0:0</td>
<td>6</td>
<td>6</td>
</tr>
<tr>
<td>2 Lec. cum Lab Courses</td>
<td>3:0:1</td>
<td>8</td>
<td>10</td>
</tr>
<tr>
<td>2 Lec. cum Tut. Courses</td>
<td>3:1:0</td>
<td>8</td>
<td>10</td>
</tr>
<tr>
<td>1 Lec. Tut. cum Lab Courses</td>
<td>1:1:1</td>
<td>3</td>
<td>5</td>
</tr>
<tr>
<td><strong>Total</strong></td>
<td><strong>10:2:2</strong></td>
<td><strong>25</strong></td>
<td><strong>31</strong></td>
</tr>
</tbody>
</table>

A student must register, as advised by Faculty Advisor, between a minimum of 16 credits and up to a Maximum of 28 credits.

3.3 Mandatory Pre-Registration for higher semester
In order to facilitate proper planning of the academic activities of the Semester, it is necessary for the students to 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 prior to the last working day of the semester.

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

i) satisfied all the academic requirements to continue with the programme of studies without termination
ii) cleared all Institute, hostel and library dues and fines, if any, of the
previous semester

iii) paid all required advance payments of the Institute and the hostel for the current semester

iv) has not been debarred from registering on any specific grounds by the Institute.

4. ADD / DROP / AUDIT options

4.1 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 subject teacher and under faculty advice. The permissible course load to be either average credits (=22) or to be within the limits of minimum (=16) and maximum (=28) credits.

4.2 DROP-option

During a specified period at the middle of a semester student's performance in CIE is reviewed by the faculty advisor. Following 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 to be re-registered by these students and taken up for study at a later time.

4.3 Withdrawal from courses

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

4.4 AUDIT-option

A student can register for courses for audit only, with a view to supplement his/her knowledge and/or skills. The student's grades in such course(s) will have to be reflected in the grade card. However, CORE courses shall not be made available for audit. But these shall not be taken into account in determining the student's academic performance in the semester. ‘U’ grade is awarded to such courses on satisfying the attendance requirements and CIE requirements. The candidate need not appear for SEE in such courses.
5. COURSE STRUCTURE:

5.1 Typical Breakdown for the B.E. Degree Curriculum:

<table>
<thead>
<tr>
<th>No.</th>
<th>Course Category</th>
<th>Credit Range</th>
</tr>
</thead>
<tbody>
<tr>
<td>1.</td>
<td>Basic Sciences (BSC)</td>
<td>24-30</td>
</tr>
<tr>
<td>2.</td>
<td>Engineering Sciences (ESC)</td>
<td>15 - 20</td>
</tr>
<tr>
<td>3.</td>
<td>Humanities, Social Sciences and Management</td>
<td>7- 10</td>
</tr>
<tr>
<td>4.</td>
<td>Professional Courses (PCC) – core</td>
<td>70 - 90</td>
</tr>
<tr>
<td>5.</td>
<td>Professional Courses (PEC) – elective</td>
<td>18</td>
</tr>
<tr>
<td>6.</td>
<td>Open Elective Courses (OE)</td>
<td>06</td>
</tr>
<tr>
<td>7.</td>
<td>Project Work (PROJ)</td>
<td>16 (VI – 2, VII-2, VIII-12) 01</td>
</tr>
<tr>
<td>8.</td>
<td>Internship</td>
<td>03</td>
</tr>
<tr>
<td>9.</td>
<td>Mandatory Learning courses</td>
<td>Non-Credit</td>
</tr>
</tbody>
</table>

Note: **Student can register between 16 to 28 credits per semester**

**Total Credits to be earned : 175**

5.2 The Department Undergraduate Committee (DUGC) will discuss and recommend the exact credits offered for the programme for the above components ‘a’ to ‘g’, 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 senate for consideration and approval.

5.3 The earned Credit Requirement for the B.E. Degree is 175. Degree is awarded by prescribing the total number of credits to be earned, rather than by using the program duration, giving flexibility to student to plan their career.

5.4 Mandatory Learning Courses

These are courses that must be completed by the student at appropriate time or at his convenience. The ‘PP’ grade is awarded for a Pass in the course and ‘NP’ grade is awarded for a Fail in the course. In case ‘NP’ grade is awarded, the student has to re-register for the same course wherein he has no alternative options. However, he/she can opt for other courses if he/she has been provided with multiple options.
The ‘PP’ and ‘NP’ grades do not carry grade points and 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 record (transcript) with Pass or Fail (PP or NP).

Courses that come under this category are the following.

Moral and Ethical Values, Communication skills, Entrepreneurship Development Programme, Environmental issues, Constitution of India, Proficiency in a Language etc.

Such courses will not carry any credits for the award of degree, but a pass in each of such course during the programme shall be a necessary requirement for the student to qualify for degree award.

5.5 PROJECT

i) Project work at 8th semester shall be completed batch wise. The batch shall consist of a maximum of 4 students.

ii) Project viva-voce examination shall be conducted individually.

5.6 ELECTIVES

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

ii) The minimum number of students to be registered for any Elective offered shall not be less than ten.

iii) A candidate shall opt for his/her choice of electives and register for the same if pre-registration is not done, at the beginning of each of 5th, 6th, 7th and 8th semesters. The candidate is permitted to opt for change of elective within 15 days from the date of commencement of the semester as per the academic calendar of the college.

6. ATTENDANCE REQUIREMENT:

6.1 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 Principal for reasons such as medical grounds, participation in University level sports, cultural activities, seminars, workshops and paper presentation.

6.2 The basis for the calculation of the attendance shall be the period of term prescribed by the College by its calendar of events. For the first semester students, the same is reckoned from the date of admission to the course (as
per CET/COMED-K or Management allotment).

6.3 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 the shortage.

6.4 A candidate having 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 ‘N’ grade in these courses.

He/she shall have to repeat those course(s). Such students 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 supplementary semester.

6.5 Attendance in CIE and SEE: Attendance at 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.

7. WITHDRAWAL FROM THE PROGRAMME

7.1 Temporary Withdrawal

a) A student who has been admitted to a degree programme of the college may be permitted once during the course to withdraw temporarily, for a period of 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 about the genuineness of the case and that even by taking into account the expected period of withdrawal, the student has the possibility to complete the programme requirements (175 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 such time as 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 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.
7.2 Permanent Withdrawal

Any student who withdraws 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.

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

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

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

8. EVALUATION SYSTEM

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

8.2 The Letter grades S, A, B, C, D, E, F indicate the level of academic achievement, assessed on a decimal (0-10) scale.

8.3 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.

<table>
<thead>
<tr>
<th>Component</th>
<th>Weightage</th>
</tr>
</thead>
<tbody>
<tr>
<td>Semester End Examination (SEE)</td>
<td>50% (50 marks)</td>
</tr>
<tr>
<td>Continuous Internal Evaluation (CIE)</td>
<td>50% (50 marks)</td>
</tr>
<tr>
<td>i) Quizzes, Tutorials, Assignments,</td>
<td></td>
</tr>
<tr>
<td>Seminars, mini projects, tutorials etc.</td>
<td>10 marks</td>
</tr>
<tr>
<td>ii) Mid-semester Examination</td>
<td>40 marks</td>
</tr>
</tbody>
</table>

Any variation, other than the above distribution, requires the approval of the pertinent DUGC and Academic Council.
8.4 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 specified period in a semester.

8.5 The course Instructor shall announce in the class and/or display at the 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.

8.6 Passing standards

<table>
<thead>
<tr>
<th>Evaluation Method</th>
<th>Passing Standard</th>
</tr>
</thead>
<tbody>
<tr>
<td>Sessional (CIE)</td>
<td>Score: ≥40% (≥20 marks)</td>
</tr>
<tr>
<td>Terminal (SEE)</td>
<td>Score: ≥40% (≥20 marks)</td>
</tr>
</tbody>
</table>

i) 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 project evaluation committee at the department level shall form the SEE of the project work.

ii) In the case of other requirements, such as, seminar, industrial internship, field work, comprehensive viva voce, if any, the assessment shall be made as laid down by the Academic council.

iii) 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 want 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 E in each case.

While such students should re-register for same course(s) if core, they can re-register for 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 a supplementary semester.

8.7 i) Grade point scale for absolute grading

<table>
<thead>
<tr>
<th>Level</th>
<th>Out Standing</th>
<th>Excellent</th>
<th>Very Good</th>
<th>Good</th>
<th>Average</th>
<th>Poor</th>
<th>Fail</th>
</tr>
</thead>
<tbody>
<tr>
<td>Grade</td>
<td>S</td>
<td>A</td>
<td>B</td>
<td>C</td>
<td>D</td>
<td>E</td>
<td>F</td>
</tr>
<tr>
<td>Grade Points</td>
<td>10</td>
<td>09</td>
<td>08</td>
<td>07</td>
<td>06</td>
<td>04</td>
<td>00</td>
</tr>
<tr>
<td>Score (Marks)</td>
<td>≥ 90</td>
<td>&lt; 90 - ≥80</td>
<td>&lt; 80 - ≥70</td>
<td>&lt; 70 - ≥60</td>
<td>&lt; 60 - ≥50</td>
<td>&lt; 50 - ≥40</td>
<td>&lt; 40</td>
</tr>
<tr>
<td>Range(%)</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

ii) The grade points 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 sum total of all the credit points earned by the student for all the courses registered in that semester.

8.8 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 S-E. Letter grade ‘F’ in any course implies failure of the student in that course and no credits earned.

8.9 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 (S-F) after the student completes the course requirements.

- Grade ‘I’: To a student having satisfactory attendance at classes and meeting the passing standard at CIE, 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, which required the student to be away from the College;

- 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 Make up Examinations within 2 working days of that particular examination for which he or she is absent, failing which they will not be given permission. This is admissible only for students who have
more than 45 CIE marks.

- 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
- Grade ‘X’: To a student having attendance ≥85% and CIE rating (90%), in a course but SEE performance observed to be poor, which could result in a F grade in the course. *(No ‘F’ grade awarded in this case but student’s performance record maintained separately).*

### 8.10 Grade Card:
Each student shall be issued a Grade Card (or Transcript) 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 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.**

### 8.11 The Make Up Examination
The Make Up Examination facility would be available to students who may have missed to attend 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. 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 same as the regular SEE for the course(s).

a) In the event of a student in the final semester failing in a Laboratory course and/or in CIE of a course, he/she could be given ‘I’ grade for the course. In such a case the concerned course instructor would have the possibility to grant the student extra time not exceeding 12 weeks for completing the course, with the concurrence of the Department/College. If no such extra time is sought/granted, the concerned student would have to re-register for the course in a succeeding semester and take steps to fulfill the requirements of the Degree.

b) 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’ grade.

c) 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/ supplementary semester and fulfill the passing standards for their CIE and (CIE+SEE).

9. 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.

\[
SGPA = \frac{\sum [(course\ credit) \times (Grade\ point)] \ (for\ all\ courses\ in\ that\ semester)}{\sum [\text{(course\ credits)}]}
\]

CGPA is computed as follows:

\[
CGPA = \frac{\sum [(course\ credits) \times (Grade\ points)] \ (for\ all\ courses\ excluding\ those\ with\ F\ grades\ until\ that\ semester)}{\sum (course\ credits) \ (for\ all\ courses\ excluding\ those\ with\ F\ grades\ until\ that\ semester)}
\]

10. COMMUNICATION OF GRADES
The SGPA and CGPA respectively, facilitate the declaration of academic performance of a student at the end of a semester and at the end of successive semesters. Both of them would be normally calculated to the second decimal position, so that the CGPA, in particular, can be made use of in rank ordering the students' performance at a College. If two students get the same CGPA, the tie could be resolved by considering the number of times a student has obtained higher SGPA; But, if it is still not resolved, the number of times a student has obtained higher grades like S,A,B etc. could be taken into account.

11. VERTICAL PROGRESSION (PROMOTION / ELIGIBILITY TO HIGHER SEMESTERS)
11.1 There shall be no restriction for promotion from an odd semester to the next even semester, provided the student has fulfilled the attendance requirement.
11.2 A Student shall be declared fail if he / she
   (i) Has not satisfied the CIE requirements of any Course/s.
(ii) Has not registered for the SEE even after satisfying the attendance and CIE requirements.

11.3  **(A) Vertical Progression in case of students admitted to First year:**

(a) Students having not more than four F grades in the two semesters of first year of the Programme shall be eligible to move to second year.

(a.1) Students having not more than four F grades in the four semesters of I and II year shall be eligible to move to III year.

(a.2) Students who have earned all the prescribed credits of I year, and having not more than four F grades in the four semesters of II and III year shall be eligible to move to IV year.

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

(a) Students having not more than four F grades (excluding the Fail or pass status of Additional Mathematics I and II) in the two semesters of II year of the Programme shall be eligible to move to III Year.

(a.1) Students having not more than four F grades (excluding the Fail or pass status of Additional Mathematics I and II, if any) in the four semesters of II and III year shall be eligible to move to IV year.

(b) The mandatory non-credit Courses Additional Mathematics I and II prescribed at III and IV semesters respectively, to lateral entry Diploma holders admitted to III semester of B.E/B.Tech. Programmes shall attend the classes during the respective semesters to satisfy attendance and CIE requirements and to appear for the University examinations.

(b.1) In case, any student fails to satisfy the attendance requirement of the Courses Additional Mathematics I and II, he/she shall not be eligible to appear for the Semester End Examinations of that semester and shall not be permitted to take admission to next higher semester. The candidate shall be required to repeat that semester during the subsequent year.

(b.2) Students who have satisfied the attendance requirement but not the CIE requirements of the Courses Additional Mathematics I and II shall be permitted to register afresh and appear for SEE after satisfying the CIE requirements in the same Course/s (with or without satisfying the attendance requirement) when offered during subsequent semester/s.

(c) Completion of Additional Mathematics I and II shall be mandatory for the award of degree.

**(C) Vertical Progression in case of B.Sc students admitted to Second year (Lateral entry):**

(a) Students having not more than four F grades (excluding the Fail or pass status of Engineering Graphics and Elements of Civil Engineering and Mechanics of First Year Engineering Programme) in the two semesters of II year of the Programme shall be eligible to move to III year.

(a.1) Students having not more than four F grades (excluding the Fail or pass
status of Engineering Graphics and Elements of Civil Engineering and Mechanics of First Year Engineering Programme, if any) in the four semesters of II and III year shall be eligible to move to IV year.

(b) The prescribed mandatory non-credit Courses Engineering Graphics and Elements of Civil Engineering and Mechanics of First Year Engineering Programme to lateral entry B. Sc holders admitted to III semester of B.E/B. Tech Programmes, shall attend the classes during the respective semesters to complete CIE and attendance requirements and to appear for the University examinations.

(b.1) In case, any student fails to satisfy the attendance requirement of the above said Courses; he/she shall not be eligible to appear for the Semester End Examinations of that semester and shall not be permitted to take admission to next higher semester. The candidate shall be required to repeat that semester during the subsequent year.

(b.2) Students who have satisfied the attendance requirement but not the CIE requirements of the above said Courses, shall be permitted to register afresh and appear for SEE after satisfying the CIE requirements in the same Course/s (with or without satisfying the attendance requirement) when offered during subsequent semester/s.

(c) Completion of Engineering Graphics and Elements of Civil Engineering and Mechanics shall be mandatory for the award of degree.

The Principal of each college shall make suitable arrangements in the timetable to facilitate the B. Sc students to attend the above mentioned courses to satisfy the CIE and attendance requirements and to appear for the University examinations.

11.4 Termination from the programme

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

i) Failure to secure a CGPA = 5.0 on three consecutive occasions.

ii) Failure to earn a credit of 175 (135 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.

12. AWARD OF CLASS

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. This can be seen from the following Table.
### Percentage Equivalence of Grade Points (For a 10-Point Scale)

<table>
<thead>
<tr>
<th>Grade Point</th>
<th>Percentage of Marks</th>
</tr>
</thead>
<tbody>
<tr>
<td>5.75</td>
<td>50 (second class)</td>
</tr>
<tr>
<td>6.25</td>
<td>55</td>
</tr>
<tr>
<td>6.75</td>
<td>60 (First class)</td>
</tr>
<tr>
<td>7.25</td>
<td>65</td>
</tr>
<tr>
<td>7.75</td>
<td>70 (Distinction)</td>
</tr>
<tr>
<td>8.25</td>
<td>75</td>
</tr>
</tbody>
</table>

Percentage = (GPA - 0.75) x 10

13. **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 review of grade is incorporated in 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.

14. **AWARD OF DEGREE**

14.1 (1) B.E. Degree

   a) Students shall be declared to have completed the Programme of B.E./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 has earned the prescribed number of credits (175 credits for regular students registered for 4 year degree programmes & 135 for lateral entry students).

   b) For the award of degree, a CGPA≥5.00 at the end of Programme 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) Completion of Engineering Graphics and Elements of Civil Engineering and Mechanics of First Year Engineering Programme shall be mandatory for the award of degree to lateral entry B.Sc. graduates.

   e) (i) Over and above the academic credits, every Day College regular student admitted to the 4 years Degree Programme and every student entering 4 years Degree Programme through lateral entry, shall earn 100 and 75 Activity Points respectively through AICTE Activity Point Programme for the
award of degree. Students transferred from other Universities/Autonomous colleges under VTU to fifth semester are required to earn 50 Activity Points from the year of entry to VTU. The Activity Points earned shall be reflected on the student’s eight semester Grade Card.

(ii) Activity Points (non-credit) have no effect on SGPA/CGPA and shall not be considered for vertical progression.

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

(2) B.E. (Honors) Degree

VTU, Belagavi has framed the guidelines for applying for the award of Bachelor of Engineering (Honors) degree.

These Regulations are applicable for the following students:

1. Admitted to I semester / I year from the academic year 2018-19 (i.e. USN XXX18XXXX)
2. Admitted to III semester / II year from the academic year 2019-20 (i.e. USN XXX19XX4XX)
3. These Regulations are uniformly applicable to Affiliated, Autonomous and Constituent Colleges under VTU.

Eligibility criterion

(i) Students have to earn 18 or more additional credits through MOOCs.
(ii) Students shall register for this course from fifth semester onwards.
(iii) Students shall obtain a grade ≥ D in all the courses in first attempt only in all the semesters till 5\textsuperscript{th}.
(iv) Students shall obtain CGPA of 8.5 and above at the end of fourth semester.
(v) For Diploma students, they shall complete Additional Mathematics I and II during 3\textsuperscript{rd} and 4\textsuperscript{th} semesters in first attempt only.

Requirements:

(i) Students shall maintain a grade ≥D in all courses from 5\textsuperscript{th} to 8\textsuperscript{th} semester in ‘first attempt’ only.
(ii) Students not having CGPA greater than or equal to 8.5 at the end of the B.E. programme shall not be eligible for the award of Honors degree, even if they have satisfied the requirement of additional credits.
(iii) Students shall take up additional course work, other than the regular courses prescribed by the University from 5\textsuperscript{th} to 8\textsuperscript{th} semester from NPTEL and other platforms notified by the University and complete the same in any number of attempts with a final score (online assignments: 25 % +
Proctored examination: 75 %) leading to the following certificates – ELITE (60 to 75 %) or ELITE + SILVER (76 to 89 %) or ELITE + GOLD (≥ 90 %) before closure of eighth semester as per the academic calendar.

(iv) Students shall be permitted to drop the registered course work (s) and select alternative course work (s) in case they cannot give proctored examination.

(v) Students have to take courses from the list of MOOCs approved by the University, which can be from NPTEL / SWAYAM / other platforms.

(vi) Students shall select courses in consultation with their Class Advisor, such that the content / syllabus of them are not similar to that of the core courses, professional electives or open electives, which the students may chose in the program.

(vii) Students shall earn the additional credits for these courses through MOOCs, by only appearing in person to the proctored examinations conducted by NPTEL / SWAYAM / other platform. The method of assessment shall be as per NPTEL online platform.

(viii) The Credit equivalence shall be as follows - 4 weeks of online course duration – 1 credit, 8 weeks of online course duration – 2 credits and 12 weeks of online course duration – 3 credits.

Registration:

(i) Any student meeting the eligibility criteria and interested to register for Honors degree qualification shall apply to the University through the Principal in the prescribed form along with the prescribed application fees within 15 working days after notification by the University.

(ii) The Registrar shall notify the registration of the student and it will be notified to the student and the student shall pay a one-time, non-refundable registration fees as prescribed by the University to confirm the registration.

Award of Honors Qualification:

(i) Students who successfully complete the MOOCs prescribed by the University and submit their E-certificate to the University through the Principal against the notification issued by the Registrar in time before the closure of eighth semester, as per the academic calendar shall be eligible for B.E. (Honors) degree. If a student does not submit the certificates in time on or before the last date, their request shall not be considered, even if they have earned the requisite number of credits.

(ii) The Honors degree shall be awarded only if the CGPA at the end of the B.E. programme is equal to or greater than 8.5.

(iii) A student who has earned the requisite number of credits and who has submitted the certificates in time and has been accepted by the
University will get B.E. degree with Honors suffixed indicating recognition of higher achievement by the student concerned.

(iv) Further students fulfilling all the above requirements shall be entitled to receive their transcripts indicating both the achievement of the student concerned.

(v) The award of the Honors degree shall be recommended by the Academic Senate and approved by the Executive Council of the University.

14.2 (1) Noncompliance of CGPA ≥ 5.00 at the end of the Programme

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

(b) In the cases of 14.2 (1) a, students shall be permitted to appear again for SEE in course/s (other than Internship, Technical seminar, Project (Mini and Main), and Laboratories) of any Semester/s without the rejection of CIE marks for any number of times, subject to the provision of maximum duration of the Programme to make up the CGPA equal to or greater than 5.00 for the award of the Degree.

(c) In case, the students earn improved grade/s in all the reapurred 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 14.2 (1) b

(d) 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 reapurred 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 14.2 (1) b

(e) In case, the students earn improved grade/s in some courses and fail in the other reapurred course/s, the CGPA shall be calculated by considering the improved grade/s and the previously earned pass grade/s of the reapurred 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 14.2 (1) b

(f) In case, the students fail (i.e., earns F grade) in all the reapurred 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 14.2 (1) b

(g) Students shall obtain written permission from the Registrar (Evaluation) to reappear in SEE to make up the CGPA equal to or greater than 5.00.

(2) Noncompliance of Mini-project

(a) The 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 fail in that course and shall have to complete the same during subsequent University examinations after satisfying the Mini-project requirements. Also, mini-project shall be considered for eligibility to VII semester.

(3) Noncompliance of Internship
(a) All the students of B.E/B.Tech shall have to undergo mandatory internship of 4 weeks during the vacation. A University examination shall be conducted during VIII semester. Internship 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 internship shall be declared fail in that Course and shall have to complete the same during subsequent University examinations after satisfy the internship requirements.

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

15 GRADUATION REQUIREMENTS AND CONVOCATION

15.1 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 centres
c) No disciplinary action pending against him/her.

15.2 The award of the degree must be recommended by the Senate

15.3 Convocation
Degree will be awarded for 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 ‘Award of Degree’) within the specified date in order to arrange for the award of the degree during convocation.

16 AWARD OF PRIZES, MEDALS, CLASS & RANKS
For the award of Prizes and Medals, the conditions stipulated by the Donor may be considered as per the statutes framed by the College 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 12.

17 CONDUCT AND DISCIPLINE

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

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

17.3 The following acts of omission/ or commission shall constitute gross violation of the Code of Conduct and are liable to invoke disciplinary measures:
   a) Ragging.
   b) Lack of courtesy and decorum; indecent behaviour anywhere within or outside the campus.
   c) Willful damage or stealthy removal of any property/belongings of the College/Hostel or of fellow students/citizens.
   d) Possession, consumption or distribution of alcoholic drinks or any kind of hallucinogenic drugs.
   e) Mutilation or unauthorized possession of Library books.
   f) Noisy and unseemly behaviour, disturbing studies of fellow students.
   g) Hacking in computer systems (such as entering into other Person’s area without prior permission, manipulation and/or Damage of computer hardware and software or any other Cyber crime etc.).
   h) Plagiarism of any nature.
   i) Any other act of gross indiscipline as decided by the Senate from time to time.
   j) Use of Mobile in the college Academic area.
   k) Smoking in College Campus and supari chewing.
   l) Unauthorized fund raising and promoting sales.

Commensurate with the gravity of offence 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.

17.4 For an offence committed in (i) a hostel (ii) a department or in a class room 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.

17.5 All cases involving punishment other than reprimand shall be reported to the Principal.

17.6 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.

18. **EARNING OF ACTIVITY POINTS FOR THE AWARD OF DEGREE**

18.1 As per VTU guidelines, every students entering 4 year degree programme should earn 100 activity points & every students entering 4 year degree programme through Lateral Entry should earn 75 activity points for the award of the Engineering Degree.

18.2 The Activity Points earned will be reflected on the student’s eighth semester Grade Card.

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

18.4 Activity Points (non-credit) have no effect on SGPA/CGPA point.

18.5 In case students fail to earn the prescribed Activity Points, Eighth semester Grade Card shall be issued only after earning the required Activity Points.

Note: Students are required to be inside the examination hall, 20 minutes before the commencement of 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.

**********
## LIST OF MAJOR SCHOLARSHIPS

<table>
<thead>
<tr>
<th>Applicable to</th>
<th>Types of scholarship</th>
<th>Method</th>
<th>Website</th>
</tr>
</thead>
<tbody>
<tr>
<td>For SC/ST Students</td>
<td>Income : Below Rs.2,50,000/-</td>
<td>Online application</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Income : Above Rs.2,50,000/- to Rs.10,00,000/-</td>
<td></td>
<td>SSP</td>
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<tr>
<td>For Others</td>
<td>Category I :</td>
<td>Online application</td>
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<tr>
<td></td>
<td>Category 2A, 3A, 3B, &amp; GM</td>
<td>Online application</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Income Below Rs.1,00,000/-</td>
<td>Online application</td>
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<tr>
<td></td>
<td>Minority students</td>
<td>Online application</td>
<td>NSP &amp; SSP</td>
</tr>
<tr>
<td></td>
<td>Income Below Rs.2,50,000/-</td>
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<td>Parents must have Beedi Id. Card</td>
<td>Beedi Scholarship</td>
<td>Online application</td>
<td>scholarships.gov.in or nsp.gov.in</td>
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<tr>
<td>1st year Students</td>
<td>Central Sector Scholarship (MHRD)</td>
<td>Online application</td>
<td>scholarships.gov.in or nsp.gov.in</td>
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<td>1st year Students</td>
<td>AICTE-Pragati.etc</td>
<td>Online application</td>
<td><a href="http://www.aicte-india.org">www.aicte-india.org</a></td>
</tr>
</tbody>
</table>

1. Scholarship details will be published in the notice board near College Academic Section. Students must see the notice board and submit the application before due dates.
2. All SC/ST and Category I students who have not paid any fee in CET must apply for Fee concession or Scholarship. Otherwise they must pay the tuition fee and college fee.
3. The students, who are applying for any of the above scholarship through online, must submit the hardcopy with supporting documents (with attestation) to the academic section in time.
B. E. SYLLABUS

ELECTRICAL & ELECTRONICS ENGINEERING
2019-23 Batch

V & VI SEMESTER

With Scheme of Teaching & Examination
<table>
<thead>
<tr>
<th>Sl. No</th>
<th>Name of Faculty</th>
<th>Qualification</th>
<th>Designation</th>
</tr>
</thead>
<tbody>
<tr>
<td>1.</td>
<td>Dr. Nagesh Prabhu</td>
<td>Ph.D.</td>
<td>Professor</td>
</tr>
<tr>
<td>2.</td>
<td>Dr. Sathyendra Kumar</td>
<td>Ph.D.</td>
<td>Professor</td>
</tr>
<tr>
<td>3.</td>
<td>Dr. Suryanarayana K.</td>
<td>Ph.D.</td>
<td>Professor &amp; HOD</td>
</tr>
<tr>
<td>4.</td>
<td>Mr. K. Vasudeva Shettigar</td>
<td>M.Tech</td>
<td>Associate Professor</td>
</tr>
<tr>
<td>5.</td>
<td>Dr. Nayana Shetty</td>
<td>Ph.D.</td>
<td>Associate Professor</td>
</tr>
<tr>
<td>6.</td>
<td>Dr. Anitha Marina Colaco</td>
<td>Ph.D.</td>
<td>Associate Professor</td>
</tr>
<tr>
<td>7.</td>
<td>Mr. Naveen J.</td>
<td>M.Tech</td>
<td>Asst. Prof Gd III</td>
</tr>
<tr>
<td>8.</td>
<td>Mr. Pradeep Kumar</td>
<td>M.Tech (Ph.D.)</td>
<td>Asst. Prof Gd III</td>
</tr>
<tr>
<td>9.</td>
<td>Dr. Latha Shenoy</td>
<td>M.Tech (Ph.D.)</td>
<td>Asst. Prof Gd III</td>
</tr>
<tr>
<td>10.</td>
<td>Dr. CifhaCrecil Saldanha</td>
<td>Ph.D.</td>
<td>Asst. Prof Gd III</td>
</tr>
<tr>
<td>11.</td>
<td>Mr. Dinesh Shetty</td>
<td>M.Tech (Ph.D.)</td>
<td>Asst. Prof Gd III</td>
</tr>
<tr>
<td>12.</td>
<td>Mr. Mahabaleshwara Sharma K.</td>
<td>M.Tech</td>
<td>Asst. Prof Gd II</td>
</tr>
<tr>
<td>13.</td>
<td>Mrs. Raksha Adappa</td>
<td>M.Tech</td>
<td>Asst. Prof Gd II</td>
</tr>
<tr>
<td>14.</td>
<td>Mr. Girisha Joshi</td>
<td>M.Tech (Ph.D.)</td>
<td>Asst. Prof Gd II</td>
</tr>
<tr>
<td>15.</td>
<td>Mrs. Soumya Rani Mestha</td>
<td>M.Tech (Ph.D.)</td>
<td>Asst. Prof Gd II</td>
</tr>
<tr>
<td>16.</td>
<td>Mr. Gururaj K.</td>
<td>M.Tech</td>
<td>Asst. Prof Gd II</td>
</tr>
<tr>
<td>17.</td>
<td>Mr. Ravikiran Rao</td>
<td>M.Tech</td>
<td>Asst. Prof Gd II</td>
</tr>
<tr>
<td>18.</td>
<td>Md. Abdul Raheman</td>
<td>M.E</td>
<td>Asst. Prof Gd II</td>
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<tr>
<td>19.</td>
<td>Mrs. Swathi Hatwar H.</td>
<td>M.Tech</td>
<td>Asst. Prof Gd II</td>
</tr>
<tr>
<td>20.</td>
<td>Mrs. Palimaru Aparna</td>
<td>M.Tech</td>
<td>Asst. Prof Gd I</td>
</tr>
<tr>
<td>22.</td>
<td>Mr. Krishna Rao</td>
<td>M.Tech (Ph.D.)</td>
<td>Asst. Prof Gd I</td>
</tr>
</tbody>
</table>
Vision
Pursuing excellence in Electrical & Electronics Engineering, creating a research environment to promote innovation and address global challenges.

Mission
- To equip students to face global challenges by excelling in professional career and higher education.
- To offer high quality graduate and post graduate programs in electrical & electronics engineering.
- To promote excellence in research, collaborative activities and contribute to social development with ethical values.

Programme Educational Objectives (PEO)
1. Excel in professional career and / or higher education by acquiring knowledge in mathematical, electrical, electronics and computer engineering principles.
2. Analyze real life problems, design electrical and electronics & multidisciplinary engineering systems and solutions that are socially acceptable
3. Inculcate and exhibit ethical values, communication skills and provide supportive and leadership roles in their profession to emerge as excellent professionals and adapt to current trends by engaging in lifelong learning to promote research.
Programme Outcomes (PO)

At the end of B.E (E&E) program the students will have an ability to

PO1 Engineering knowledge: Apply the knowledge of mathematics, science, engineering fundamentals, and an engineering specialization for the solution of complex engineering problems.

PO2 Problem analysis: Identify, formulate, review research literature, analyze complex Electrical & Electronics Engineering problems and draw substantiated conclusions by applying the principles of mathematics, basic science 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 public health and safety, and 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 modelling 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 the 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 the 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 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 (PSO)**

PSO1  An ability to demonstrate the electrical and electronics engineering concepts by developing working models.

PSO2  Ability to model, simulate and develop application specific systems to meet industrial /societal needs.
## Detailed Scheme and Syllabus for 2019-23 Batch
### V Semester (2019-23)

<table>
<thead>
<tr>
<th>Code</th>
<th>Course Title</th>
<th>L-T-P-J</th>
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<th>SEE</th>
<th>Total</th>
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<tbody>
<tr>
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<td>Linear Integrated Circuits</td>
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<td>3</td>
<td>50</td>
<td>50</td>
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<tr>
<td>19EE502</td>
<td>Signal Analysis &amp; Processing</td>
<td>3-2-0-J</td>
<td>4</td>
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<tr>
<td>19EE503</td>
<td>Linear Control Systems</td>
<td>3-2-0-J</td>
<td>4</td>
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<tr>
<td>19EE504</td>
<td>Power Electronics</td>
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<td>19EE505</td>
<td>Management &amp; Entrepreneurship</td>
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<td>19EE506</td>
<td>Transformers and Induction Machines Laboratory</td>
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## VI Semester (2019-23)

<table>
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<tr>
<th>Code</th>
<th>Course Title</th>
<th>L-T-P-S/J</th>
<th>Credits</th>
<th>CIE</th>
<th>SEE</th>
<th>Total</th>
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<tbody>
<tr>
<td>19EE601</td>
<td>Power Systems Analysis &amp; Stability</td>
<td>3-2-0-J</td>
<td>4</td>
<td>50</td>
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<tr>
<td>19EE602</td>
<td>Switchgear and Protection</td>
<td>3-0-0-S</td>
<td>3</td>
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<tr>
<td>19EE603</td>
<td>High voltage Engineering</td>
<td>3-0-0-S</td>
<td>3</td>
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<td>19EE604</td>
<td>VLSI Circuits and Design</td>
<td>3-0-0-0</td>
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<tr>
<td>19EE605</td>
<td>Power Electronics Laboratory</td>
<td>0-0-2-0</td>
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<td>19EE606</td>
<td>Linear IC and Control Systems Laboratory</td>
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<td>19EE607</td>
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<td>19EEE2xx</td>
<td>Program Elective – 3 (G2)</td>
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<td>19IL002</td>
<td>Employability Skill Development –II</td>
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<td>19-2-8-S/J</td>
<td>23</td>
<td>500</td>
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<td>900</td>
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L – Lecture  
T – Tutorials  
P – Practical  
S – Self Study  
J – Project Based Learning
# LIST OF PROGRAM ELECTIVES

(Student can register for 6 program electives between 5th to 8th semesters from the list given below. Students are advised to register one elective each from Group-I & Group-II in any semester to avoid SEE of both electives on same day)

<table>
<thead>
<tr>
<th>Group – I</th>
<th>Group - II</th>
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</thead>
<tbody>
<tr>
<td>Course Code</td>
<td>Elective Course Title</td>
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<tr>
<td>------------------------</td>
<td>------------------------</td>
</tr>
<tr>
<td>I. Power Electronics &amp; Drives</td>
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</tr>
<tr>
<td>19EEE101</td>
<td>Power Semiconductor Devices</td>
</tr>
<tr>
<td>19EEE102</td>
<td>Switched Mode Power Converter</td>
</tr>
<tr>
<td>19EEE103</td>
<td>Computer Control of Electrical drives</td>
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<tr>
<td>II. Control System</td>
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<tr>
<td>19EEE111</td>
<td>Fuzzy Logic Control</td>
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<tr>
<td>19EEE112</td>
<td>Artificial Neural Networks</td>
</tr>
<tr>
<td>19EEE113</td>
<td>Advanced Control Theory</td>
</tr>
<tr>
<td>19EEE114</td>
<td>Robotics and Automation</td>
</tr>
<tr>
<td>19EEE115</td>
<td>Physiology Control System and Simulation Modelling</td>
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<tr>
<td>III. Energy System</td>
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<tr>
<td>19EEE121</td>
<td>Renewable Energy Sources</td>
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<tr>
<td>19EEE122</td>
<td>Energy Audit &amp; Demand Side Management</td>
</tr>
<tr>
<td>19EEE123</td>
<td>Electrical Power Quality</td>
</tr>
<tr>
<td>19EEE124</td>
<td>Integration of Distributed Generation Systems</td>
</tr>
<tr>
<td>19EEE125</td>
<td>Electrical Machines Design</td>
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<tr>
<td>IV. Power System</td>
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<tr>
<td>19EEE131</td>
<td>HVDC Power Transmission</td>
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<tr>
<td>19EEE132</td>
<td>Smart Electric Grid</td>
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<tr>
<td>19EEE133</td>
<td>Modern Power System Protection</td>
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<tr>
<td>19EEE134</td>
<td>Power System Planning</td>
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<tr>
<td>19EEE135</td>
<td>Power System Operation &amp; Control</td>
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<tr>
<td>V. Microelectronics</td>
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<tr>
<td>19EEE141</td>
<td>ARM System Architecture</td>
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<tr>
<td>19EEE142</td>
<td>Analog and Mixed Signal Layout</td>
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<tr>
<td>Course Code</td>
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<td>------------</td>
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<tr>
<td>19EEE243</td>
<td>Introduction to ASIC and FPGA Design</td>
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<tr>
<td>19EEE151</td>
<td>OOP using C++</td>
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<tr>
<td>19EEE161</td>
<td>Hybrid Electric Vehicles</td>
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<tr>
<td>19EEE162</td>
<td>Hybrid and Plug-in Hybrid Vehicles</td>
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<tr>
<td>19EEE163</td>
<td>Power Electronics &amp; Drives for Electric Vehicles</td>
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**VI. IT and Managements**

<table>
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<tr>
<th>Course Code</th>
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<tbody>
<tr>
<td>19EEE251</td>
<td>Fundamentals of Python Programming</td>
</tr>
<tr>
<td>19EEE252</td>
<td>Operating System</td>
</tr>
<tr>
<td>19EEE253</td>
<td>Operations Research</td>
</tr>
<tr>
<td>19EEE254</td>
<td>Introduction to Machine Learning with Python</td>
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**VII. Electric Vehicles Technologies**

<table>
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<th>Course Title</th>
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</thead>
<tbody>
<tr>
<td>19EEE251</td>
<td>Battery storage and Fuel Cells for Electric Vehicles</td>
</tr>
<tr>
<td>19EEE262</td>
<td>Electric Vehicle Battery Charging Methods and Topologies</td>
</tr>
<tr>
<td>19EEE263</td>
<td>Modeling and Control of Hybrid Electric Vehicles</td>
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CORE COURSES – V SEMESTER

LINEAR INTEGRATED CIRCUITS

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<th>Course Code</th>
<th>CIE Marks</th>
<th>SEE Marks</th>
<th>Credits</th>
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<tr>
<td>19EE501</td>
<td>50</td>
<td>50</td>
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</tbody>
</table>

*Note: Lecture hours indicated are for teaching theoretical concepts. Illustrative examples and numerical problems are to be worked out in tutorial classes.

Prerequisites: Basic Electronics (19EC112), Analog Electronics Circuits (19EE304), Network Analysis (19EE302)

Course Learning Objectives:

1. To differentiate ideal and practical OP-AMP and identify various practical OP-AMP specifications and offset error voltages / currents and other critical parameters.
2. To analyze and design the direct coupled and capacitor coupled operational amplifier circuits & discusses OP-AMP circuit stability issues and frequency compensating methods.
3. To demonstrate the use of OP-AMP in signal processing applications
4. To analyze the non-linear behavior of the OP-AMP and design OP-AMP circuits in open loop and with positive feedback.

UNIT – I

Operational Amplifier: The basic operational amplifier, Ideal Op-Amp concept, Practical Op-Amps, OP-AMP as a DC amplifier, Offset error voltages and currents. 3*+1 Hours

OP-AMP as an AC Amplifier: Capacitor Coupled Voltage Follower, High Zin capacitor coupled voltage follower, capacitor coupled non-inverting amplifier, High Zin capacitor coupled non-inverting amplifier, Capacitor coupled inverting amplifier. Setting upper cut-off frequency, capacitor coupled difference amplifier, use of single polarity supply. 4*+5 Hours

OP-AMP Frequency Response and Compensation: Op-Amp circuit stability, frequency and phase response, frequency compensating methods, Manufacturer’s recommended compensation, Op-Amp circuit bandwidth, slew rate effects, stray capacitance effects, load capacitance effects, Circuit stability precautions. 4*+4 Hours

UNIT – II

OP-AMP Signal Processing Circuits: Precision Half wave and full wave rectifiers, limiting circuits, clamping circuits, peak detectors, sample and hold circuits. 3*+3 Hours

OP-AMP Nonlinear Circuits: Op-Amps in switching circuits, crossing detectors, inverting Schmitt trigger circuits, Non-inverting circuits, Astable multivibrators, Monostable multivibrators, Op-Amp based SCR triggering circuit. 3*+3 Hours

Active Filters: First and Second order high pass and low pass filters. Band pass filter, Band stop filters. Higher order filters. 3*+3 Hours

Specialized IC Applications: Universal active filters, Phase locked loops, Power amplifiers. 3*+0 Hours
UNIT – III

555 TIMER - Monostable and Astable multivibrators and applications 2*+2 Hours

DC-Voltage Regulators: Voltage regulator basics, Voltage follower regulator, adjustable output regulator, Precision voltage regulator, Integrated Circuit voltage Regulator. 3*+3 Hours

Course Outcomes:
At the end of the course student will be able to
1. Analyze the Op-Amp parameters and their limitations to design amplifier circuits.
2. Describe Op-Amp frequency response, circuit stability issues to design frequency compensating circuits.
3. Analyze linear and non-linear behavior of Op-Amp to design signal processing circuits.
4. Design Op-Amp based active filter circuits and describe specialized IC applications.
5. Use IC 555 and Op-Amp to design timers and voltage regulators.

<table>
<thead>
<tr>
<th>Course Outcomes Mapping with Program Outcomes &amp; PSO</th>
</tr>
</thead>
<tbody>
<tr>
<td>Program Outcomes →</td>
</tr>
<tr>
<td>---------------------</td>
</tr>
<tr>
<td>19EE501.1</td>
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<tr>
<td>19EE501.2</td>
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<td>19EE501.3</td>
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<tr>
<td>19EE501.4</td>
</tr>
<tr>
<td>19EE501.5</td>
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</table>

1: Low 2: Medium 3: High
* - If simulation task /model development is conducted in CIE, else no mapping

SEE Question Paper Pattern:
- There will be 8 questions of 20 marks each in the question paper categorized into 3 Units as per the syllabi & contact hours. The student will have to answer 5 full questions, selecting 2 full questions each from Unit - I&Unit – II and 1 full question from Unit – III.

TEXTBOOKS:
2. RamakanthGayakwad, Operational Amplifiers and Linear IC’s, 4th edition — Prentice Hall, 2000..

REFERENCE BOOKS:
E-Books / MOOC:
1. TI Precision Labs - Op Amps
2. NPTEL course on Op-Amp Practical Applications: Design, Simulation and Implementation by Prof. Hardik Jeetendra Pandya, IISc Bangalore

*SIGNAL ANALYSIS & PROCESSING*

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<td>Total Hours</td>
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*Note: Lecture hours indicated are for teaching theoretical concepts. Illustrative examples and numerical problems are to be worked out in tutorial classes.

J – Project Based Learning with suitable Simulation Tools

Prerequisites: VCTT (19EE301), PTNM (19EE401), NA (19EE302)

**Course Learning Objectives:**
1. To understand the basic operations on signals and properties of systems.
2. To explain the properties of linear time invariant systems in terms of impulse response description.
3. To know the Fourier representation of continuous time & discrete time periodic & aperiodic signals and their properties.
4. To evaluate DFT of various signals using its properties.
5. To evaluate the computational complexities of DFT using fast and efficient algorithms.
6. To know the importance of sampling theorem in signal processing.
7. To design infinite impulse response digital filters using bilinear transformation techniques.
8. To understand the procedures used for the design of linear phase FIR filters using rectangular window and Kaiser window

**UNIT – I**

Introduction: Continuous time and Discrete time signals, transformation of independent variables, exponential and sinusoidal signals, unit impulse, unit step function and Sinc function. The sampling theorem, Reconstruction of a signal from its samples using interpolation, The effect under sampling: Aliasing, Discrete time processing of continuous time signals, Sampling of discrete time signals

8*:5 Hours

**UNIT – II**

Continuous time and Discrete time systems, Continuous time LTI systems: The Convolution Integral. Discrete time LTI system: Convolution Sum. Properties of LTI system (Numerical excluded), Causal LTI systems described by Difference and Differential equations.

UNIT – III

The Continuous-time Fourier transform Properties of continuous-time Fourier transform, Systems characterized by Linear Constant Coefficient Differential equations.  
The Discrete-Time Fourier Transform: Representations of aperiodic signals, duality, Systems characterized by Linear Constant Coefficient Difference equations.  

UNIT – IV

Fourier representation of Finite duration sequences: Discrete Fourier Transform (DFT), Properties of DFT Computation of DFT: Decimation-in-Time FFT algorithms, Decimation-in-Frequency FFT algorithms. Effects of finite register length in Discrete Fourier Transform Computations: Analysis of quantization in Direct Computation of the DFT, Analysis of Quantization effects in Fixed Point and floating point FFT algorithms and Effect of coefficient of quantization in the FFT.  

UNIT – V


Course Outcomes:
At the end of the course student will be able to
1. Analyze signals and systems to study the behavioral aspects & determine the impulse response of CT & DT systems using convolution.  
2. Analyze Discrete LTI systems to determine the impulse response using convolution & application of Fourier series over CT & DT periodic signals.  
3. Apply Fourier technique to obtain the frequency domain representation of continuous-time & discrete-time aperiodic signals.  
4. Apply FFT to compute the frequency domain representation of discrete time sequence.  
5. Design of IIR and FIR filters to determine the filter coefficients for a given specification  

Course Outcomes Mapping with Program Outcomes & PSO

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1: Low 2: Medium 3: High
SEE QUESTION PAPER PATTERN:

- There will be 10 questions of 20 marks each in the question paper categorized into 5 units as per the syllabi & contact hours. The student will have to answer 5 full questions, selecting one full question from each unit.

TEXTBOOKS:

2. Discrete time signal processing, Alan V Oppenheim and Ronald W Schafer, PHI, 5th Indian Reprint, 2015

REFERENCE BOOKS:


E-Books / MOOC:

1. The Scientist and Engineer's Guide to Digital Signal Processing By Steven W. Smith, Ph.D.
3. NPTEL Course on Principles of Signals and Systems by Prof. Aditya K. Jagannatham, IIT Kanpur
4. Signal Processing: Continuous and Discrete on MIT Open courseware
5. Signals & Systems on MIT Open courseware
6. Digital Signal Processing 1: Basic Concepts and Algorithms on Coursera
7. Digital Signal Processing on MIT Open courseware
8. NPTEL Course on Signals and Systems by Prof. Kushal K. Shah, IISER Bhopal

***************
# LINEAR CONTROL SYSTEMS

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*Note: Lecture hours indicated are for teaching theoretical concepts. Illustrative examples and numerical problems are to be worked out in tutorial classes.

J – Project Based Learning with suitable Simulation Tools

**Prerequisites:** VCTT (19EE301), Engineering Mathematics-2(18MA201), Network Analysis (19EE302)

**Course Learning Objectives:**
1. To introduce modeling and analysis of electrical, electromechanical and mechanical systems.
2. To familiarize the students with analytical and graphical techniques to study the system stability
3. To make the students familiar with the time and frequency domain analysis of the system.

## UNIT – I

**Modeling of systems:** The control system, Mathematical models of physical system - electrical, mechanical, electromechanical systems, gear train, analogous system, introduction of state space modeling, simple system, DC servomotor, AC servo motor construction and working principle.

*8*+5 Hours

## UNIT – II

**Block diagrams and signal flow graphs:** Transfer functions, Block diagram algebra, Signal Flow graphs (State variable formulation excluded)

*5*+3 Hours

**Time Response of feedback control systems:** Standard test signals, Unit step response of first and second order systems, time response specifications of first & second order systems, steady–state static errors, and error constants.

*3*+2 Hours

## UNIT – III

**Stability analysis:** Concepts of stability, necessary conditions for stability, Routh-stability criterion, relative stability analysis

*4*+2 Hours

**Root–Locus Techniques:** Introduction, root locus concepts, construction of root loci, effect of addition of poles and zeroes.

*4*+3 Hours

## UNIT – IV

**Frequency domain analysis:** Frequency response specification, correlation between time and frequency response, Bode plots. All pass, minimum & non-minimum phase systems, assessment of relative stability using Bode plots, determination of transfer functions from Bode plots.

*7*+6 Hours
UNIT – V

Polar plots, Nyquist Criteria: Mathematical preliminaries, Nyquist stability criterion, assessment of relative stability using Nyquist plots 4*+3 Hours

Compensators and Controllers: Compensators, lead, lag, lag-lead networks, controllers P, PI, PID (qualitative analysis) 4*+2 Hours

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

1. Develop mathematical models of electrical, mechanical and electromechanical linear systems to study the system dynamics.
2. Compute system transfer function using block diagram reduction and signal flow graph to carry out time domain analysis.
3. Apply Routh Hurwitz criterion and root locus technique to assess system stability.
4. Analyze sinusoidal transfer function of physical systems using Bode plot to study the stability.
5. Sketch polar and Nyquist plots of a transfer function and list various compensators to observe system behaviour.

Course Outcomes Mapping with Program Outcomes & PSO

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1: Low 2: Medium 3: High

SEE QUESTION PAPER PATTERN:
- There will be 10 questions of 20 marks each in the question paper categorized into 5 units as per the syllabi & contact hours. The student will have to answer 5 full questions, selecting one full question from each unit.

TEXTBOOKS:

REFERENCE BOOKS:
E-Books / MOOC:
1. NPTEL Course on Control systems by Prof. C. S. Shankar Ram, IIT Madras
2. NPTEL Course on Control Engineering By Prof. RamkrishnaPasumarthy, IIT Madras

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Prerequisites: Basic Electronics (19EC112), AEC (19EE304)

Course Learning Objectives:
1. To understand the types and characteristics of power semiconductor devices
2. To familiarize the principle of operation of SCR & characteristics
3. To describe the principle of operation of AC voltage controller, controlled rectifier circuits and performance analysis.
4. To get acquainted with the different types of chopper configurations and methods of control.
5. To understand the principle of operation of single-phase and three-phase inverter circuits.

UNIT – I

Introduction, Power Semiconductor Devices: Applications of Power Electronics, power semiconductor devices, control characteristics. Types of power electronic circuits, peripheral effects.

4 Hours


7 Hours

UNIT – II

Thyristors: Introduction, characteristics. Two Transistor Model. Turn-on and turn-off. di/dt and dv/dt protection. Thyristor types. Series and parallel operation of Thyristors. Thyristor firing circuits, UJT, Sample design of firing circuits using UJT.

6 Hours


5 Hours

UNIT – III


5 Hours

thyristor chopper (only qualitative analysis)  

5 Hours

UNIT – IV


10 Hours

UNIT – V


10 Hours

**Course Outcomes:**
At the end of the course student will be able to
1. Identify suitable power semiconductor device to use in power modulator for a given application.
2. Illustrate the principle of operation of thyristors & characteristics to study various firing circuits and commutation methods.
3. Describe the principle of operation of AC voltage controller and DC choppers to evaluate performance parameters.
4. Analyze various controlled rectifier configurations to regulate dc voltage.
5. Describe the operation of single and three phase inverter circuits to obtain desired AC voltage.

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<tr>
<th>Course Outcomes Mapping with Program Outcomes &amp; PSO</th>
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1: Low 2: Medium 3: High

**SEE QUESTION PAPER PATTERN:**
- There will be 10 questions of 20 marks each in the question paper categorized into 5 units as per the syllabi & contact hours. The student will have to answer 5 full questions, selecting **one full** question from **each unit**.

**TEXTBOOK:**
REFERENCE BOOKS:

E-Books / MOOC:
1. NPTEL Course on Power Electronics By Prof. G.Bhuvaneshwari, IIT Delhi
2. Introduction to Power Electronics on Coursera
3. Power Electronics Specialization on Coursera
4. NPTEL Course on Advance power electronics and Control by Prof. Avik Bhattacharya, IIT Roorkee
5. Power Electronics on MIT Open courseware

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MANAGEMENT & ENTREPRENEURSHIP

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Course Learning 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 project management along with capital building process.
6. To discuss about different institutions at state and central levels supporting business enterprises.

UNIT – I


Directing and Controlling: 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  

15 Hours

UNIT – II

Social Responsibilities of Business: Meaning of Social Responsibility, Social Responsibilities of Business towards Different Groups, Social Audit, Business Ethics and Corporate Governance.

Entrepreneurship: 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


15 Hours

UNIT – III


New Control Techniques- PERT and CPM, Steps involved in developing the network, Uses and Limitations of PERT and CPM  

9 Hours

Course Outcomes:
At the end of the course student will be able to  
1. Describe the field of management, task of the manager, planning and steps in decision making.
2. Discuss the structure of organization, importance of staffing, leadership styles, modes of communication, techniques of coordination and importance of managerial control in business.
3. Describe the concepts of entrepreneurship and a businessman’s social responsibilities towards different groups.
4. Develop an understanding of role of SSI’s in the development of country and state/central level institutions/agencies supporting business enterprises.
5. Discuss the concepts of project management, capital budgeting, project feasibility studies, need for project report and new control techniques.
Course Outcomes Mapping with Program Outcomes & PSO

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1: Low 2: Medium 3: High

SEE Question Paper Pattern:
- There will be 8 questions of 20 marks each in the question paper categorized into 3 Units as per the syllabi & contact hours. The student will have to answer 5 full questions, selecting 2 full questions each from Unit - I & Unit - II and 1 full question from Unit – III.

TEXTBOOKS:

REFERENCE BOOKS:

************
Course Learning Objectives:
1. To familiarize the methods of testing transformer efficiency and regulation.
2. To understand the torque slip characteristics of an induction machine.
3. To perform the speed control of three phase induction machine.
4. To get acquainted to parallel operation and three-phase connections of single-phase transformers.

List of Experiments
2. Sumpner’s test.
4. Polarity test & connection of three- single-phase transformers in star – delta and determination of efficiency & regulation – for balanced direct loading for UPF.
5. Scott connection- for balanced and unbalanced two phases UPF loads.
7. Open-circuit& Blocked rotor test:
   a. Circle diagram of 3-phase induction Motor- performance evaluation
   b. Obtain the equivalent circuit diagram of a 3-phase I.M. and obtain its performance evaluation.
8. Speed control of 3-phase induction motor- stator voltage control & rotor resistance control (performance circuits for at least two different voltages/ two rotor resistance values).
9. Load test on- induction generator.
10. Load test on 1 phase induction motor.
11. Speed control of 3-phase induction motor by V/f method(Demo)

Course Outcomes:
At the end of the course student will be able to
1. Perform suitable testson transformer to predetermine/ determine efficiency and regulation.
2. Perform suitable test to analyze torque-slip characteristics of an induction machine.
3. Apply rotor resistance technique to control the speed of three-phase induction machine and test the use of star delta starter.
4. Operate two single-phase transformers in parallel to compute load sharing.
5. Connect three single-phase transformers banks to obtain different three-phase connections.
6. Conduct suitable tests to draw circle diagram and equivalent circuit to evaluate the performance of three -phase induction machine.
Course Outcomes Mapping with Program Outcomes & PSO

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E Books:

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CIRCUITS AND MEASUREMENTS LABORATORY

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Course Learning Objectives:
1. To understand the process to verify various network theorems
2. To measure circuit parameters using bridges.
3. To measure active and reactive power in three-phase circuits.
4. To know the calibration procedures of single-phase energy meter
5. To determine ratio & phase angle error in current transformer.

List of Experiments
1. Measurement of low resistance using Kelvin Double Bridge.
4. Verification of Superposition and Reciprocity theorems
5. Verification of Thevenin’s and Norton’s theorem
6. Verification of Maximum power transfer theorem
7. Characteristics of series and parallel resonance
9. Transient response of first and second order circuits using RL, RC and RLC Circuits
10. Determination of ratio & phase angle error in CT.
11. Calibration and adjustment of single-phase energy meter.
Course Outcomes:
At the end of the course student will be able to
1. Use suitable bridge circuit to measure resistance, inductance and capacitance.
2. Record the transient response of first and second order RLC circuits to compute the performance parameters.
3. Conduct experiments on given circuit to validate network theorems.
4. Conduct experiments on given three-phase circuit to measure active and reactive power.
5. Conduct experiment on given RLC circuit to verify resonance condition.
6. Conduct experiment to determine ratio & phase angle error in CT.
7. Calibrate single-phase energy meter and carry out brake magnet, friction compensation and power factor adjustments to minimize the error.

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EMPLOYABILITY SKILL DEVELOPMENT

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UNIT – I
- Quantitative- Numbers(Odd, even, H.C.F & L.C.M, Square roots& cube roots, Average, Percentage)
- Analytical/ logical- Numerical logic(next number in series, odd man out)
- Verbal- Vocabulary (root words, prefix, suffix)

UNIT – II
- Quantitative-Ratios& Proportions, Partnership
- Analytical/ logical- Coded language
- Verbal- Vocabulary (synonyms)

UNIT – III
- Quantitative- Time & work
- Analytical/ logical- Syllogism
- Verbal- Vocabulary (antonyms)
Syllabus of V & VI Semester B.E./Electrical & Electronics Engineering

UNIT – IV

- Quantitative- Pipes & Cistern
- Analytical/ logical- Direction (N-E-W-S)
- Verbal- One word substitution

UNIT - V

- Quantitative- Speed
- Analytical/ Logical- Seating arrangement
- Verbal- Idiom/ phrases

UNIT – VI

- Quantitative- Problems on trains
- Analytical /logical- Blood relations
- Verbal- Sentence completion

UNIT – VII

- Quantitative- Problems on boats & streams
- Analytical/ logical- Blood relations
- Verbal- Active & Passive voice

UNIT – VIII

- Quantitative- Allegation & Mixtures
- Analytical/ logical- Statement & Conclusion
- Verbal- Direct & indirect speech

REFERENCE BOOKS:

EXAMINATION PATTERN:
- This course is a mandatory learning course without credits. Continuous internal examination (CIE) consists of 2 internal exams (20 marks each) and tasks (10 marks). There is no semester end examination (SEE). The student will be awarded PP or NP grade as per autonomous regulations.
CORE COURSES - VI SEMESTER

POWER SYSTEMS ANALYSIS & STABILITY

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J – Project Based Learning with suitable Simulation Tools

* Note: Lecture hours indicated are for teaching theoretical concepts. Illustrative examples and numerical problems are to be worked out in tutorial classes.

Prerequisites: 19EE302 (NA), 19EE303 (DC & SM), TD (19EE406)

Course Learning Objectives:

1. To introduce the per unit system and explain its advantages.
2. To understand the concept of one line diagram and its application in power system.
3. To derive impedance & reactance diagram and compute the per unit quantities.
4. To understand the response of a synchronous machine under symmetrical short circuit condition.
5. To resolve un-balanced three-phase quantities to symmetrical components.
6. To understand the concept of sequence networks to solve various unsymmetrical faults.
7. To learn the dynamics of synchronous machine and derive the swing equation.
8. To understand the equal area criterion for the evaluation of stability of a sample system.

UNIT – I

Representation of Power System Components: Circuit models of Transmission line, Synchronous machines, Transformer and Load. One line diagram, Impedance diagram, per unit notation, Selection and change of base for per unit quantities, per unit Impedance diagram of power system.

8*+5 Hours

UNIT – II

Symmetrical Three-Phase Faults: Transients in RL series circuits, Short-circuit current and reactance’s of synchronous machine on no-load, Internal voltage of loaded synchronous machine under transient conditions, symmetric short circuit MVA calculations, Short circuit current computation through Thevenin’s theorem, Problems, Selection of circuit breakers, concept of short circuit capacity of bus.

8*+5 Hours

UNIT – III

SYMMETRICAL COMPONENTS: Symmetrical component transformation, Resolution of unbalanced phasors into their symmetrical components and vice-versa, Power in terms of symmetrical components, Phase shift of symmetrical components in Star – Delta transformer bank. Positive, Negative and Zero Sequence impedances and Sequence networks of power system elements (Transmission line, Synchronous machine and Transformer).

8*+5 Hours

UNIT – IV

Unsymmetrical Faults: Symmetrical component analysis of Unsymmetrical faults, Line-
To-Ground (L-G), Line-To-Line (L-L), Double Line-To-Ground (L-L-G) faults on an Unloaded Alternator and Power System with and without fault impedance and connections of sequence networks. Open conductor faults in power systems.

7*+6 Hours

**UNIT – V**


8*+5 Hours

**Course Outcomes:**
At the end of the course student will be able to
1. Model the power system components to construct per unit impedance diagram.
2. Analyze symmetrical three phase faults in power system to determine short circuit kVA.
3. Apply the concept of symmetrical components to calculate sequence components and draw sequence networks.
4. Analyze the unsymmetrical faults using symmetrical components to determine fault currents.
5. Analyze dynamics of synchronous machine to evaluate transient stability.

**Course Outcomes Mapping with Program Outcomes & PSO**

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1: Low 2: Medium 3: High

**SEE QUESTION PAPER PATTERN:**
- There will be 10 questions of 20 marks each in the question paper categorized into 5 units as per the syllabi & contact hours. The student will have to answer 5 full questions, selecting one full question from each unit.

**TEXTBOOKS:**

**REFERENCE BOOKS:**

**E Books / NPTEL / MOOC**
1. NPTEL Course on Power system analysis by Prof. Debapriya Das, IIT Kharagpur
2. NPTEL Course on Computer Aided Power System Analysis by Prof. Biswarup Das, IIT Roorkee
SWITCHGEAR AND PROTECTION

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*Self Study Topics – To be covered under the supervision of the course instructors.

Prerequisites: T&D(19EE406), TIM(19EE402), DCSM(19EE303)

Course Learning Objectives:
1. To understand the basic equipment in power system/substation.
2. To familiarize with the different grounding systems implemented in power systems.
3. To understand the construction and working of different types of circuit breakers used in power systems.
4. To study the characteristics and working of various types of relays
5. To understand the various protection schemes of electrical machines.

UNIT – I

Switches and fuses: Isolating switch, load breaking switch, Fuse law, cut-off characteristics, Time current characteristics, fuse material, HRC fuse, liquid fuse, Application of fuse.

Grounding Systems: Introduction, resistance grounding systems, neutral grounding, ungrounded system, resonant grounding, solid grounding, reactance grounding, resistance grounding, earthing transformer

SS Topic: neutral grounding transformer.


SS Topic: resistance switching.

UNIT – II

Construction & principle of operation of Circuits Breakers: Air Circuit breakers – Air break and Air blast Circuit breakers, oil Circuit breakers - Single break, double break and minimum OCB, SF6 breaker - Preparation of SF6 gas, Puffer and non Puffer type of SF6 breakers,
Vacuum circuit breakers, advantages and disadvantages of different types of Circuit breakers

SS Topic: short circuit test layout.

Protective Relaying: Requirement of protective relaying, zones of protection, primary and backup protection, essential qualities of protective relaying, classification of protective relays.

7 Hours

2 Hours
**Induction type relay:** Non-directional and directional over current relays, IDMT and Directional characteristics. Differential relay – Principle of operation, percentage differential relay, bias characteristics, distance relay – Three stepped distance protection, Impedance relay, Reactance relay, Mho relay, Buchholz relay, Negative Sequence relay, relay coordination

**SS Topics:** Microprocessor based over current relay – block diagram approach.

6 Hours

**UNIT – III**

**Protection Schemes:**
Generator Protection – Merz-Price protection, prime mover faults, stator and rotor faults, protection against abnormal conditions – unbalanced loading, loss of excitation, over speeding. Transformer Protection - differential protection, differential relay with harmonic restraint.

5 Hours

**SS Topic:** Inter-turn faults
Induction Motor Protection – Protection against electrical faults such as phase fault, ground fault. Protection of induction motor against abnormal operating conditions such as single phasing, phase reversal and overload.

4 Hours

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

1. Describe the necessity of switches, fuses and the importance of grounding systems to select a suitable protection device & grounding scheme.
2. Apply the theory of circuit breaking to determine re-striking, recovery voltage and RRRV.
3. Describe the principle of various circuit breakers to choose a suitable one for a given application.
4. Describe the working principle of various relays and suggest relay settings for different protective zones of transmission line.
5. Apply protection schemes to protect generators, transformers and induction motors.

**Course Outcomes Mapping with Program Outcomes & PSO**

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1: Low 2: Medium 3: High

SEE Question Paper Pattern:
- There will be 8 questions of 20 marks each in the question paper categorized into 3 Units as per the syllabi & contact hours. The student will have to answer 5 full questions, selecting 2 full questions each from Unit - I & Unit – II and 1 full question from Unit – III.
TEXTBOOKS:

REFERENCE BOOKS:

E Books / MOOCS / NPTEL
1. NPTEL course on Power System Protection and Switchgear By Prof. Bhaveshkumar R. Bhalja, IIT Roorkee
2. NPTEL Course on Power System Protection by ByProf. Ashok Kumar Pradhan, IIT Kharagpur

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HIGH VOLTAGE ENGINEERING

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*Self Study Topics – To be covered under the supervision of the course instructors.

Prerequisites: TD (19EE405), TIM (19EE402), DCSM (19EE303)

Course Learning Objectives:
1. To introduce the concept of high voltage technology
2. To familiarize with concept of HV breakdown phenomena of dielectrics
3. To study methods of generation of HVAC and HVDC voltages and concept of generation of impulse voltage and current
4. To introduce the concept of measurement of high voltages.
5. To study the non-destructive insulation techniques and high voltage tests on electrical apparatus.

UNIT – I

Introduction: Introduction to HV technology, advantages of transmitting electrical power at high voltages, need for generating high voltages in laboratory. Important applications of high voltage. 3 Hours


Self study topic: Time lags in breakdown 7 Hours

Solid dielectrics: Intrinsic Breakdown, avalanche breakdown, thermal breakdown, and electromechanical breakdown.
**Syllabus**

**Syllabus of V & VI Semester B.E./Electrical & Electronics Engineering**

**UNIT – I**

**Liquid dielectrics:** Suspended particle theory, electronic Breakdown, cavity breakdown (bubble’s theory).

5 Hours

**Generation Of HV AC And DC Voltage:** HV AC-HV transformer; Need for cascade connection and working of transformers units connected in cascade. Series resonant circuit- principle of operation and advantages. Tesla coil. HV DC- voltage doubler circuit. Calculation of high voltage regulation, ripple and optimum number of stages for minimum voltage drop

SS Topic: Cock Croft- Walton type high voltage DC set

8 Hours


8 Hours

**UNIT – III**


5 Hours

**Non-Destructive Insulation Testing Techniques:** Dielectric loss and loss angle measurements using Schering Bridge, Transformer ratio Arms Bridge. Need for discharge detection and PD measurements aspects.

4 Hours

**Self study topic:** Isolators, cables, Insulators, High Voltage Tests on Electrical Apparatus

**Course Outcomes:**

At the end of the course student will be able to

1. Describe the basics of HV technology and analyze the breakdown phenomenon to understand the properties of gaseous dielectrics.
2. Analyze breakdown mechanisms in solid & liquid dielectrics, high AC and DC voltage generation to compute parameters of voltage doubler circuit.
3. Describe the generation of impulse voltages and currents needed to test the insulating medium.
4. Analyze high voltage and current measurement techniques to study the factors affecting the measurement.
5. Describe non-destructive insulation testing methods to study testing of high voltage apparatus.
Course Outcomes Mapping with Program Outcomes & PSO

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SEE Question Paper Pattern:
- There will be 8 questions of 20 marks each in the question paper categorized into 3 Units as per the syllabi & contact hours. The student will have to answer 5 full questions, selecting 2 full questions each from Unit - I & Unit – II and 1 full question from Unit – III.

TEXTBOOKS:

REFERENCE BOOKS:

E-Books / MOOC
2. http://www.nptel.ac.in/courses/108104048/

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VLSI CIRCUITS AND DESIGN

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Prerequisites: LD (19EE305), AEC(19EE304)

Course Learning Objectives:
1. To introduce the VLSI Technology, its components and characteristics.
2. To examine the electrical characteristics of MOS transistors.
3. To demonstrate the design procedure, rule to be followed and the concept of MOSFET Scaling in VLSI.
4. To illustrate the Geometry Effects and characteristics of MOS Inverters and universal gates.
5. To discuss advanced techniques and applications to CMOS logic circuits.

UNIT – I

CMOS Processing: Introduction to IC Technology, Moore’s law, VLSI design flow, VLSI Technology, Wafer fabrication process using Czochralski method, Photolithography, Well and Channel Formation, Gate oxide, Gate and Source/Drain formation, Contact & Metallization, fabrication of nMOS Transistor, Depletion type and Enhancement type MOS, CMOS n-well and P-well process, twin tub process, BiCmos

7 Hours

MOS TRANSISTORS (Electrical Characteristics): Two terminal MOS structure, flat band voltage, MOS system under external bias, structure and operation of MOS transistors, threshold voltage, drain to source current $I_{ds}$ verses $V_{ds}$ relationships, body effect, channel length modulation, mobility variation, Tunneling, punch through, hot electron effect MOS, models, small signal AC Characteristics

8 Hours

UNIT – II

Design: Mask Layer, Stick Diagram, Symbolic diagram, Sheet resistance, capacitance layer, inverter delays, rise time, fall time, cascading and super buffer. RC delay model, Linear Delay Model, Logical effort, Parasitic Delay, Design Rules

4 Hours

Scaling: MOSFET scaling and geometry effects: Introduction, constant field scaling, constant voltage scaling, short channel Effects, narrow channel effects, Comparison of MOSFET parameters due to scaling

4 Hours

Application-MOS Inverters Static Characteristics: Introduction, voltage transistor characteristics, noise immunity and noise margin, power and area considerations, resistive load inverter calculation of $V_{oh}$, $V_{ol}$, $V_{il}$, $V_{ih}$, inverters with $n$ type MOSFET load (enhancement, depletion) characteristics, CMOS inverter static characteristics (excluding derivation) design of CMOS inverter, latch up bulk CMOS

8 Hours

UNIT – III

Application- 2 input NOR and NAND gates: MOS based 2 input NOR and NAND gate (with derivation), CMOS based 2 input NOR and NAND gate (excluding derivation)
Application- Other Forms Of CMOS Logic: Pseudo nMOS logic, dynamic CMOS logic,
clocked CMOS logic, CMOS domino logic, parity generator, multiplexer, dynamic shift registers.

Course Outcomes:
At the end of the course student will be able to
1. Illustrate the CMOS VLSI design flow to outline the CMOS IC fabrication process
2. Analyze the structure, operation of MOS transistor to study the electrical characteristics.
3. Use layout design rules to sketch CMOS logic circuits & compare effect of scaling on MOSFET parameters.
4. Analyze MOS static characteristics to design the NMOS and CMOS inverter circuits.
5. Design logic circuits using MOS transistors to study the IC fabrication aspects.

Course Outcomes Mapping with Program Outcomes & PSO

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SEE Question Paper Pattern:
- There will be 8 questions of 20 marks each in the question paper categorized into 3 Units as per the syllabi & contact hours. The student will have to answer 5 full questions, selecting 2 full questions each from Unit - I & Unit – II and 1 full question from Unit – III.

TEXTBOOKS:

REFERENCE BOOKS:
E-Books / MOOC
1. NPTEL Course on Digital VLSI Testing by Prof. Santanu Chattopadhyay, IIT Kharagpur
2. NPTEL Course on CMOS Digital VLSI Design by Prof. Sudeb Dasgupta, IIT Roorkee
3. NPTEL Course on VLSI Physical Design by Prof. Indranil Sengupta, IIT Kharagpur

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POWER ELECTRONICS LABORATORY

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Course Learning Objectives:
1. To study the Static characteristics of SCR, MOSFET and IGBT.
2. To design and test the UJT relaxation oscillator for triggering SCR.
3. To study AC voltage controller, single-phase controlled rectifier, single-phase inverter, and chopper circuits
4. To validate SCR commutation circuits.

List of Experiments
1. Static characteristics of SCR.
2. Static characteristics of MOSFET and IGBT.
3. SCR turn-on circuit using synchronized UJT relaxation oscillator.
4. Digital Triggering Circuit for Triggering SCR.
5. Speed Control of Stepper Motor.
6. A.C. voltage controller using TRIAC and DIAC combination connected to R and R-L loads.
8. SCR turn-off using LC commutation
9. SCR turn-off using Auxiliary commutation
10. Speed control of a separately excited D.C. motor using MOSFET chopper.
11. IGBT-Based Single phase PWM Inverter

Course Outcomes:
At the end of the course student will be able to
1. Draw the static characteristics of MOSFET, IGBT and SCR to identify different regions of operation.
2. Design and test UJT relaxation oscillator to trigger SCR.
3. Verify LC and Auxiliary commutation circuits to turn-off SCR used in choppers.
4. Build AC voltage controller using TRAIC-DIAC triggering circuit to produce variable voltage.
5. Build and test single-phase full-wave rectifier to check circuit behavior with R & R-L load.
6. Test IGBT based single-phase full-bridge inverter to observe the effect of various modulation techniques.
7. Use chopper circuit to demonstrate the speed control of a separately excited D.C. motor.
**Course Outcomes Mapping with Program Outcomes & PSO**

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**LINEAR IC AND CONTROL SYSTEMS LABORATORY**

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**Course Learning Objectives:**

1. To design & verify basic Op-Amp circuits.
2. To design and test Op-Amp based Schmitt trigger and multi-vibrator circuits.
3. To test Op-Amp based precision rectifiers and analyze active filter circuits.
4. To design and test 555-based circuits and IC-based voltage regulators.
5. To study the performance characteristics of P, PI & PID controllers and various compensators.
6. To study the speed-torque characteristics of DC and AC servo motors.

**List of Experiments**

   a. Inverting and Non-inverting amplifiers.
   b. Zero crossing detector
   a. Differentiator
   b. Integrators
3. Inverting and Non-Inverting Schmitt trigger for different hysteresis values using Op-amp.
4. Relaxation Oscillators- astable and monostable multivibrators using Op-Amp
5. Precision Rectifiers-precision HWR and FWR using Op-amp, Transfer characteristics.
6. Voltage regulators using IC LM723
7. Timer IC 555 experiments: Monostable multivibrator, Astable multivibrator, Schmitt trigger
10. DC and AC Servo motor characteristics
11. Performance characteristics of P, PI, and PID controller
Course Outcomes:
At the end of the course student will be able to
1. Design and test Op-Amp based linear circuits to process analog signals.
2. Design and test the Op-Amp based non-linear, multivibrator circuits and filters to process analog signals.
3. Use linear IC555 and IC LM723 to design multivibrator and voltage regulator circuits.
4. Apply P, PI, PD & PID controllers to observe the effect on system response.
5. Use Lag, lead and lag-lead compensators to improve the system stability.
6. Verify the performance of DC and AC Servo motors to plot torque-speed characteristics.

Course Outcomes Mapping with Program Outcomes & PSO

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1: Low  2: Medium  3: High

REFERENCE BOOKS:

E Learning / E Books
1. TI Precision Labs - Op Amps
2. IIT Bombay Linear Integrated Circuits Virtual Lab

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MINI PROJECT

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Course Learning Objectives:
1. To prepare a project synopsis based on theoretical understanding of the concepts and literature survey.
2. To develop and test a hardware prototype.

Course Outcomes:
At the end of the course student will be able to
1. Apply theoretical concepts to identify an engineering problem.
2. Review literature to understand the state-of-the-art technologies.
3. Build a team and contribute effectively towards the project.
4. Develop a hardware prototype to meet the design specifications.
5. Develop technical writing and presentation skills to communicate effectively.

Course Outcomes Mapping with Program Outcomes & PSO

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B. E. SYLLABUS

ELECTRICAL & ELECTRONICS ENGINEERING
2019-23 Batch

V & VI SEMESTER

With Scheme of Teaching & Examination (Program Elective Courses)
# Detailed scheme and syllabus of Program Electives for 2019-23 Batch

**List of Program Electives:**
(Student can register for 6 program electives between 5th to 8th semesters from the list given below. Students are advised to register one elective each from Group-I & Group-II in any semester to avoid SEE of both electives on same day)

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VI. IT and Managements

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<td>Power Electronics &amp; Drives for Electric Vehicles*</td>
<td>19EE504</td>
<td>19EEE263</td>
<td>19EE161</td>
<td>Modeling and Control of Hybrid Electric Vehicles *</td>
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I. POWER ELECTRONICS & DRIVES

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**Prerequisites:** Knowledge of Basic Semiconductor devices.

**Course Learning Objectives:**
1. To understand the principle of operation of power MOSFET and IGBT with their characteristics and effect of reverse recovery transients on switching stresses & losses
2. To study the construction and switching characteristics of various power semiconductor devices
3. To illustrate the importance of gate drive circuits for power devices, design of snubber circuits and heat sinks.

**UNIT – I**

**Introduction:** Power switching devices overview – Attributes of an ideal switch, application requirements, circuit symbols; Power handling capability – (SOA); selection strategy – On-state and switching losses – EMI due to switching – Power diodes – Types, forward and reverse characteristics, switching characteristics – rating

**Power MOSFET:** Basic structure & operation, I-V Characteristics, On-state operation, Turn-on, turn-off process, Switching characteristics: Turn-on transient, dv/dt capability, Turn-off transient, turn-off time, Switching losses, Safe operating Area, Effect of reverse recovery transients on switching stresses & losses, dv/dt limitations.

**UNIT – II**

**Power IGBT:** basic structure & operation, i-v characteristics, Latch-up in IGBT, Switching characteristics: turn-on, Turn-off transient, current tailing, Switching losses, Device limits & SOA, Over-current & short-circuit protection of IGBT

**Power Electronics Devices:** Construction and features of - Phase Controlled thyristors, inverter graded thyristors, ASCR, RCT, SUS, SBS, SCS, GTO, MCT, SIT, IGCT, MTO, ETO, PIC. Comparison of power devices.

**UNIT – III**

**Firing and Protecting Circuits:** Necessity of isolation, pulse transformer, optocoupler – Gate drives circuit: SCR, MOSFET, IGBTs and base driving for power BJT. - Over voltage, over current and gate protections; Design of snubbers, Guidance for heat sink selection, heat sink types and design – Mounting types.
Course Outcomes:
At the end of the course student will be able to
1. Analyze characteristics of power semiconductor devices to select an appropriate
device for given application
2. Summarize switching and I-V characteristics of MOSFET to know the maximum
switching frequency limit.
3. Analyze the I-V and switching characteristics to summarize dv/dt and di/dt
limitations, over current and short circuit protections to ensure safe operation of
IGBT.
4. Describe the construction and features of the emerging power electronic devices.
5. Analyze the importance of gate drive and protection circuits to switch power
electronic converters.

Course Outcomes Mapping with Program Outcomes & PSO

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1: Low 2: Medium 3: High

SEE Question Paper Pattern:
- There will be 8 questions of 20 marks each in the question paper categorized into 3
Units as per the syllabi & contact hours. The student will have to answer 5 full
questions, selecting 2 full questions each from Unit - I & Unit – II and 1 full question
from Unit – III.

TEXTBOOKS:
2. Mohan, Undeland and Robins, “Power Electronics – Converters, applications and

REFERENCE BOOKS:
2. B.W Williams 'Power Electronics Circuit Devices and Applications'. Palgrave

E-Books / MOOC
1. Module 1 of http://www.nptel.ac.in/courses/Webcourse-contents/IIT%20Kharagpur/
   Power%20Electronics/New_index1.html
2. https://www.coursera.org/learn/converter-zircuits/lecture/b5VYY/sect-4-2-0-
   introduction-to-power-semiconductors
SWITCHED MODE POWER CONVERTERS

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J - The course instructor can implement PBL (Project Based Learning) in this course.

Prerequisites: Power Electronics (19EE504).

Course Learning Objectives:
1. To introduce the concept of switched mode power converters
2. To study the working of non-isolated and isolated DC-DC switching power converters
3. To understand the working of switched mode DC-AC inverters
4. To understand the concept of resonant converter
5. To study various power line disturbance and power conditioners
6. To design high frequency transformer and inductor

UNIT – I

DC-DC switched mode converter topologies: Introduction, generalized comparison between switched mode and linear dc regulator, Control of dc-dc converters, Buck, Boost, Buck-Boost, Cuk dc-dc converter topologies, Full-bridge dc-dc converter.

DC-DC converter with isolation: Flyback converters, other Flyback converter topologies, forward converter, push-pull converter, half and full bridge converter.

UNIT – II

DC-AC switched mode inverters: Basic concept of switch-mode Inverters, single-phase inverter, three phase inverters. SPWM inverter, detailed theory, working principles, modes of operation with circuit analysis, ripple in the inverter output, switch utilization, problems.

Resonant switch converters: Classification of resonant converter, Resonant switch converter – ZCS, ZVS, ZVS-CV dc-dc converters; Resonant dc-link inverter with ZVS, problems.

UNIT – III

Power line disturbances, Power Conditioner, Uninterruptible Power Supplies, solar power based bidirectional inverter.
High frequency inductor and transformers design: specific inductor, transformer design, Inductor and transformer design procedure.
Course Outcomes:
At the end of the course student will be able to
1. Compare and contrast the Linear Voltage Regulator & SMPC. Describe the working principle of various non-isolated dc-dc converters and design the converter for a given specification
2. Describe the principle of operation of various isolated dc-dc converter and illustrate the design steps to be followed.
3. Analyze various switched mode inverters configurations to calculate performance parameters.
4. Analyze the performance of different resonant converters base on their working principle.
5. Design the magnetic components to be used in switched mode power supply and analyze the role of power conditioners to suppress various power line disturbances.

Course Outcomes Mapping with Program Outcomes & PSO

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1: Low 2: Medium 3: High
*- If PBL is carried out as a team

SEE Question Paper Pattern:
- There will be 8 questions of 20 marks each in the question paper categorized into 3 Units as per the syllabi & contact hours. The student will have to answer 5 full questions, selecting 2 full questions each from Unit - I & Unit - II and 1 full question from Unit – III.

TEXTBOOKS:

REFERENCE BOOKS:

E Books /MOOC/ NPTEL
1. http://nptel.ac.in/courses/108108036/

***************
Syllabus of V & VI Semester B.E./Electrical & Electronics Engineering

COMPUTER CONTROL OF ELECTRICAL DRIVES

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Prerequisites: Power Electronics (19EE504), Industrial Drives and Applications (19EE703).

Course Learning Objectives:
1. Review the applications micro controllers and power electronics in industrial drives
2. Explain the classification and control of AC drive using digital logic
3. Illustrate the control of synchronous machine and phase controlled converters.
4. Explain the principals of slip power recovery schemes and effect of EMI.
5. Identify the use of expert system application to drives and understand the concept of vector control of ac drives.

UNIT – I

REVIEW OF MICRO CONTROLLERS IN INDUSTRIAL DRIVES
SYSTEM: Typical Micro controller’s 8 bit 16 bit (only block diagram) Digital Data Acquisition system, voltage sensors, current sensors, frequency sensors and speed sensors.

EVOLUTION OF POWER ELECTRONICS IN DRIVES: Power semiconductors devices used for drives control, Ratings, comparison and their applications. Block diagram of power integrated circuit for DC motor drives.

AC MACHINE DRIVES: general classification and National Electrical Manufacturer Association (NEMA) classification, Speed control of Induction motors with variable voltage constant frequency, constant voltage variable frequency, (v/f) constant operation, drive operating regions. Variable stator current operation. Effect of Harmonics.

UNIT – II

SYNCHRONOUS MACHINE DRIVES: Wound field machine, comparison of Induction and wound field synchronous machines, Torque angle characteristics of salient pole synchronous machines, synchronous reluctance permanent magnet synchronous machines (SPM), variable reluctance machines (VRM).

PHASE CONTROLLED CONVERTERS: Converter controls, Linear firing angle control, cosine wave crossing control, phase locked Oscillator principle
Electromagnetic Interference (EMI) and line power quality problems, cyclo converters, voltage fed converters, Rectifiers, Current fed Converters.

PRINCIPALS OF SLIP POWER RECOVERY SCHEMES: Static Kramer’s drive system, block schematic diagram, phasor diagram and limitations, Static Scherbins scheme system using D.C link converters with cyclo converter modes of operation, modified Scherbins Drive for variable source, constant frequency (VSCF) generation.
UNIT – III

PRINCIPLE OF VECTOR CONTROL OF A C DRIVES: Phasor diagram, digital implementation block diagram, Flux vector estimation, indirect vector control block diagram with open loop flux control, synchronous motor control with compensation.

4 Hours

EXPERT SYSTEM APPLICATION TO DRIVES (ONLY BLOCK DIAGRAM): Expert system shell, Design methodology, ES based P-I tuning of vector controlled drives system, Fuzzy logic control for speed controller inverter control drives, structure of fuzzy control in feedback system.

4 Hours

Course Outcomes:
At the end of the course student will be able to
1. Describe the advances in microcontrollers and power electronics to understand their application in industrial drives.
2. Analyze different speed control methods of AC drives to choose appropriate method for a given drive requirements.
3. Analyze torque angle characteristics of synchronous motor drive, synchronous reluctance and variable reluctance machines, Understand phase-controlled converters used in control of electrical dives.
4. Describe the principals of slip power recovery schemes to improve the efficiency of drive.
5. Describe principle of vector control of AC drives and application of expert systems for control of electrical drives.

Course Outcomes Mapping with Program Outcomes & PSO

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1: Low 2: Medium 3: High

SEE Question Paper Pattern:
- There will be 8 questions of 20 marks each in the question paper categorized into 3 Units as per the syllabi & contact hours. The student will have to answer 5 full questions, selecting 2 full questions each from Unit - I & Unit – II and 1 full question from Unit – III.

TEXTBOOKS:

REFERENCE BOOKS:
1. “Advanced Microprocessor and Interfacing”- Badri Ram TMH, 2001
Syllabus of V & VI Semester B.E./Electrical & Electronics Engineering

SPECIAL ELECTRICAL MACHINES

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Prerequisites: DCSM (19EE303), TIM (19EE402).

Course Learning Objectives:

1. To study the working principle of stepper motor and its control
2. To understand working of switched reluctance motor
3. To know the difference between PMDC & BLDC motors
4. To understand principle of operation of permanent magnet synchronous motor
5. To introduce single phase special machines

UNIT – I

**Stepper Motor:** Variable reluctance (VR) Stepper Motor, Permanent Magnet Stepper Motor, Hybrid Stepper Motor, Other Types, Windings of Stepper Motor, open –loop, closed loop control of stepper motor, Microprocessor based control of stepper motor.

8 Hours

**Switched Reluctance Motor (SRM):** Construction, Principle of working, Basic SRM analysis, constraints on pole arc and tooth arc, Power Converter Circuits, Control of SRM, Rotor Position sensors, Current Regulator, Microprocessor Based Control of SRM, Sensorless Control of SRM.

7 Hours

UNIT – II

**Synchronous Reluctance Motor (SyRM):** Construction, Working, Control of SyRM, Advantage, Applications.

3 Hours

**PMDC and BLDC Motors:** Permanent Magnet DC (PMDC)Motor – Construction, working, Types of PMDC Motors, Brushless Permanent Magnet DC (BLDC) Motors – Classification, construction, Electronic commutation, principle of operation, BLDC square wave motor, Types of BLDC motor, Control of BLDC motor, Microprocessor Based control, DSP Based Control, Sensorless Control, Comparison of DC and BLDC motor, Applications

9 Hours

**Permanent Magnet Synchronous Motor:** Construction, principle of operation, Control of PMSM, Applications of PMSM.

3 Hours

UNIT – III


5 Hours

**Servo Motors:** DC Servo Motors – Construction, Principle of operation, voltage equation, control of DC servo motor. AC Servo Motor – Construction, working, torque speed characteristics.

4 Hours
Course Outcomes:
At the end of the course student will be able to
1. Describe working principle of different stepper motor types to achieve microprocessor based control.
2. Summarize working principle and requirements of power converter to achieve sensorless control of switched reluctance motor.
3. Compare and differentiate PMDC & BLDC motors to select a drive based on requirements
4. Describe the principle of operation of permanent magnet synchronous motor.
5. Outline the operation of single phase special machines and servo motors.

Course Outcomes Mapping with Program Outcomes & PSO

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TEXTBOOK:
1. E. G Janardanan, ‘Special Electrical Machines’ PHI Delhi, 2014.

REFERENCE BOOKS:

***************
SOLID STATE LIGHTING CONTROL

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J -The course instructor can implement PBL (Project Based Learning) in this course.

**Course Learning Objectives:**

1. To acquaint knowledge different types of light source and its utility.
2. To know the integration of lighting in diverse application.
3. To upgrade the knowledge in smart lighting.
4. To enumerate the skill in energy saving using solid state lighting.
5. To give insight to design steps involved in building solid state lighting

**UNIT – I**

**Introduction:** different types of light source – black body radiator, human vision, mesopic, scotopic, photopic vision, human light transduction model, lumen, luminous intensity, illumination, luminous efficacy, maintenance factor, depreciation factor, photometric analysis.

7 Hours

**Color science:** introduction to solid state lighting, construction of solid state lighting source, color rendition, correlated color temperature, binning, Macadam ellipse, different steps in Macadam ellipse, chromaticity diagram, color mixing, color evaluation techniques objective and subjective color analysis – problems

8 Hours

**UNIT - II**

**Converters for Lighting:** drivers, linear regulator, switch mode regulators using buck, boost and buck boost converter

8 Hours

**Light and health:** light as radiation, tissue damage by ultraviolet radiation, Tissue Damage by Visible and Near Infrared Radiation, Tissue Damage from Infrared Radiation beyond 1400 nm, Threshold Limit Values, Practical Considerations, Aging Effects, Risk of Exceeding Limits, Using Task Lights, Eyestrain, Migraine, Autism, Visual Comfort and Human Variability, Light Operating through the Circadian System, Sleep, blue light hazard.

9 Hours

**UNIT - III**

**Application of Solid-state lighting:** Horticulture lighting, Hospital lighting, architectural lighting, commercial lighting, Seasonal Affective disorder, Alzheimer, museum lighting.

7 Hours
**Course Outcomes:**
At the end of the course student will be able to
1. Analyze the color discrimination of the light source based on subjective and objective analysis
2. Identify the LED binning and illustrate the importance of Macadam ellipse
3. Categorize the color characteristic of the light source
4. Design the drivers for LEDs based on linear and switch mode regulators
5. Comprehend the application of solid-state lighting in health, commercial and non-commercial sectors

**Course Outcomes Mapping with Program Outcomes & PSO**

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1: Low 2: Medium 3: High

**SEE Question Paper Pattern:**
- There will be 8 questions of 20 marks each in the question paper categorized into 3 Units as per the syllabi & contact hours. The student will have to answer 5 full questions, selecting 2 full questions each from Unit - I & Unit - II and 1 full question from Unit - III.

**TEXTBOOKS:**

**REFERENCE BOOKS:**
1. LED lighting a primer to lighting the future Sal Cangeloso, Maker press, 2012
The course instructor can implement PBL (Project Based Learning) in this course.

**Course Learning Objectives:**

1. Analyze power electronic systems using ICs and apply the knowledge in a theoretical context.
2. Understand switching regulator control circuits.
3. Design high performance power electronic circuits using different ICs for various applications.
4. Think laterally and originally to solve power electronic circuits, and evaluate problems for switching power supplies.
5. Analyze Power Plant control using Programmable Logic Controller.

**UNIT – I**

**Introduction:** Measurement techniques for voltages, current, power, power factor in power electronic circuits, other recording and analysis of waveforms, sensing of speed.

7 Hours

**Switching Regulator Control Circuits:** Introduction, isolation techniques of switching regulator systems, PWM systems.

8 Hours

**UNIT – II**

**Commercial PWM Control ICs and their Applications:** TL 494 PWM Control IC, UC 1840 Programmable off line PWM controller, UC 1524 PWM control IC, UC 1846 current mode control IC, UC 1852 resonant mode power supply controller.

8 Hours

**Switching Power Supply Ancillary, Supervisory & Peripheral Circuits and Components:** Introduction, Opto-couplers, self-biased techniques used in primary side of reference power supplies, Soft/Start in switching power supplies, current limit circuits, over voltage protection, AC line loss detection, Implementation of different gating circuits.

8 Hours

**UNIT – III**

**Programmable Logic Controllers (PLC):** Basic configuration of a PLC, Programming and PLC, program modification, power plant control using PLCs.

8 Hours

**Course Outcomes:**

At the end of the course student will be able to

1. Describe the techniques used for measurements of parameter in a power electronics circuit.
2. Describe the operation of switching regulator control circuits.
3. Understand the architecture of commercial PWM control ICs.
4. Describe switching power supply ancillary, supervisory & peripheral circuits and components used in designing switching power supply.
5. Apply Programmable Logic Controller in power plant control.
### Course Outcomes Mapping with Program Outcomes & PSO

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<th>Program Outcomes</th>
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1: Low  \ 2: Medium  \ 3: High

*- If PBL is carried out as a team

### SEE Question Paper Pattern:
- There will be 8 questions of 20 marks each in the question paper categorized into 3 Units as per the syllabi & contact hours. The student will have to answer 5 full questions, selecting 2 full questions each from Unit - I & Unit - II and 1 full question from Unit – III.

### TEXTBOOKS:
3. UNIT rode application notes: http://www.smps.us/UNIT rode.html

***
II. CONTROL SYSTEM

FUZZY LOGIC CONTROL

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J - The course instructor can implement PBL (Project Based Learning) in this course.

Course Learning Objectives:

1. To differentiate conventional Set theory and Fuzzy logic
2. To study the concept of linguistic variables and inference rules
3. To analyse the application of fuzzy logic controller systems.
4. To understand the fuzzy knowledge-based controllers (FKBC)
5. To understand the process of performance monitoring and adaption mechanism using FKBC.

UNIT – I

Introduction: Fuzzy sets, Properties of fuzzy sets, operation in fuzzy sets, fuzzy relations, cardinality operations on fuzzy relations, Fuzzy Cartesian product and composition, fuzzy Tolerance and equivalence relations. 7 Hours

Theory of approximate reasoning: Linguistic variables, linguistic hedges, Fuzzy if then statements, inference rules, compositional rule of inference, graphical technique of inference, Fuzzification and defuzzification procedures. 8 Hours

UNIT – II

Development of membership functions-intuition, inference, rank ordering, neural networks, genetic algorithm, inductive reasoning Assumptions in a Fuzzy control system design, Simple fuzzy logic controllers, Examples of fuzzy logic controllers. 10 Hours

Fuzzy knowledge-based controllers (FKBC): Basic concept structure of FKBC, choice of membership functions, scaling factors, rules, FKBC as a Non-linear transient element, Design of P, PI, PD, PID controllers, sliding mode FKBC, Sugeno FKBC. 8 Hours

UNIT – III

ADAPTIVE FUZZY CONTROL: Process performance monitoring, adaption mechanisms, membership functions, tuning using gradient descent and performance criteria. Set organizing controller, Model based controller. 6 Hours

Course Outcomes:

At the end of the course student will be able to

1. Describe the fundamentals of Fuzzy logic to apply in systems with uncertainty.
2. Classify the linguistic variables & inference rules to formulate knowledge based system
3. Design sample fuzzy control systems to study the system behavior
4. Analyze fuzzy knowledge-based controllers (FKBC) to compare its performance with conventional controllers.
5. Describe the adaptive fuzzy control system to enhance the performance of FKBC systems.
## Course Outcomes Mapping with Program Outcomes & PSO

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<th>Program Outcomes</th>
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1: Low 2: Medium 3: High

### SEE Question Paper Pattern:
- There will be 8 questions of 20 marks each in the question paper categorized into 3 Units as per the syllabi & contact hours. The student will have to answer 5 full questions, selecting 2 full questions each from Unit - I & Unit – II and 1 full question from Unit – III.

### TEXTBOOKS:

### REFERENCE BOOKS:

### E-Books / MOOC/ NPTEL
1. http://nptel.ac.in/courses/108104049/
2. http://videolectures.net/acai05_berthold_fl/

***************
ARTIFICIAL NEURAL NETWORKS

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J - The course instructor can implement PBL (Project Based Learning) in this course.

Course Learning Objectives:
1. To introduce the concept and use of ANN
2. To explain the concept of supervised learning and various leaning algorithms.
3. To illustrate the use of Accelerating learning process and need of prediction network
4. To familiarize with the concept of Learning vector quantizing and associative modeling
5. To understand the need of optimization and different optimization algorithms

UNIT – I

Introduction, history, structure and function of single neuron, neural net architectures, neural learning, use of neural networks. 7 Hours

Supervised learning, single layer networks, perceptron’s, linear separability, perceptron training algorithm, guarantees of success, modifications. 4 Hours

Multiclass networks-I, multilevel discrimination, preliminaries, back propagation, setting parameter values, theoretical results. 5 Hours

UNIT – II

Accelerated learning process in layered neural network, application, mandaline, adaptive multilayer networks. 4 Hours

Prediction networks, radial basis functions, polynomial networks, regularization, unsupervised learning, winner take all networks. 4 Hours

Learning vector quantizing, counter propagation networks, adaptive resonance theorem, topologically organized networks, distance based learning, noncognition. 4 Hours

Associative models, hop field networks, brain state networks, Boltzmann machines, hetero associations. 4 Hours

UNIT – III

Optimization using hop filed networks, simulated annealing, random search, evolutionary computation. 7 Hours
Course Outcomes:
At the end of the course student will be able to
1. Describe the architecture of neural network to identify the functionalities of different layers.
2. Apply the single layer and multilayer learning algorithms to solve nonlinear system.
3. Describe the accelerated learning process and unsupervised learning algorithm.
4. Analyse the learning vector quantizing and associative modelling techniques to solve uncertainty in the system.
5. Describe the various neural network optimization algorithms

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TEXTBOOKS:

REFERENCE BOOKS:

E-Books / MOOC
1. http://nptel.ac.in/courses/117105084/
3. http://cse22-iiith.vlabs.ac.in/
The course instructor can implement PBL (Project Based Learning) in this course.

Prerequisites: Linear Control System (19EE503), VCTT (19EE301)

Course Learning Objectives:
1. To outline the state model and deduce the state equations for LTI systems.
2. To compute state transition matrix, the Eigen values and Eigen vectors.
3. To analyze the system for controllability and observability.
4. To design the controller using pole placement techniques to ensure stability.
5. To understand the behaviour of non-linear system and analyse the phase trajectory.
6. To study the Lyapunov stability criteria for nonlinear systems.

UNIT – I

State variable analysis & design, canonical representation and transfer function, linearization of state equations, State space representation using physical variables. State space representation using phase variables & canonical variables, Derivation of transfer function from state model, Solution of state equation.

State transition matrix & its properties, computation using Laplace transformation, Cayley-Hamilton method (only computation), Eigenvalues, Eigen vectors, generalized Eigen vectors, diagonalization.

UNIT – II

Concept of controllability & observability, methods of determining the same. Pole placement techniques: stability improvements by state feedback, necessary & sufficient conditions for arbitrary pole placement.

Introduction, behaviour of non-linear system, common physical non-linearity-saturation, friction, backlash, dead zone, relay, multi variable non-linearity, Phase plane method, singular points, stability of nonlinear system, limit cycles, construction of phase trajectories by Isocline method and Delta method.

UNIT – III

Lyapunov’s stability criteria for linear as well as nonlinear systems, stability definitions, theorems, sign definiteness, direct method, second method, Krasovskii’s method, variable gradient method and for linear systems for state variable models.
Course Outcomes:
At the end of the course student will be able to
1. Develop various state space model to obtain the transfer function for LTI system
2. Compute state transition matrix to solve the state equation
3. Analyze the pole placement techniques to enhance the stability of the system.
4. Identify the behavior of nonlinear system & evaluate various methods of stability to understand the system behavior.
5. Apply Lyapunov criteria to evaluate the Stability of linear and nonlinear system.

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1: Low 2: Medium 3: High
* if simulations are carried out as a part of PBL component in group

SEE Question Paper Pattern:
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TEXTBOOKS:

REFERENCE BOOKS:

E Books /MOOC/ NPTEL
1. http://nptel.ac.in/courses/108103007/
2. https://www.coursera.org/learn/designing-organization/lecture/Md2km/4-2-2-traditional-control-systems
3. https://www.edx.org/course/introduction-control-system-design-first-mitx-6-302-0x************
The course instructor can implement PBL (Project Based Learning) in this course.

**Course Learning Objectives:**
1. To understand the basic of composition of a robot
2. To illustrate various robot sensors and construction of robot
3. To familiarize the concept of kinematics of the robot
4. To enumerate the functions and advantages of the robot
5. To know the robot programming concept

**UNIT – I**


**Robot sensors:** Introduction, desirable features of sensors, magnetic sensors, fibre optic, tactile sensors, proximity and non-proximity sensors.

Manipulators, Actuators and grippers: Construction of manipulators, types of actuators, grippers, classification, force analysis of gripper mechanism, designing of grippers.

**UNIT – II**

*Control:* Introduction, Actuator dynamics, Set-Point Tracking, Drive Train Dynamics, Trajectory Interpolation, Feed forward Control and Computed Torque.

*Kinematics:* Forward, inverse and velocity kinematics Denavit-Hardenberg Representation, Examples

*Dynamics:* Euler Lagrange Equations, Expressions for kinetic and potential energy, Equation of Motions, Common configuration, Newton Euler Formulation.

Robot machine vision: Introduction, image processing and analysis.

**UNIT – III**

*Robot programming:* Lead through programming methods, Robot programming languages-examples.

*Case studies:* Robot applications in manufacturing, robot cell design, machine interface, multiple robots, robot in assembly and inspection.
Course Outcomes:
At the end of the course student will be able to
1. Recognize the components and classify robots based on its composition
2. Identify and describe various sensors to construct the robot.
3. Derive the kinematics of the robot to derive the control aspects
4. Apply the mathematical models to validate the dynamics of the system
5. Identify different programming methods and languages to the effective functioning
   of robot.

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<th>Program Outcomes Mapping with Program Outcomes &amp; PSO</th>
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1: Low 2: Medium 3: High

SEE Question Paper Pattern:
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  Units as per the syllabi & contact hours. The student will have to answer 5 full
  questions, selecting 2 full questions each from Unit - I & Unit – II and 1 full question
  from Unit – III.

REFERENCE BOOKS:
1. Mark W. Spong & M. Vidyasagar. Robot Dynamics and Control, Willey India
   Publisher, 2009.
   Education India Private Limited; 2 edition (23 May 2012)
5. Saeed B. Niku, Introduction to robotics, PHI, 2005

E-Books / MOOC / NPTEL
1. http://nptel.ac.in/downloads/112101098/
2. http://nptel.ac.in/downloads/112101099/

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PHYSIOLOGY CONTROL SYSTEM AND SIMULATION MODELLING

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Prerequisites: VCTT, PTNM, Control Systems, Advanced Control Theory

Course Learning Objectives:
1. To introduce the basic system concepts and differences between an engineering and physiological control systems.
2. To acquaint students with different mathematical techniques applied in analysing a system and the various types of nonlinear modelling approaches.
3. To teach neuronal membrane dynamics and to understand the procedures for testing, validation, and interpretation of physiological models.
4. To study the cardiovascular model and apply the modelling methods to multi-input and multi-output systems.

UNIT – I

Introduction to Physiological control systems: -Introduction, Similarities and difference with Technological control, Transfer of substances between physiological compartments: By diffusion, by fluid flow and separated by a thin membrane using differential equations. 7 Hours

Regulation in physiological control system: Regulation of electrolyte concentration, acid base balance, red blood cell production, arterial pressure, blood volume, respiration, body temperature, blood glucose. 8 Hours

UNIT – II

Biological control structure and modelling: Basic control structure and detailed parameters, Biofeedback, modelling of human thermal regulatory system including control aspects, Biochemistry of digestion, types of heat loss from body. 8 Hours

Control and regulation of respiratory system: Modelling of oxygen uptake, mass balance of lungs, gas transport mechanism of lungs, oxygen and carbon dioxide transport in blood and tissue. 7 Hours

UNIT – III

Application of biological control: Eye tracking control, Pupil control. 5 Hours

MATLAB Application and simulation: Derivation of Cardiovascular control system theoretical and using matlab. 4 Hours
Course Outcomes:
At the end of the course student will be able to
1. Comprehend the basic system concepts and differences between an engineering and physiological control systems.
2. Understand the application of various mathematical techniques in designing a bio-control system.
3. Comprehend the techniques of plotting the responses in both the domain analysis.
4. Apply time domain and frequency domain analysis to study the biological systems.
5. Develop simple models of the physiological control systems and analyze its stability.

SEE Question Paper Pattern:
- There will be 8 questions of 20 marks each in the question paper categorized into 3 Units as per the syllabi & contact hours. The student will have to answer 5 full questions, selecting 2 full questions each from Unit - I & Unit – II and 1 full question from Unit – III.

TEXTBOOKS:
1. Bio- Medical Engineering Principles By: David. Cooney, Michel Deckker INC.
3. The Application of Control Theory of a Physiological System by Howard T Milhorn
4. Automatic control systems: By Benjamin C Kuo.

REFERENCE BOOKS:

List of experiments for task by simulation

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<td>Develop the simplified model of cardiovascular system and measure the rise time, peak overshoot, settling time and steady state error for the nominal values of L, C and R and compare with the response of diseased person.</td>
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<td>Identify the physiological system from the time response analysis for the known input and output conditions.</td>
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<td>4</td>
<td>Frequency response analysis and designing of lag/lead compensator for improving the phase margin, gain margin and bandwidth of the light pupil reflex model. Estimate the range of K for stability.</td>
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<td>5</td>
<td>Design of controllers (P,PI, PID) for improving time domain specifications of lung mechanics</td>
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### PROGRAMMABLE LOGIC CONTROLLERS

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**J** - The course instructor can implement PBL (Project Based Learning) in this course.

**Prerequisites:** LD (19EE305)

**Course Learning Objectives:**
1. To understand the role of PLC in automation and SCADA, hardware capabilities of PLC in industrial automation.
2. To Program a PLC using ladder Diagram, Functional Block Diagram (FBD), Sequential Functions Charts (SFC), Instruction List (IL) and Structured Text (ST) methods
3. To Program a PLC using timers, counters, shift registers, data handling instructions.

#### UNIT – I

**Introduction:** Introduction to Programmable logic controller (PLC), SCADA Fundamentals: Introduction, Open system: Need and advantages, Building blocks of SCADA systems, role in automation, advantages and disadvantages, hardware, internal architecture, sourcing and sinking, characteristics of I/O devices, list of input and output devices, examples of applications. I/O processing, input/output units, signal conditioning, remote connections, networks, processing inputs I/O addresses. Human Machine Interfaces (HMIs).

8 Hours

#### UNIT – II

**Programming:** Ladder programming - ladder diagrams, logic functions, latching, multiple outputs, entering ladder programs, functional blocks, program examples, location of stop and emergency switches.

7 Hours

**Programming Languages:** Instruction list, sequential functions charts, structured text

**Internal Relays:** ladder programs, battery- backed relays, one - shot operation, set and reset, master control relay, example programs, jump and call subroutines.

9 Hours

#### UNIT – III

**Timers and counters:** Types of timers, programming timers, OFF- delay timers, pulse timers, programming examples, forms of counter, programming, up and down counting, timers with counters, sequencer.

8 Hours

**Shift register and data handling:** shift registers, ladder programs, registers and bits, data handling, arithmetic functions, closed loop control, Structure of control system, Temperature control

7 Hours
Note: Discussing the programming should be restricted to only one type of PLC (Mitsubishi)

Course Outcomes:
At the end of the course, the student will be able to
1. List and describe characteristics of various I/O devices and interface them to PLC unit
2. Apply suitable logic using various programming languages to achieve specific control mechanism for a given application
3. Use internal relays of PLC to control peripheral devices
4. Identify timer/counter resources of a PLC to design control logic for interfaced device.
5. Choose special functionalities of PLC to control and monitor functions and design the real-world applications

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1: Low 2: Medium 3: High

SEE Question Paper Pattern:
- There will be 8 questions of 20 marks each in the question paper categorized into 3 Units as per the syllabi & contact hours. The student will have to answer 5 full questions, selecting 1 question from Unit - I and 2 full questions each from Unit – IIand Unit – III.

TEXTBOOKS:

REFERENCE BOOKS:

E Books / MOOC/ NPTEL:
4. http://nptel.ac.in/courses/112102011/
5. http://nptel.ac.in/courses/112103174/
Course Learning Objectives:

1. To know the various aspects of instrumentation.
2. To understand the working principles of various measuring instruments and their characteristics.
3. To comprehend with the working of various transducers.
4. To know the need of Data acquisition, conversion and transmission.

UNIT – I

Instrumentation: Frequency meter, measurement of time and frequency (mains), tachometer, phase meter, capacitance meter. Automation in digital Instrumentation.

Analyzer: Wave analyzers and Harmonic distortion, Basic wave analyzer, Frequency selective wave analyzer, Harmonic distortion analyzer and Spectrum analyzer.

UNIT – II

Measuring Instruments: Output power meters, Field strength meter Vector impedance meter, Q meter applications-Z, Z 0 and Q. Basic LCR bridge, RX meters.

Measurement of power: Measurement of large amount of RF power (calorimetric method), measurement of power on a transmission line, standing wave ratio measurements.

Transducers: Synchro’s, Capacitance Transducers, Load cells, Piezo electrical Transducers, IC type temperature sensors, Pyrometers, Ultrasonic temperature Transducer, Reluctance pulse pick-ups, Flow measurement-mechanical Transducers; Magnetic flow meters, turbine flow meters. β-gauge.

UNIT – III

Data acquisition and conversion: Generalized data acquisition system (DAS), Signal conditioning of inputs, single channel DAS, multi-channel DAS, data loggers, compact data logger.

Course Outcomes:
At the end of the course student will be able to
1. Describe the principle of different sensors for the measurement of frequency and phase
2. List various types of signal analyzer to understand the operating principle & applications.
3. Describe the operating principle of various measuring instruments to determine the electrical parameters
4. Describe the working principles of various transducers to measure the electrical parameters of physical system
5. Describe the process of data acquisition and conversion for the effective data transmission

Course Outcomes Mapping with Program Outcomes & PSO

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1: Low 2: Medium 3: High

SEE Question Paper Pattern:
- There will be 8 questions of 20 marks each in the question paper categorized into 3 Units as per the syllabi & contact hours. The student will have to answer 5 full questions, selecting 2 full questions each from Unit - I & Unit – II and 1 full question from Unit – III.

REFERENCE BOOKS:
2. Modern Electronic Instrumentation and Measuring Techniques, Cooper D and A D Helfrick, PHI, 2009

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INDUSTRIAL SERVO CONTROL SYSTEMS

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J - The course instructor can implement PBL (Project Based Learning) in this course.

Course Learning Objectives:
1. To explain the evolution and classification of servos, with descriptions of servo drive actuators, amplifiers, feedback transducers, performance, and troubleshooting techniques.
2. To discuss system analogs and vectors, with a review of differential equations.
3. To represent servo drive components by their transfer function, to combine the servo drive building blocks into system block diagrams.
4. To determine the frequency response techniques for proper servo compensation.
5. To explain perform indices and performance criteria for servo systems.

UNIT – I


Machine Servo Drives: Types of Drives, Feed Drive Performance.
Troubleshooting Techniques: Techniques by Drive, Problems: Their Causes and Cures.

UNIT – II

Indexes of Performance: Definition of Indexes of Performance for Servo Drives, Indexes of Performance Electric and Hydraulic Drives 8 Hours

Performance Criteria: Percent Regulation, Servo System Responses.
Machine Considerations: Machine feed drive Considerations, Ball Screw Mechanical Resonances and Reflected Inertias for Machine Drives 7 Hours
UNIT – III

Machine Considerations: Drive Stiffness, Drive Resolution, Drive Acceleration, Drive Speed Considerations, Drive Ratio Considerations, Drive Thrust/Torque and Friction Considerations, Drive Duty Cycles

8 Hours

Course Outcomes:
At the end of the course student will be able to
1. Identify the benefits of servo system and various components to use in hydraulic /electric circuits.
2. Derive differential equations & transfer functions of servosystem to apply in physical systems.
3. Apply the generalized control theory for servo systems to study the frequency response.
4. Describe the various performance criteria & servo plant compensation techniques to the servo system
5. Identify the various machine considerations for servo drive systems.

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1: Low 2: Medium 3: High

SEE Question Paper Pattern:
- There will be 8 questions of 20 marks each in the question paper categorized into 3 Units as per the syllabi & contact hours. The student will have to answer 5 full questions, selecting 2 full questions each from Unit - I & Unit – II and 1 full question from Unit – III.

TEXTBOOK:

REFERENCE BOOKS:

**************
**DISCRETE CONTROL SYSTEM**

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**J** - The course instructor can implement PBL (Project Based Learning) in this course.

**Prerequisites:** Linear Control System, Advanced Control Theory

**Course Learning Objectives:**
1. To model the discrete-time systems by pulse transfer function
2. To study the stability of discrete time systems and the time response of discrete systems.
3. To examine the response of discrete time systems and the controllability observability and stability of discrete state space model.
4. To introduce the concept of state feedback system and the digital control systems with deadbeat response.
5. To analyze the sampled data control systems using root locus and bode plot techniques

**UNIT – I**

**Introduction to digital control:** Introduction, Discrete time system representation, Mathematical modeling of sampling process, Data reconstruction

**Modelling discrete-time systems by pulse transfer function:** Revisiting Z-transform, Mapping of s-plane to z-plane, Pulse transfer function, Pulse transfer function of closed loop system, Sampled signal flow graph.

8 Hours

**Stability analysis of discrete time systems:** Jury stability test, Stability analysis using bi-linear transformation

**Time response of discrete systems:** Transient and steady state responses, Time response parameters of a prototype second order system.

8 Hours

**UNIT – II**

**Discrete state space model:** Introduction to state variable model, Various canonical forms, Characteristic equation, state transition matrix, Solution to discrete state equation

**Controllability, observability and stability of discrete state space models:** Controllability and observability, Stability, Lyapunov stability theorem.

8 Hours

**State feedback design:** Pole placement by state feedback, Set point tracking controller, Full order observer, Reduced order observer.

**Deadbeat response design:** Design of digital control systems with deadbeat response, Practical issues with deadbeat response design, Sampled data control systems with deadbeat response

7 Hours

**UNIT – III**

**Illustration of design procedures of sampled data control systems:** Root locus method, Nyquist stability criteria, Bode plot, Controller design using root locus, Lead compensator design using Bode plot, Lag compensator design using Bode plot, Lag-lead
Compensator design in frequency domain (qualitative)  

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

1. Develop the mathematical modelling of the discrete-time systems to derive the pulse transfer function.
2. Analyse the stability & time response characteristics of discrete time systems to observe the system performance.
3. Develop various state space model & construct state matrix to solve the state equation.
4. Design the various state feedback system & identify the issues of deadbeat response design to digital control system.
5. Analyse discrete time controllers using root locus and bode plot techniques to evaluate the system stability.

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**SEEE Question Paper Pattern:**
- There will be 8 questions of 20 marks each in the question paper categorized into 3 Units as per the syllabi & contact hours. The student will have to answer 5 full questions, selecting 2 full questions each from Unit-I & Unit – II and 1 full question from Unit – III.

**TEXTBOOKS:**

**REFERENCE BOOKS:**
2. K. Ogata, Discrete time control system.

**E-Books / MOOC**
1. NPTEL - Course on Digital Control Systems

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MICRO- AND NANO-SCALE SENSORS AND TRANSDUCERS

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**Course Learning Objectives:**
1. To explain measurement of pressure using sensors, based nanotechnology, their structure, theory of operation.
2. To explain structure, theory of operation of sensors based on nanotechnology for Motion, acceleration, measurement, gas and smoke detection.
3. To explain sensors based on nanotechnology for the measurement of atmospheric moisture and moisture inside the electronic components.
4. To explain Optoelectronic and Photonic Sensors used in optical microphones, fingerprint readers, and highly sensitive seismic sensors.
5. To explain the structure, operation of Biological Sensors, Chemical Sensors, and the so-called “Lab-on-a-Chip” sensors used in multipurpose biological and chemical analysis devices and Electric, Magnetic, and RF/Microwave, Integrated Sensor/Actuator Units and Special Purpose Sensors driven by nanotechnology.

**UNIT – I**

**Pressure Sensors:** Capacitive Pressure Sensors, Inductive Pressure Sensors, Ultrahigh Sensitivity Pressure Sensors.

**Motion and Acceleration Sensors:** Ultrahigh Sensitivity, Wide Dynamic Range Sensors, Other Motion and Acceleration Microsensors.

**Gas and Smoke Sensors:** A CO Gas Sensor Based on Nanotechnology, Smoke Detectors.

14 Hours

**UNIT – II**

**Moisture Sensors:** Structure, Theory, Main Experimental Results, Auxiliary Experimental Results.

**Optoelectronic and Photonic Sensors:** Optoelectronic Microphone, Other Optoelectronic and Photonic Micro Sensors.

**Biological, Chemical, and “Lab on a Chip” Sensors:** Lab on a Chip Sensors, Other Biochemical Micro- and Nano-Sensors.

**Electric, Magnetic, and RF/Microwave Sensors:** Magnetic Field Sensors, Other Important Electromagnetic/RF Micro- and Nano-Sensors.

16 Hours

**UNIT – III**

**Integrated Sensor/Actuator Units and Special Purpose Sensors:** Aircraft Icing Detectors, Other Special Purpose Small-Scale Devices.

9 Hours
Course Outcomes:
At the end of the course student will be able to
1. Classify various pressure sensors, and select a sensor depending upon the application.
2. Categorize various motion & acceleration sensors, gas and smoke sensors and choose a sensor for a particular application
3. Classify various moisture sensors, Optoelectronic & Photonic Sensors and select a sensor depending upon the application.
4. Categorize various Biological, Chemical, and “Lab on a Chip” Sensors, Electric, Magnetic, and RF/Microwave Sensors and choose a sensor for a particular application
5. Classify various Integrated Sensor/Actuator Units and Special Purpose Sensors and select a sensor depending upon the application.

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SEE QUESTION PAPER PATTERN:
- There will be 8 questions of 20 marks each in the question paper categorized into 3 Units as per the syllabi & contact hours. The student will have to answer 5 full questions, selecting 2 full questions each from Unit - I & Unit – II and 1 full question from Unit – III.

TEXTBOOKS:

***************
III. ENERGY SYSTEMS

RENEWABLE ENERGY SOURCES

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J - The course instructor can implement PBL (Project Based Learning) in this course.

Course Learning Objectives:
1. To understand the principle of extraction of energy from conventional and non-conventional sources.
2. To familiarize with the operation and applications of solar based thermal, electrical and PV systems.
3. To justify the usage of energy storage techniques.
4. To discuss the design process and implementation of wind based energy conversion systems.
5. To study the process of design and implementation of biomass based energy conversion systems.

UNIT – I

Energy Sources: 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.


UNIT – II

Energy Storage: Introduction, necessity of energy storage, and methods of energy storage (classification and brief description using block diagram representation only).

4 Hours
Wind Energy: Introduction, wind and its properties, history of wind energy, wind energy scenario – world and India. basic principles of wind energy conversion systems (WECS), classification of WECS, 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: 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.

Energy from Ocean: Tidal energy – Principle of tidal power, components of tidal power plant (TPP), classification of tidal power plants, 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) and hybrid cycle (block diagram description of OTEC); site-selection criteria, bio fouling, advantages & limitation of OTEC

Emerging Technologies: 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 nonconventional energy sources and solar radiation geometry to estimate & 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. Apply the biomass conversion technologies to design biomass-based energy systems.
5. Describe tidal, ocean thermal and fuel cell energy conversion systems to understand emerging renewable energy technologies.

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1: Low 2: Medium 3: High

112
SEE Question Paper Pattern:
- There will be 8 questions of 20 marks each in the question paper categorized into 3 Units as per the syllabi & contact hours. The student will have to answer 5 full questions, selecting 2 full questions each from Unit - I & Unit – II and 1 full question from Unit – III.

TEXTBOOKS:

REFERENCE BOOKS:

**********
Course Learning Objectives:
1. To determine the demand, profile of usage and techniques of energy measurement
2. To understand the power distribution for economic development of the nation.
3. To understand the parameters of electrical system optimization
4. To introduce and analyze various techniques of demand side management.
5. To be familiarized with load management & different electrical tariff systems

UNIT – I

Introduction: Energy situation – world and India, energy consumption, conservation. codes, standards and legislation. 5 Hours

Energy Economic Analysis: The time value of money concept, developing cash flow models, Payback analysis, depreciation, taxes and tax credit – problems. 5 Hours

Energy Auditing: Introduction, elements of energy audits, energy use profiles, measurements in energy audits, presentation of energy audit results. 5 Hours

UNIT – II

Electrical System Optimization: The power triangle, motor horsepower, power flow concept, electrical equipment and power factor – correction & location of capacitors. 5 Hours

Demand Side Management: Introduction to DSM, concept of DSM, benefits of DSM, different techniques of DSM – time of day pricing, multi-utility power exchange model and time of day models for planning. 10 Hours

UNIT – III

Energy efficient motors, Lighting basics, Electrical rate tariff: Load management, load priority technique, peak clipping, peak shifting, valley filling, strategic conservation, energy efficient equipment. 9 Hours

Course Outcomes: At the end of the course student will be able to
1. Estimate energy consumption & conservation by suggesting installation modification to compute payback period.
2. Measure and collect data to present energy audit results.
3. Analyze the power flow based on motor horsepower to suggest power factor correction.
4. Describe various techniques to implement demand side management.
5. Evaluate various methods to manage the load using energy efficient equipment.
Course Outcomes Mapping with Program Outcomes & PSO

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<th>Program Outcomes</th>
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1: Low 2: Medium 3: High

SEE Question Paper Pattern:
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TEXTBOOKS:

REFERENCE BOOKS:
2. Hand book on energy auditing - TERI (Tata Energy Research Institute)

***************
Course Code: 19EEE123 | CIE Marks: 50
Teaching Hours/Week (L:T:P): 3:0:0 | SEE Marks: 50
Total Hours: 39 | Credits: 03

Prerequisites: PSAS (19EE601), PE (19EE504)

Course Learning Objectives:
1. To introduce the concept of power quality and their classes.
2. To illustrate the voltage sags and interruptions, their sources, estimation & protection
3. To analyze the transient over voltages, fundamentals of harmonics, harmonic sources & effects of harmonic distortions.
4. To discuss power quality bench marking process and utility interface
5. To review the monitoring considerations and standards.

UNIT – I

Definitions: General classes of power quality problems, Transients, long duration voltage variation, short duration voltage variations, voltage imbalance, waveform distortion, power quality terms 3 Hours

Voltage sags and interruptions: Sources of sags and interruptions, estimating voltage sag performance, fundamental principles of protection, monitoring sags. 5 Hours

Transients over voltages: Sources of transient over voltages, principles of overvoltage protection, utility capacitor switching transients, fundamentals of harmonics: harmonic distortion, voltage versus transients, harmonic indexes, harmonic sources from commercial loads, harmonic sources from Industrial loads, effects of harmonic distortion, intra-harmonics 8 Hours

UNIT - II

Applied harmonics: Harmonic distortion evaluations, principles for controlling harmonics, harmonic studies, devices for controlling harmonic distortion, harmonic filters, standards of harmonics 7 Hours

Power quality benchmark: Introduction, benchmark process, power quality contract, power quality state estimation, including power quality in distribution planning, Interface to utility system, power quality issues, interconnection standards 8 Hours

UNIT – III

Power quality monitoring: Monitoring considerations, power quality measurement equipments, assessment of power quality measurement data, application of intelligent systems and power quality monitoring standards. 8 Hours
Course Outcomes:
At the end of the course student will be able to
1. Describe various power quality issues to estimate voltage sag and performance.
2. Analyze transient over voltages & harmonics to understand the factors affecting the power quality
3. Describe the principle for controlling the harmonics and filters to meet the standards
4. Describe the power quality benchmarking process and power quality contract to solve power quality issues.
5. Identify the Monitoring considerations, standards, measurement equipment, and application of intelligent systems.

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<th>Course Outcomes Mapping with Program Outcomes &amp; PSO</th>
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1: Low 2: Medium 3: High

SEE Question Paper Pattern:
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TEXTBOOK:

REFERENCE BOOKS:

***********************************
Course Learning Objectives:
1. To explain power generation by alternate energy source like wind power and solar power.
2. To explain selection of size of units and location for wind & solar systems.
3. To study the effects of integration of distributed generation on the performance of the system.
4. To provide practical and useful information about grid integration of distributed generation.
5. To understand impact of integration of DG on power system stability and operation.

UNIT – I

Distributed Generation: Introduction, status, properties of wind power, power distribution as a function of wind speed, solar power: status, properties, space requirements, photovoltaic's, seasonal variation in production capacity, combined heat-and-power: status, options for space heating, hydropower: properties of large hydro, properties of small hydro, variation with time, tidal power, wave power, geothermal power, thermal power plant.

7 Hours

Distributed Generation (continued): Interface with the grid. Power system performance: impact of distributed generation on the power system, aims of the power system, hosting capacity approach, power quality, voltage quality and design of distributed generation, hosting capacity approach for events, increasing the hosting capacity.

4 Hours

Overloading and Losses: Impact of distributed generation, overloading: radial distribution networks, active power flow only, active and reactive power flow overloading: redundancy and meshed operation redundancy in distribution networks meshed operation, losses.

4 Hours

UNIT – II

Overloading and Losses (continued): Increasing the hosting capacity: increasing the loadability building new connections, inter trip schemes, advanced protection schemes, energy management systems. Power electronics approach, demand control, prioritizing renewable energy, dynamic loadability.

Voltage Magnitude Variations: Impact of distributed generation, voltage margin and hosting capacity: voltage control in distribution systems, voltage rise owing to distributed generation, hosting capacity, estimating hosting capacity without measurements, sharing hosting capacity.
Design of Distribution Feeders: Basic design rules, terminology, an individual generator along a medium-voltage feeder, low voltage feeders, series and shunt compensation, a numerical approach to voltage variations: example for two-stage boosting, general expressions for two-stage boosting tap changers with line-drop compensation: transformer with one single feeder, adding a generator. probabilistic methods for design of distribution feeders: need for probabilistic methods, the system studied, generation with constant production, adding wind power.

6 Hours

Voltage Magnitude Variations (continued): Statistical approach to hosting capacity, increasing the hosting capacity: new or stronger feeders, alternative methods for voltage control accurate measurement of the voltage magnitude variations, allowing higher overvoltage’s overvoltage protection, over voltage curtailment compensating the generators voltage variations, distributed generation with voltage control, coordinated voltage control.

5 Hours

Power Quality Disturbances: Impact of distributed generation, fast voltage fluctuations: fast fluctuations in wind power, fast fluctuations in solar power, rapid voltage changes, very short variations. voltage unbalance: weaker transmission system, stronger distribution system, large single-phase generators, stronger distribution grid voltage unbalance.

5 Hours

UNIT – III

Power Quality Disturbances (continued): Low-frequency harmonics: wind power: induction generators, generators with power electronics interfaces, synchronous generators, measurement example, harmonic resonances, weaker transmission grid, and stronger distribution grid. High-frequency distortion: emission by individual generators, grouping below and above 2 khz, limits below and above 2 khz, voltage dips: synchronous machines balanced dips and unbalanced dips, induction generators and unbalanced dips, increasing the hosting capacity: strengthening the grid, emission limits for generator units, emission limits for other customers, higher disturbance levels, passive harmonic filters, power electronics converters, reducing the number of dips, broadband and high-frequency distortion.

8 Hours

Course Outcomes:
At the end of the course the student will be able to:
1. Describe solar, wind, hydro and tidal power generation to understand the concepts of distributed generation
2. Analyze the system performance on integrating the distributed generation system with the grid
3. Analyze the effects of the DG integration to determine the increased risk of overload and system losses
4. Describe the effects of DG integration to study the impact of power quality issues.
5. Analyze the power quality disturbance to understand the impact of voltage dips on system load.
Course Outcomes Mapping with Program Outcomes & PSO

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1: Low 2: Medium 3: High

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TEXTBOOK:

ELECTRICAL MACHINE DESIGN

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* Note: Lecture hours indicated are for teaching theoretical concepts. Illustrative examples and numerical problems are to be worked out in tutorial classes.

Prerequisites: DCSM (19EE303), TIM (19EE402)

Course Learning Objectives:
1. To describe the process of electrical machine design
2. To illustrate the design of single phase and three phase transformer
3. To analyze the design of DC machines
4. To analyze the design of Three phase Induction Machine

UNIT – I

Principles of electrical machine design:
Introduction, considerations for the design of electrical machines, limitations. Different types of materials and insulators used in electrical machines.

Design of transformers (Single phase and three phase): Output equation for single phase and three phase transformers, choice of specific loadings, expression for volts/turn, determination of main dimensions of the core, types of windings and estimation of number of turns and cross sectional area of primary and secondary windings, estimation of no load current, expression for leakage reactance and voltage regulation. Design of tank and cooling tubes (round and rectangular).
UNIT – II

DESIGN OF DC MACHINES: Output equation, choice of specific loadings and choice of number of poles, design of Main dimensions of the DC machines, Design of armature slot dimensions, commutator and brushes, magnetic circuit - estimation of ampere turns, design of yoke and poles, field windings – shunt, series and inter poles. 6*+6 Hours

DESIGN OF INDUCTION MOTORS: Output equation, Choice of specific loadings, main dimensions of three phase induction motor, Stator winding design, 4*+4 Hours

UNIT – III

DESIGN OF INDUCTION MOTORS (Contd.)
choice of length of the air gap. Estimation of number of slots for the squirrel cage rotor, design of Rotor bars and end ring, design of Slip ring Rotor, Estimation of no load current and leakage reactance. 6*+6 Hours

Course Outcomes:
At the end of the course student will be able to
1. Describe the design process of electrical machines for given specification
2. Design single phase and three phase transformer for required specification
3. Design the field system of a DC machine for given specification
4. Design the armature of a DC machine for given specification
5. Design a three-induction machine for required specification

Course Outcomes Mapping with Program Outcomes & PSO

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1: Low 2: Medium 3: High

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TEXTBOOKS:

REFERENCE BOOKS:

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ILLUMINATION TECHNOLOGY

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J - The course instructor can implement PBL (Project Based Learning) in this course.

Course Learning Objectives:
1. To understand the importance of Light
2. To comprehend the propagation of light & photometric units
3. To demonstrate the process of production of radiation and their characteristics
4. To enumerate the principle of artificial light sources.
5. To design the objectives and methods for Interior lighting.

UNIT – I


7 Hours


Inter relation between the various photometric quantities, luminous efficacy, spectral eye sensitivity curve-light watt-brightness-luminous existence-radiometric quantities & units- point by point method of luminance calculations – problems.

8 Hours
UNIT – II


8 Hours

Artificial light sources: construction- principle of operation- luminous efficiency- lamp life & color characteristics of incandescence, Tungsten halogen, fluorescent, high pressure mercury vapor, High Pressure sodium vapor and metal halide lamps- new trends in lamp technology.

UNIT – III

Interior Lighting Design: Lighting design objectives-safely and health performance-appearance & comport lighting design flow chart. Lighting for commercial and public buildings such as offices, hotels teaching establishments and hospital lighting. Lighting for industrial buildings, low & high bay area’s general lighting designs. Lighting for display-Shops & super markets, art galleries, museum lighting, lumen method of calculations-simple problems.

6 Hours

Light and health: light as radiation, tissue damage by ultraviolet radiation, Tissue Damage by Visible and Near Infrared Radiation, Tissue Damage from Infrared Radiation beyond 1400 nm, Threshold Limit Values, Practical Considerations, Aging Effects, Risk of Exceeding Limits, Using Task Lights, Eyestrain, Migraine, Autism, Visual Comfort and Human Variability, Light Operating through the Circadian System, Sleep, blue light hazard.

3 Hours

Course Outcomes:
At the end of the course student will be able to
  1. Analyze the electromagnetic spectrum of light to justify the concepts of vision systems.
  2. Describe the light propagation principle to illustrate the photometric parameters
  3. Describe the process of radiation to analyze and distinguish color rendering properties.
  4. Apply the concept of artificial light sources to suggest efficient lighting system.
  5. Design lighting systems to suggest interior and exterior in-addition to health safety.

| Course Outcomes Mapping with Program Outcomes & PSO |
|--------------------------------------------|---|---|---|---|---|---|---|---|---|---|---|---|
| Program Outcomes→ | 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9 | 10 | 11 | 12 | PSO |
| Course Outcomes | 19EEE221.1 | 2 | 3 |   |   |   |   |   |   |   |   |   | 1 |
| 19EEE221.2 | 2 | 3 | 1 | 2 |   |   |   |   |   |   |   |   | 2 |
| 19EEE221.3 | 2 | 3 | 1 | 2 |   |   |   |   |   |   |   |   | 2 |
| 19EEE221.4 | 2 | 3 | 2 | 2 |   |   |   |   |   |   |   |   | 2 |
| 19EEE221.5 | 2 | 2 | 3 | 1 | 2 |   |   |   |   |   |   |   | 2 |

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TEXTBOOK:

REFERENCE BOOKS:

OPERATION AND MAINTENANCE OF SOLAR ELECTRICAL SYSTEMS

<table>
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<th>Course Code</th>
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Course Learning Objectives:
1. To understand the solar radiation and PV technologies
2. To familiarize with PV inverters and mounting methods of PV systems
3. To examine the site assessment, design process of the grid connected system and its sizing.
4. To know the procedures of installation, commissioning and maintenance of PV systems.
5. To discuss the types of financial incentives available, calculation of payback time

UNIT – I

Solar Resource and Radiation: Solar resources, quantifying solar radiation, the effect of the Earth’s atmosphere on solar radiation, Sun geometry, Geometry for installing solar arrays.

3 Hours


3 Hours

PV Cells, Modules and Arrays: Characteristics of PV cells, Graphic representations of PV cell performance, Connecting PV cells to create a module, Specification sheets, creating a string of modules, Creating an array, Photovoltaic array performance, Irradiance, Temperature, Shading

2 Hours

Inverters and Other System Components: Introduction, Inverters, Battery inverters,
Grid-interactive inverters, Transformers, Mainstream inverter technologies, String inverters, Multi-string inverter, Central inverter, Modular inverters, Inverter protection systems, Self-protection, Grid protection, Balance of system equipment: System equipment excluding the PV array and inverter, Cabling, PV combiner box, Module junction box, Circuit breakers and fuses, PV main disconnects/isolators, Lightning and surge protection, System monitoring, Metering, Net metering, Gross metering.

**Mounting Systems:** Roof mounting systems, Pitched roof mounts, Pitched roof mounts for tiled roofs, Pitched roof mounts for metal roofs, Rack mounts, Direct mounts, Building-integrated systems, Ground mounting systems, Ground rack mounts, Pole mounts, Sun-tracking systems, Wind loading, Lightning protection

**UNIT – II**

**Site Assessment:** Location of the PV array, Roof specifications, Is the site shade-free?, Solar Pathfinder, SolmetricSuneye, HORI catcher, iPhone apps, Software packages, Available area, Portrait installation, Landscape installation, Energy efficiency initiatives, Health, safety and environment (HSE) risks, Local environment, Locating balance of system equipment, Site plan.

**Designing Grid-connected PV Systems:** Design brief, Existing system evaluation, Choosing system components, Modules, Mounting structure, Inverters, Cabling, Voltage sizing, Current sizing, Monitoring, System protection, Over-current protection, Fault-current protection, Lightning and surge protection, Grounding/earthing, Mechanical protection, Array protection, Sub-array protection, Extra low voltage (ELV) segmentation.

**Sizing a PV System:** Introduction, Matching voltage specifications, Calculating maximum voltage, Calculating minimum voltage, Calculating the minimum number of modules in a string, Calculating the maximum voltage, Calculating the maximum number of modules in a string, Calculating the minimum voltage, Calculating the minimum number of modules in a string, Matching current specifications, Matching modules to the inverter's power rating, Losses in utility-interactive PV systems, Temperature of the PV module, Dirt and soiling, Manufacturer's tolerance, Shading, Orientation and module tilt angle, Voltage drop, Inverter efficiency, Calculating system yield.

**Installing Grid-connected PV Systems:** PV array installation, DC wiring, Cabling routes and required lengths, Cable sizing, PV combiner box, System grounding/earthing, Inverter installation, Installation checklist, Interconnection with the utility grid, required information for installation, Safety.

**System Commissioning:** Introduction, Final inspection of system installation, Testing, Commissioning, System documentation.

**System Operation and Maintenance:** System maintenance, PV array maintenance, Inverter maintenance, System integrity, Troubleshooting, Identifying the problem, Troubleshooting PV arrays, Troubleshooting underperforming systems, Troubleshooting inverters, other common problems.
UNIT – III

**Marketing and Economics of Grid-connected PV Systems:** Introduction, PV system costing, Valuing a PV system, Simple payback and financial incentives, Simple payback, Feed-in tariffs, Rebates, Tax incentives, Loans, Renewable portfolio standards and renewable energy certificates, Marketing, Insurance.

4 Hours

**Case Studies:** Case studies A to G

4 Hours

**Course Outcomes:**
At the end of the course student will be able to
1. Describe basic concepts of solar cell to illustrate PV technologies
2. Describe various PV inverter topologies & to suggest the methods of mounting the PV panels
3. Describe the factors related to site assessment to design the grid connected systems.
4. Outline the process of PV installation and commissioning to operate & maintain the PV systems.
5. Analyze the economics of grid connected PV systems to calculate the payback time.

**Course Outcomes Mapping with Program Outcomes & PSO**

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1: Low 2: Medium 3: High

**SEE Question Paper Pattern:**
- There will be 8 questions of 20 marks each in the question paper categorized into 3 Units as per the syllabi & contact hours. The student will have to answer 5 full questions, selecting 2 full questions each from Unit - I & Unit – II and 1 full question from Unit – III.

**TEXTBOOKS:**

***************
Prerequisites: Basic Electrical Engineering (20EE105), Instrumentation and Measurements (19EE306), DC and Synchronous machines 

Course Learning Objectives:
1. To understand the types and working of various heating and welding equipment.
2. To be familiarized with the electrolysis process and its control using electrical power.
3. To select different traction equipment based on their characteristics and to control them.
4. To introduce to Illumination, its requirements and study the construction & working of different types of lamps.
5. To introduce electric and hybrid vehicles and associated technologies.

UNIT – I

HEATING AND WELDING: Advantages and methods of electric heating, resistance ovens, induction heating, dielectric heating, the arc furnace, heating of building, electric welding, resistance and arc welding, control device and welding equipment

9 Hours

ELECTROLYTIC PROCESS: Fundamental principles, extraction, refining of metals, electroplating. Factors affecting electro deposition process, power supply for electrolytic process.

7 Hours

UNIT – II

ELECTRIC TRACTION: System of traction, speed time curve, tractive effort at /co-efficient of adhesions, selection of traction motors, method of speed control, energy saving by series parallel control,

7 Hours

AC TRACTION EQUIPMENT: AC series motor, characteristics, regenerative braking, linear induction motor and their use. AC traction, diesel electric equipment, train lighting system, specific energy, factors affecting specific energy consumption.

7 Hours

UNIT – III

ILLUMINATION: Laws of illumination, lighting calculation, factory lighting, flood lighting, street lighting, different types of lamps, incandescent, fluorescent, vapor and CFL and their working, Glare and its remedy

6 Hours
INTRODUCTION ELECTRIC AND HYBRID VEHICLES:
Configuration and performance of electrical vehicles, traction motor characteristics, tractive effort, transmission requirement, vehicle performance and energy consumption.

Course Outcomes:
At the end of the course student will be able to
1. List the various methods of electrical heating and welding to select an appropriate method for a given application.
2. Describe the fundamental principles of electrolytic processes of extraction and refinement of metals.
3. Select and control electric motors for traction to achieve energy savings.
4. Analyze the characteristics of AC traction motors, train lighting system and compute specific energy consumption.
5. Apply fundamentals of illumination to design lighting for a given application and outline the transmission requirements of EVs.

Course Outcomes Mapping with Program Outcomes & PSO

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TEXTBOOKS:

REFERENCE BOOKS:

***************
INDUSTRIAL HEATING

Course Code: 19EEE224  CIE Marks: 50
Teaching Hours/Week (L:T:P): 3:0:0  SEE Marks: 50
Total Hours: 39  Credits: 03

Course Learning Objectives:
1. To explain construction, classification of industrial furnaces
2. To know the different processes of heat transfer in industrial furnaces
3. Explicate the heating capacity of continuous furnaces.
4. Discuss the methods of saving energy in industrial furnace systems
5. Explain the operation and control of industrial furnaces.

UNIT – I


7 Hours

Heating Capacity of Batch Furnaces: Definition of Heating Capacity, Effect of Rate of Heat Liberation, Effect of Rate of Heat Absorption by the Load, Effect of Load Arrangement, Effect of Load Thickness, Vertical Heating, Batch Indirect-Fired Furnaces, Batch Furnace Heating Capacity Practice, Controlled Cooling in or After Batch Furnaces.

8 Hours

UNIT – II

Heating Capacity of Continuous Furnaces: Continuous Furnaces Compared to Batch Furnaces, Continuous Dryers, Ovens, and Furnaces for <1400 F (<760 C), Continuous Midrange Furnaces, 1200 to 1800 F (650 to 980 C), Sintering and Pelletizing Furnaces, Axial Continuous Furnaces for Above 2000 F (1260 C), Continuous Furnaces for 1900 to 2500 F (1038 to 1370 C), Continuous Liquid Heating Furnaces.

7 Hours


8 Hours

UNIT – III

Operation and Control of Industrial Furnaces: Burner and Flame Types, Location, Flame Fitting, Unwanted NOx Formation, Controls and Sensors- Care, Location, Zones, Air/Fuel Ratio Control, Furnace Pressure Control Turndown Ratio, Furnace Control Data Needs, Soaking Pit Heating Control, Uniformity Control in Forge Furnaces, Continuous Reheat Furnace Control.

9 Hours
**Course Outcomes:**
At the end of the course the student will be able to:
1. Describe the heating process and industrial furnace to outline the construction and classification
2. Describe batch furnaces to study the methods of heat transfer in industries
3. Describe the operation of continuous furnaces to compare with the batch furnaces.
4. Analyze the methods of saving energy to calculate fuel consumption & energy costs in industrial furnace systems
5. Describe the operation of industrial furnaces to control furnaces using sensors.

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**TEXTBOOK:**
Prerequisites: DCSM (EE303), TIM (EE402), EPGE (405)

Course Learning Objectives:
1. To discuss the terminology of DC and AC armature windings.
2. To discuss design and procedure to draw armature winding diagrams for DC and AC machines.
3. To discuss the substation equipment, their location in a substation and development of a layout for substation.
4. To discuss different sectional views of transformers, DC machine, its parts and alternator and its parts.
5. To explain development of sectional views of Transformers, DC machine and alternators using the design data, sketches

UNIT – I

Introduction to CAD: Study of auto CAD graphics package. Exercises on computer aided electrical drawing - single line diagram for a typical substation.

Winding Diagrams:
(a) Developed Winding Diagrams of D.C. Machines: Simplex Double Layer Lap and Wave Windings.
(b) Developed Winding Diagrams of A.C. Machines:
(c) Integral and Fractional Slot Double Layer Three Phase Lap and Wave Windings.
(d) Single Layer Windings – Un-Bifurcated 2 and 3 Tier Windings, Mush Windings, Bifurcated 3Tier Windings.


15 Hours

UNIT – II

Electrical Machine Assembly Drawings Using Design Data, Sketches or Both: Transformers - Sectional Views of Single And Three Phase Core And Shell Type Transformers.

7 Hours


8 Hours
UNIT – III

Electrical Machine Assembly Drawings Using Design Data, Sketches or Both: Alternator – Sectional Views of Stator and Rotor dealt separately. 9 Hours

Course Outcomes:
At the end of the course the student will be able to:
1. Develop armature winding diagram for DC and AC machines
2. Develop a Single Line Diagram of Generating Stations and substation using the standard symbols.
3. Construct sectional views of core and shell types transformers using the design data
4. Construct sectional views of assembled DC AC machine and their parts using the design data or the sketches
5. Construct sectional views of assembled machine and their parts using the design data or the sketches

Course Outcomes Mapping with Program Outcomes & PSO

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Semester End Exam:
- The course Semester End Exam will be similar to a Laboratory Course.

TEXTBOOKS:

*****************************************************************************
IV. POWER SYSTEM

HVDC POWER TRANSMISSION

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J - The course instructor can implement PBL (Project Based Learning) in this course.

Prerequisites: PE (19EE504), T&D (19EE406), PSAS (19EE601)

Course Learning Objectives:
1. To introduce concepts of HVDC and HVAC generation transmission and comparison between them.
2. To choose converter and their control configuration for HVDC power transmission and their configuration.
3. To illustrate the bridge converter under different modes of operation.
4. To explain the various methods to control the HVDC converters.
5. To identify different types of protection used for HVDC system.

UNIT – I

General aspects of DC transmission and comparison of it with Ac transmission: Historical sketch, constitution of EHV AC and DC links, Limitations and Advantages of AC and DC Transmission.

Converter circuits: Valve Characteristics, Properties of converter circuits, assumptions, single phase, three phase converters, choice of best circuits for HV DC circuits.

UNIT – II

Analysis of the bridge converter: Analysis with grid control but no overlap, Analysis with grid control and with overlap less than 60 deg, Analysis with overlap greater than 60 deg, complete characteristics of rectifier, Inversion.

Control of HVDC converters and systems: grid control, basic means of control, power reversal, limitations of manual control, constant current versus constant voltage, desired feature of control, actual control characteristics, constant -minimum -Ignition –angle control, constant –current control, constant –extinction –angle control, stability of control.

UNIT – III

Protection: general, DC reactor, voltage oscillations and valve dampers, current oscillations and anode dampers, DC line oscillations and line dampers, clear line faults and reenergizing the line.
**Course Outcomes:**
At the end of the course student will be able to
1. Compare the HVDC and HVAC transmission systems to list out the advantages and disadvantages.
2. Analyze different converter circuits configuration to select best converter configuration for HVDC power transmission
3. Analyze bridge converter for different modes of operation without and with overlap
4. Apply different techniques for control the HVDC converters
5. Describe different types of protection schemes used in HVDC transmission system.

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**TEXTBOOK:**

**REFERENCE BOOKS:**

**E-Books / MOOC /NPTEL**
1. [http://nptel.ac.in/courses/108104013/](http://nptel.ac.in/courses/108104013/)
135

SMART ELECTRIC GRID

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Course Learning Objectives:
1. To study the Information and Communication Technologies related to smart grid.
2. To understand the Information security and different sensing and automation techniques.
3. To know the principles of Distribution management systems and transmission system operation for smart equipment’s.
4. To study the power quality issues and their management in smart grid.
5. To know the importance of micro grids and distributed energy resources.

UNIT – I

The Smart Grid: Introduction, Overview of the technologies required for the Smart Grid.
Information and Communication Technologies: Data communication, Switching techniques, Communication channels, layered architecture and protocols; Ethernets, Wireless Lan, Bluetooth and Zigbee communication technology.

8 Hours

Information security for the Smart Grid – Introduction, Encryption and decryption, Authentication, Digital signatures, Cyber security standards

4 Hours

Sensing, Measurement, Control and Automation Technologies: Smart metering - An overview of the hardware used, Communications infrastructure and protocols for smart metering.

4 Hours

UNIT – II

Distribution automation equipment and Management systems – Introduction, Data sources and associated external systems, Modelling and analysis tools,
Transmission system operation - Phasor measurement UNIT s, Wide area applications.

8 Hours

Power electronics in Smart Grid – Introduction, Renewable energy generation, Photovoltaic systems, Wind, hydro and tidal energy systems, Fault current limiting.

8 Hours

UNIT – III


7 Hours
Course Outcomes:
At the end of the course student will be able to
1. Identify various Information and Communication Technologies to learn the usage in electric grid.
2. Illustrate the Information security and automation techniques for protection and automation of smart electric grid.
3. Describe the principles of Distribution management systems and transmission system operation for smart equipment’s.
4. Illustrate the interfacing of power electronics devices to learn integration renewable energy sources to smart grid.
5. Describe power quality issues, power conditioners and monitor system to monitor the health of smart electric grid.

Course Outcomes Mapping with Program Outcomes & PSO

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TEXTBOOK:

REFERENCE BOOKS:
7. Tony Flick and Justin Morehouse, “Securing the Smart Grid”, Elsevier Inc.

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MODERN POWER SYSTEM PROTECTION

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Total Hours | 39 | Credits | 03 |

Prerequisites: PSAS (19EE601), SGP (19EE602)

Course Learning Objectives:

1. To introduce various static relays used in PS protection.
2. To illustrate the need of Comparators and list out various comparators and their characteristics.
3. To explain the concept of static over current, timer and voltage relays.
4. To illustrate the use and implementation of distance relays.
5. To explain the Principles of Digital/ Numerical Relays

UNIT – I

Static Relays: Introduction, Basic construction, Classification, Basic Circuits, Smoothing Circuits, Voltage regulation, square wave Generator, Time delay Circuits, Level Detectors, Summation device, Sampling Circuits, Zero crossing detector, output devices.

7 Hours

Comparators: Replica impedance, Mains Transformers, General equation of phase and Amplifiers, Comparators, Realization of ohm, mho, Impedance and offset impedance characteristics, Dualist principal, Static amplifier comparator – Rectifier bridge circulations current type, sampling comparator, static phase comparator accident circuits type Rectifier phase comparator, Block split comparator, Zen or diode phase comparator

8 Hours

UNIT – II

STATIC OVER CURRENT, TIMER AND VOLTAGE RELAYS:

Instantaneous over current Relay, Definite time lay relay, inverse time over current relay, static timer relay, Basic relay circuits, mono stable delay circuits Single phase Instantaneous over voltage and under voltage relays, instantaneous over voltage relay using Op amp.

8 Hours

Distance Relay: general Principal of operation, Zone discrimination, Fault area on impedance diagram, Basic measuring elements, Different characteristics used in distance relaying- Impedance, Reactance, Admittance. Ohm, Distance relay settings, Distance measurement Problems.

7 Hours

UNIT – III


4 Hours

Digital Relays: Block Schematic approach of microprocessor-based relays, over current relay, Protection Transformer differential protection, Directional relay scheme, Impedance relay scheme.

5 Hours
Course Outcomes:
At the end of the course student will be able to
1. Describe the basic components to understand the construction and working of static relay
2. Apply general equation phase and amplitude comparators to realize the different relay characteristics.
3. Describe static relay circuits for protection against over current, over voltage and under voltages
4. Analyze different distance relays for zone and directional discrimination.
5. Describe the Principle of operation of Digital/ Numerical Relays utilized in various relay protection schemes.

Course Outcomes Mapping with Program Outcomes & PSO

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1: Low 2: Medium 3: High

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- There will be 8 questions of 20 marks each in the question paper categorized into 3 Units as per the syllabi & contact hours. The student will have to answer 5 full questions, selecting 2 full questions each from Unit - I&Unit – II and 1 full question from Unit – III.

TEXTBOOKS:

REFERENCE BOOKS:

**********
Syllabus of V & VI Semester B.E./Electrical & Electronics Engineering

POWER SYSTEM PLANNING

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Prerequisites: T&D (19EE406), PSAS (19EE601)

Course Learning Objectives:
1. To discuss primary components of power system planning namely load forecasting, evaluation of energy resources
2. To explain planning methodology for optimum power system expansion, various types of generation, transmission and distribution
3. To discuss evaluation of operating states of transmission system, their associated contingencies and determination of the stability of the system for worst case conditions
4. To discuss reliability criteria for generation, transmission, distribution and reliability evaluation and analysis.
5. To discuss planning and implementation of electric –utility activities designed to influence consumer uses of electricity.

UNIT – I


Electricity Forecasting: Load Requirement, System Load, Electricity Forecasting, Forecasting Techniques, Forecasting Modelling, Spatial – Load Forecasting, Peak Load Forecast, Reactive – Load Forecast, Unloading of a System


UNIT – II


**UNIT – III**


**Course Outcomes:**  
At the end of the course student will be able to  
1. Describe primary components of power system planning, load forecasting for forecasting of future load requirements of both demand and energy by deterministic and statistical techniques using forecasting tools  
2. Apply planning methodology for optimum power system expansion, various types of generation, transmission and distribution  
3. Evaluate the operating states of transmission system, their associated contingencies and determination of the stability of the system for worst case conditions  
4. Describe reliability criteria for generation, transmission, distribution & reliability evaluation and analysis.  
5. Describe the planning and implementation of electric –utility activities designed to influence consumer uses of electricity.

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TEXTBOOK:

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**POWER SYSTEM OPERATION AND CONTROL**

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Prerequisites: NA (19EE302), T&D (19EE406), PSAS (19EE601), DCSM (19EE303)

**Course Learning Objectives:**
1. Explain the importance of Control Center and SCADA system in Power system operation.
2. Study the operation of Automatic Generation Control system in Power system.
3. Understand the generation and absorption of reactive power and methods of voltage control.
4. Understand the importance and study of various methods of unit commitment.
5. Study the various factors affecting the Power system security and contingency analysis.

**UNIT – I**

**CONTROL CENTER OPERATION OF POWER SYSTEMS:**
Introduction to SCADA, control center, digital computer configuration, automatic generation control, area control error, operation without central computers, expression for tie-line flow and frequency deviation, parallel operation of generators.

8 Hours

**AUTOMATIC GENERATION CONTROL:** Automatic voltage regulator, automatic load frequency control, AVR control loops of generators, performance of AVR, ALFC of single area systems, concept of control area, multi-area systems, POOL operation-two area systems.

8 Hours

**UNIT – II**

**CONTROL OF VOLTAGE AND REACTIVE POWER:** Introduction, generation and absorption of reactive power, relation between voltage, power and reactive power at a node, single machine infinite bus systems, methods of voltage control, sub synchronous resonance, voltage stability, voltage collapse.

8 Hours

**UNIT COMMITMENT:** Statement of the problem, need and importance of unit commitment, methods-priority lists method, dynamic programming method, constraints, spinning reserve, and examples.

7 Hours
UNIT – III

POWER SYSTEM SECURITY Factors affecting power system security, power system contingency analysis, detection of network problems, network sensitivity methods, calculation of network sensitivity factor, contingency ranking.

8 Hours

Course Outcomes:
At the end of the course student will be able to
1. Describe the control Centre operation of power system to understand the tie line power flow and frequency deviation
2. Analyze the effect of Automatic Voltage Regulator and Automatic Generation Control on Load Frequency Control of single and two area systems
3. Analyze the effect of reactive power control on Voltage stability and voltage collapse at a load bus
4. Apply various methods unit commitment for optimum operation of generation systems
5. Analyze the various factors affecting the security power system for contingency ranking.

Course Outcomes Mapping with Program Outcomes & PSO

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TEXTBOOKS:

REFERENCE BOOKS:

*************
FLEXIBLE AC TRANSMISSION SYSTEMS (FACTS)

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J-The course instructor can implement PBL (Project Based Learning) in this course.

Prerequisites: PE (19EE504), T&D (19EE406), PSAS (19EE601)

Course Learning Objectives:
1. Explain and understand the concept of various FACTS Controllers for power flow control
2. Study the requirement and importance of different High-power Semiconductor devices and VSC for control of power Flow
3. Study the application and control of self and line commutated current source Converters
4. Study the control of shunt compensation by passive and active shunt FACTS controllers for enhancement of power transfer capability and damping of power oscillations.
5. Study the application of series FACTS controllers for controlling / routing the power through the desired transmission paths

UNIT – I

FACTS Concepts and general system configuration: Transmission, interconnection, flow of power in AC system, power flow and dynamic stability consideration, of a transmission interconnection, relative importance of controllable parameters, basic types of FACTs controllers, shunt, series, combined shunt and series connected controllers.

9 Hours

UNIT – II

POWER SEMICONDUCTOR DEVICES: Types of high power devices, principle of high power device characteristics and requirements, IGBT and GTO devices.

3 Hours

VOLTAGE SOURCED CONVERTERS: Basic concepts, single phase full wave bridge converter operation, and square wave voltage harmonics for a single-phase bridge 3 phase full wave bridge converter.

4 Hours

SELF AND LINE COMMUTATED CURRENT SOURCE CONVERTER: Basic concepts, 3 phase full wave diode rectifier, thyristor-based converter, current sourced converter with turnoff devices, Current sourced versus voltage source converter.

5 Hours

SHUNT COMPENSATION: Objectives, Midpoint voltage regulation for line segmentation, End of line voltage support to prevent voltage instability, Improvement of transient stability, power oscillation damping.

3 Hours

UNIT – III

STATIC SHUNT COMPENSATOR SVC AND STATCOM: Methods of controllable VAR generation, static VAR compensator, STATCOM, comparison between SVC and STATCOM.

7 Hours

STATIC SERIES COMPENSATORS: Objectives of series compensation; variable impedance type of series compensation, GCSC, TSSC, TCSC. Switching converter type series compensation- SSSC, external control for series reactive compensators,
application of static series compensation for improvement of transient stability and power oscillation damping.  

8 Hours

**Course Outcomes:**

At the end of the course student will be able to

1. Describe various FACTS controllers required for control of active and reactive power flow in a transmission network.
2. Compare various High-power Semiconductor devices and analyze the working of Voltage Soured Converters (VSC) and Current Soured Converters (CSC) for active and reactive power flow control.
3. Design Shunt compensation schemes for the improvement of transient stability and damping of power oscillations
4. Analyze the working of static shunt compensation schemes using SVC and STATCOM for voltage and reactive power control
5. Analyze various series compensation schemes using variable impedance and VSC based series FACTS controllers for controlling / routing the power through the desired transmission paths.

**Course Outcomes Mapping with Program Outcomes & PSO**

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**TEXTBOOKS:**


**REFERENCE BOOKS:**


**E Book / MOOC/NPTEL**

1. NPTEL Course on “FACTS DEVICES” by Dr. Avik Bhattacharya, IIT Roorkee

**********
The course instructor can implement PBL (Project Based Learning) in this course.

Course Learning Objectives:
1. To study the Difference between Algorithmic based methods and knowledge based methods
2. To understand the use of the soft computing techniques for voltage control problems.
3. To know the appropriate AI framework for solving power system protection problems.
4. To study the different AI techniques for demand forecasting
5. To know the Adaptive AI techniques in the power system protection and control

UNIT – I

Introduction: Definition of AI difference between soft computing techniques and hard computing systems, expert systems brief history of ANN, Fuzzy and GA.

3 Hours

Fuzzy logic and Hybrid systems: Concept of Fuzzy in Power system, Fuzzy Techniques and Applications in power system.

4 Hours


4 Hours

Artificial Intelligence techniques for voltage control:
Introduction, Algorithm methods, Voltage collapse monitoring, Reactive power management, Combined active and reactive dispatch. AI techniques for Voltage control

4 Hours

UNIT – II


2 Hours

Artificial Neural network for static security assessment: Introduction to power system security assessment, AI techniques to power system security assessment- Fuzzy techniques, ANN

3 Hours


3 Hours

Intelligence systems for demand forecasting: Introduction, stages in building a forecast model, Identifying the model, survey of intelligence system for demand
forecasting.

UNIT – III

A practical application and implementation of adaptive techniques using neural networks into auto-reclose protection and system control: Introduction, Auto recloser description: conventional scheme, Adaptive reclose description, neural network description, system simulation, fault records, feature extraction, Neural Network training, Neural Network testing.

8 Hours

Course Outcomes:
At the end of the course student will be able to
1. List the various soft computing and hard computing techniques to apply in power system
2. Compare different AI techniques to choose an appropriate methods for voltage control in power system
3. Select appropriate AI framework for solving power system protection problems.
4. Describe various AI techniques for demand forecasting.
5. Describe the Adaptive AI techniques to apply in power system protection and control

Course Outcomes Mapping with Program Outcomes & PSO

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TEXTBOOKS:

REFERENCE BOOKS:
1. Introduction to Artificial Intelligence and Expert System by Dan W Patterson, PHI

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Syllabus of V & VI Semester B.E./Electrical & Electronics Engineering

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Prerequisites: PSAS (19EE601), DCSM (19EE303)

Course Learning Objectives:

1. To understand the system modelling and dynamics of synchronous generator
2. To model the load connected to power system and analyze its small signal stability
3. To introduce various excitation and prime mover controllers
4. To model various prime movers
5. To carry out transient analysis of power system and understand the importance of stability controllers

UNIT – I

System Modeling and Dynamics of Synchronous Generator: Basic concepts, Review of classical methods, modeling of synchronous machine, Swing equation, Park’s transformation – Park’s voltage equation, Park’s mechanical equation (torque). Applications – (a) Voltage build up in synchronous machine, and (b) Symmetrical short circuit of generator. Solution for transient analysis, Operational impedance, Relationship between $T_{do}'$ and $T_{do}''$ 8 Hours

Load Modeling: Introduction, Two approaches – Polynomial model and Exponential model. Small Signal Angle Stability: Small signal angle stability with SMIB system, detailed model of SMIB 7 Hours

UNIT – II

Excitation and Prime Mover Controllers: Introduction, Types of excitation, AVR with and without ESS, TGR, Amplifier PSS, Static exciters. 8 Hours

Modeling of Prime Movers: Introduction, Three major components, Block diagram, Hydraulic turbine, Steam turbine. 8 Hours

UNIT – III

Transient Stability Analysis: Simulation for Transient stability Evaluation, Transient stability controllers. 8 Hours

Course Outcomes:

At the end of the course student will be able to

1. Model the synchronous generator for understanding its dynamics.
2. Apply techniques to model the load to understand the dynamics of load and SMIB system.
3. Describe the concept of excitation and prime mover controllers used in the voltage regulation.
4. Describe the various components to model the prime mover.
5. Perform the transient stability analysis to understand the importance of stability controller.
Course Outcomes Mapping with Program Outcomes & PSO

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1: Low  2: Medium  3: High

SEE Question Paper Pattern:
- There will be 8 questions of 20 marks each in the question paper categorized into 3
Units as per the syllabi & contact hours. The student will have to answer 5 full
questions, selecting 2 full questions each from Unit - I & Unit – II and 1 full question
from Unit – III.

TEXTBOOKS:
1. “Power System Dynamics, Stability and Control”- Padiyar K.R., BPB Publicatons,
2002.

REFERENCE BOOKS:
1. “Dynamics and Control of Large Electric Power Systems”- Marija Ilic; John
Zaborszky, , IEEE Press and John Wiley & Sons, Inc.2000
2. “Power System Control and Stability Revised Printing”- Paul M. Anderson and A. A.
Fouad, John Wiley & Sons, Inc. 2002

**************
REACTIVE POWER MANAGEMENT

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Prerequisites: NA (19EE302), T&D (19EE406), PSAS (19EE601)

Course Learning Objectives:
1. To introduce the concept of reactive power, its generation and absorption in power system.
2. To illustrate various methods of voltage or reactive power control.
3. To demonstrate the principle of transmission system compensation, Effect of harmonics on reactive power control.
4. To comprehend the concept of resonance, shunt capacitors and filters.
5. To explain the reactive power coordination techniques.

UNIT - I
Introduction, Importance of reactive power control in Electrical Power System, Generation and absorption of Reactive power, Relation between Voltage, Power and Reactive power at a node.

Methods of voltage or Reactive power control: Shunt reactor, Shunt capacitor, Series capacitor, Synchronous condenser, Static VAR system

UNIT – II
Principles of Transmission system compensation, Effect of Harmonics on reactive power control: Harmonic sources.

Resonance, Shunt capacitors and Filters, Telephonic Interference.

UNIT – III
Reactive power coordination: Reactive power management, Transmission benefits, Reactive power dispatch and equipment impact.

Course Outcomes:
At the end of the course student will be able to
1. Describe the importance of reactive power, its generation and absorption in power system.
2. Analyze methods utilised to control the voltage or reactive power.
3. Describe the compensation techniques and effect of harmonics on reactive power in a transmission system.
4. Analyse effect of shunt capacitors, filters and telephonic interference on transmission system.
5. Describe the reactive power coordination techniques to manage the reactive power in a system.
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1: Low 2: Medium 3: High

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- There will be 8 questions of 20 marks each in the question paper categorized into 3 Units as per the syllabi & contact hours. The student will have to answer 5 full questions, selecting 2 full questions each from Unit - I & Unit – II and 1 full question from Unit – III.

TEXTBOOKS:

REFERENCE BOOKS:

E-Books / MOOC / NPTEL
1. http://nptel.ac.in/courses/108101040/20

**************************
### ELECTRICAL DESIGN, ESTIMATION AND COSTING

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#### Course Learning Objectives:

1. To discuss market survey, estimates, purchase enquiries, tenders, comparative statement and payment of bills and Indian electricity act and some of the rules.
2. To discuss distribution of energy in a building, wiring and methods of wiring, cables used in internal wiring, wiring accessories, fittings and fuses.
3. To discuss design of lighting points and its number, total load, sub-circuits, size of conductor and different types of service mains and estimation of power circuits.
4. To discuss estimation of overhead transmission and distribution system and its components.
5. To discuss main components of a substation, their graphical representation and preparation of single line diagram of a substation.

#### UNIT – I


**Wiring:** Introduction, Distribution of energy in a Building, PVC Casing and Capping, Conduit Wiring, Desirabilities of Wiring. Types of cables used in Internal Wiring, Multi Strand Cables, Voltage Grading and Specification of Cables Main Switch and Distribution Board, Conduits and its accessories and Fittings. Lighting Accessories and Fittings, Types of Fuses, Size of Fuse, Fuse UNIT s, Earthing Conductor.

**Internal Wiring:** General rules for wiring, Design of Lighting Points (Refer to Seventh Chapter of the TEXTBOOK), Number of Points, Determination of Total Load, Number of Sub –Circuits, Ratings Main Switch and Distribution Board and Size of Conductor. Current Density, Layout.

#### UNIT – II

**Service Mains:** Introduction, Types, Estimation of Underground and Overhead Service Connections.

**Design and Estimation of Power Circuits:** Introduction, Important Considerations Regarding Motor Installation Wiring, Input Power, Input Current to Motors, Rating of Cables, Rating of Fuse, Size of Condit, Distribution Board Main Switch and Starter.

**Estimation of Overhead Transmission and Distribution Lines:** (Review of Line Supports, Conductor Materials, Size of Conductor for Overhead Transmission Line,
Types of Insulators) [No Question Shall be Set From the Review Portion].
Cross Arms, Pole Brackets and Clamps, Guys and Stays, Conductors Configuration
Spacing and Clearances, Span Lengths, Lightning Arrestors, Phase Plates, Danger
Plates, Anti Climbing Devices, Bird Guards, Beads of Jumpers, Muffs, Points to be
Considered at the Time of Erection of Overhead Lines, Erection of Supports, Setting of
Stays, Fixing of Cross Arms, Fixing of Insulators, Conductor Erection. Repairing and
Jointing of Conductors, Dead End Clamps, Positioning of Conductors and Attachment to
Insulators, Jumpers, Tee-Offs, Earthing of Transmission Lines, Guarding of Overhead
Lines, Clearances of Conductor from Ground, Spacing Between Conductors, Important
Specifications.

UNIT – III

Estimation of Substations: Main Electrical connection, Graphical Symbols for Various
Types of Apparatus and Circuit Elements on Substation main Connection Diagram,
Single Line Diagram of Typical Substations, Equipment for Substation, Substation
Auxiliaries Supply, Substation Earthing.

Course Outcomes:
At the end of the course student will be able to
1. Explain the purpose of estimation and costing.
2. Discuss market survey, estimates, purchase enquiries, preparation of tenders,
   comparative statements and payment of bills to know about the process of
   estimation.
3. Discuss the distribution of energy in a building, wiring and methods of wiring,
   cables used in internal wiring, wiring accessories and fittings, fuses and types of
   fuses to be installed in a building.
4. Discuss design of lighting points, total load, sub-circuits and size of conductor of
   conductor to estimate its cost.
5. Discuss overhead transmission and distribution system and its components to
   estimate its cost. Discuss main components of a substation to prepare the single
   line diagram, earthing and estimation of a substation.

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1: Low 2: Medium 3: High

TEXTBOOK:
1. J. B. Gupta, A Course in Electrical Installation Estimating and Costing, Katson

REFERENCE BOOK:
   Book House, 2014
V. MICROELECTRONICS

ARM SYSTEM ARCHITECTURE

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Prerequisites: MC (19EE403)

Course Learning Objectives:

1. To introduce the architecture, internal functioning and assembly instructions of ARM core
2. To comprehend the functionality, interfacing, and programming of ARM core
3. To understand the floating-point representation and VFP coprocessor implementation
4. To outline details of cache architectures, AMBA bus, virtual memory management concepts with the detailed explanation on the Memory Management Unit (MMU) and Memory Protection Unit (MPU)
5. To illustrate the overview of various peripherals used with ARM core and review of big.LITTLE technology for various ARM processor

UNIT – I

ARM Introduction and Pipeline structures: Types of computer Architectures, ISA's and ARM history. Embedded system software and hardware, stack implementation in ARM, endianness, and condition codes. Processor core vs CPU core, ARM7TDMI interface signals, memory interface, Bus cycle types, Register set, Operational modes. Instruction format, ARM Core dataf model, ARM 3 stage pipeline, ARM family attribute comparison. ARM 5 stage pipeline, Pipeline hazards, Data forwarding - a hardware solution.


UNIT – II

ARM Coprocessor interface and Vector Floating Point Processor (VFP) ARM coprocessor interface and instructions, Coprocessor instructions, data processing instruction, data transfers, register transfers. Number representations, floating point representation (IEEE754). Flynn's taxonomy, SIMD and Vector processors, VFP and ARM interactions,
An example vector operation.

**7 Hours**

**Cache and Memory Management and Protection:** Memory technologies, Need for memory hierarchy, Hierarchical memory organization, Virtual memory. Cache memory, Mapping functions, Cache design, Unified or split cache, multiple level of caches, ARM cache features, coprocessor 15 for system control. Processes, memory map, protected systems, ARM systems with MPU, Memory Protection Unit (MPU). Physical Vs virtual memory, Paging, Segmentation. MMU Advantage, virtual memory translation, Multitasking with MMU, MMU organization, Tightly Coupled Memory (TCM).

**8 Hours**

**UNIT – III**

ARM tools and peripherals ARM development environment, Arm Procedure Call Standard (APCS), example C program. Embedded software development, image structure, linker inputs and outputs, memory map, application startup. AMBA overview, typical AMAB based microcontroller, AHB bus features, AHB bus transfers, APB bus transfers, APB bridge. DMA, Peripherals, Programming peripherals in ARM. big. LITTLE technology ARM ISAs, ARMv5, ARMv6, ARM v7, ARMv8.

**8 Hours**

**Course Outcomes:**

At the end of the course student will be able to

1. Describe architecture, internal functioning and assembly instructions of ARM7TDMI to comprehend basics of ARM
2. Apply ARM7 based assembly level programming skills to perceive the various coprocessors interfaced in an SoC.
3. Describe the cache design, virtual memory, memory protection concepts to visualise the implementation in a typical SoC designs
4. Describe AMBA bus architecture, various HW peripherals in SoCs to build their design aspects
5. Apply processor software tool chains for embedded software solution development

**Course Outcomes Mapping with Program Outcomes & PSO**

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1: Low 2: Medium 3: High

**SEE Question Paper Pattern:**

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TEXTBOOK:

REFERENCE BOOKS:
5. Manuals and Technical Documents from the ARM Inc, web site.

E Books / MOOC / NPTEL

***************

J -The course instructor can implement PBL (Project Based Learning) in this course.

Prerequisites: VLSI Circuits & Design (19EE604)

Course Learning Objectives:
1. To understand CMOS process and its construction
2. To introduce various types of matching and mismatches
3. To illustrate floor-planning and power routing
4. To introduce sensitivity, reliability & failure mechanism
5. To comprehend ESD & types of packaging

UNIT – I

CMOS Process Overview: Silicon deposition, Photolithography, Diffusion/Ion Implantation, Metalization, Formation of devices
Device Construction: PMOS, NMOS, Drain extended MOS, Diodes, Bipolars, Resistors, Capacitors
Matching: Matching and Mismatches in detail, Types of Matching and its usage, Resistor Matching, Capacitor matching
Isolation: Need for isolation: Noise in substrate, Guardring /Substrate connections, Integration of analog and digital blocks

15 Hours
UNIT – II

Floor-planning: Area Estimation, Module level (Understanding Hierarchy features), Block Level. Bbox concept, UNIT / Half cell concept, Pin Placement
Power Routing: Planning Power, Power to Devices, Star connection
Sensitivity: Shielding sensitive signals, routing clk /high frequency signals, DBKs
Reliability and Failure mechanism: Electromigration, Antenna effect, Latch up, Density.

14 Hours

UNIT – III

ESD Care-about: I/O cells ESD event, CDM Clamp
Packaging: Types of packaging, BGA, FLIP CHIP, WCSP

10 Hours

Course Outcomes:
At the end of the course student will be able to
1. Describe the CMOS process overview to elicit device construction
2. Identify the device matching and isolation with respect to CMOS devices
3. Apply floor planning and power routing to design analog CMOS devices
4. Identify sensitivity, reliability and failure mechanism to erudite electro-migration, antenna effect, and latch up, density issues in CMOS.
5. Describe the ESD and packaging details to comprehend application of CMOS

Course Outcomes Mapping with Program Outcomes & PSO

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TEXTBOOK:

REFERENCE BOOKS:
EMBEDDED SYSTEMS

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J -The course instructor can implement PBL (Project Based Learning) in this course.

Prerequisites: LD(19EE305), MC (19EE403)

Course Learning Objectives:
1. To familiarize the concept of embedded system
2. To identify various processing elements of embedded system and their structure
3. To introduce various memory elements used in embedded systems
4. To understand various interfacing devices used with embedded systems
5. To introduce the concept of Real Time Operating Systems

UNIT – I


8 Hours

Processing Elements: Custom single purpose processor design-RT level custom single purpose processor design-optimizing custom single purpose processors -General purpose processor’s software: architecture, operation, programmer’s view and development environment – ASIPs - selecting a microprocessor - general purpose processor design.

8 Hours

UNIT – II

Memory: Introduction-memory write-ability and storage permanence, common memory types-composing memory-memory hierarchy and caches-advanced RAM.

7 Hours


9 Hours

UNIT – III

Introduction to Real-Time Operating Systems: Software architectures, Hard and soft real time systems, Basic functions of RTOS kernel, tasks and states, tasks and data, semaphores and shared data, Message Ques, Mailboxes and Pipes

8 Hours
Course Outcomes:
At the end of the course student will be able to
1. Describe the overview of embedded system to comprehend associated technologies
2. Analyse various processing element in an embedded system to develop optimum design
3. Identify the necessity of memory devices to comprehend use in embedded system
4. Describe peripherals associated with embedded system to interface various modules
5. Describe architecture of RTOS to comprehend functional capabilities of RTOS

<p>| Course Outcomes Mapping with Program Outcomes &amp; PSO |
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1: Low 2: Medium 3: High

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- There will be 8 questions of 20 marks each in the question paper categorized into 3 Units as per the syllabi & contact hours. The student will have to answer 5 full questions, selecting 2 full questions each from Unit - I & Unit - II and 1 full question from Unit – III.

TEXTBOOKS:
2. Embedded System Premier, David E Simon, Addison Wesley

REFERENCE BOOKS:

**********************
J -The course instructor can implement PBL (Project Based Learning) in this course.  
Prerequisites: LD (19EE305)

Course Learning Objectives:
1. To understand basic concepts of hardware description languages
2. To apply computer-aided design tools for design of complex digital logic circuits
3. To model, simulate, verify, and synthesize with hardware description languages
4. To understand the architectural features of Verilog
5. To design digital systems using VHDL and Verilog

UNIT – I

15 Hours

UNIT – II

Entities, architecture specification and configurations, Component instantiation, Concurrent and sequential constructs, Use of Procedures and functions, Examples of design using VHDL.  
7 Hours

Syntax and semantics of Verilog, Variable types, arrays and tables, operators, expressions and signal assignments, Modules, nets and registers, Concurrent and sequential constructs, Tasks and functions  
8 Hours

UNIT – III

Modelling flip-flops using VHDL, VHDL models for a multiplexer, Compilation & simulation of VHDL code, Modeling a sequential machine, variables, signals and constants, Arrays, VHDL operators, VHDL functions & procedures, Packages and libraries, VHDL model for a counter. Examples of design using Verilog, Synthesis of logic from hardware description  
9 Hours

Course Outcomes:
At the end of the course student will be able to
1. Describe basic concepts of hardware description language to write program using HDL
2. Apply programming skills to design digital logic circuits using HDL
3. Describe synthesize program using HDL to design digital logic circuits
4. Describe the architectural features of Verilog to write program using HDL
5. Apply VHDL and Verilog to design digital system
### Course Outcomes Mapping with Program Outcomes & PSO

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### TEXTBOOKS:

### REFERENCE BOOKS:

***************
The course instructor can implement PBL (Project Based Learning) in this course.

**Course Learning Objectives:**

1. To study the design flow of different types of ASIC
2. To familiarize the different types of programming technologies and logic devices
3. To learn the architecture of different types of FPGA
4. To understand partitioning, floor planning, placement and routing including circuit extraction of ASIC
5. To analyse the synthesis, Simulation and testing of digital systems.
6. To understand the importance and applications of SOC.

**UNIT – I**

**OVERVIEW OF ASIC AND PLD:** Types of ASICs - Design flow – CAD tools used in ASIC Design – Programming Technologies: Antifuse – static RAM – EPROM and EEPROM technology, Programmable Logic Devices : ROMs and EPROMs – PLA–PAL. Gate Arrays – CPLDs and FPGAs

8 Hours

**ASIC PHYSICAL DESIGN:** System partition -partitioning - partitioning methods – interconnect delay models and measurement of delay - floor planning -placement – Routing : global routing - detailed routing - special routing - circuit extraction – DRC

7 Hours

**UNIT – II**

**LOGIC SYNTHESIS, SIMULATION AND TESTING:** Design systems - Logic Synthesis - Half gate ASIC -schematic entry - low level design language - PLA tools -EDIF- CFI design representation. Verilog and logic synthesis - VHDL and logic synthesis - types of simulation -boundary scan test – fault simulation - automatic test pattern generation.

8 Hours

**FPGA:** Logic blocks, routing architecture, design flow technology - mapping for FPGAs, XilinxXC4000 - ALTERA’s FLEX 8000/10000, ACTEL’s ACT-1,2,3 and their speed performance Case studies: Altera MAX 5000 and 7000 - Altera MAX 9000 – Spartan II and Virtex II FPGAs - Apex and Cyclone FPGAs.

8 Hours

**UNIT – III**

**SOC DESIGN:** Design methodologies – Processes and flows - Embedded software development for SOC – Techniques for SOC testing –configurable SOC – hardware / software codesign Case studies: Digital camera, Bluetooth radio / modem, SDRAM and USB.

8 Hours
Course Outcomes:
At the end of the course student will be able to
1. Describe the design flow to identify different types of ASIC
2. Apply different types of programming techniques to design logic devices
3. Apply logic synthesis, simulation and testing to design digital systems
4. Analyse various manufacturer FPGA to write program for given application
5. Describe embedded software development to design applications of SOC.

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REFERENCE BOOKS:

*******************
VI. IT & MANAGEMENT COURSES

OBJECT ORIENTED PROGRAMMING USING C++

<table>
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J - The course instructor can implement PBL (Project Based Learning) in this course.

**Prerequisites:** CCP (19CS111)

**Course Learning Objectives:**
1. To study the concept of Object Oriented programming and its realization in C++.
2. To discuss the concept of functions and classes.
3. To illustrate the concepts of objects constructors and destructors
4. To understand the meaning of operator overloading type conversion and inheritance.

**UNIT – I**

**Principles of Object-Oriented Programming:** Review of Procedure Oriented Programming, Basic concepts of Object Oriented Programming – Object, Class, Encapsulation, Inheritance, Polymorphism; Benefits of OOPs, Applications of OOP’s.

3 Hours

**The Basic Language C++:** A comparison of C and C++, Structure of C++ program with Class, Preprocessor directives, C++ Statements – Input/Output, Comments, Tokens, Keywords, Identifiers, Constants, Data types – string, pointer, reference, boole, enumeration, array, complex number; typedef names, type compatibility, type conversion, qualifier – const, volatile; Operators in C++, Operator Precedence; C++ expressions – New and Delete.

5 Hours

**Functions in C++:** Introduction, The main() function, Function prototype, Call by reference, Return by reference, Inline functions, Default arguments, const Arguments, Function Overloading

3 Hours

**Classes:** Introduction – declaration and definition of a Class, defining member functions, C++ program with a Class, Making an outside function Inline, Nesting of member functions, Arrays within a class, Static data members, static member functions.

4 Hours

**UNIT – II**

**Objects:** global & local objects, scope & lifetime, memory allocation for objects, dynamically allocated objects, pointers to objects, arrays of objects, function arguments with objects, returning objects; const member functions, pointer to members.

4 Hours

**Constructors and Destructors:** Introduction, Constructors, Parameterized Constructors, Multiple constructors in a class, Constructors with default arguments, Dynamic initialization of objects, Copy constructor, Constructing two-dimensional arrays, const Objects, Destructors.

4 Hours

**Operator Overloading and Type Conversion:** Introduction, Defining operator overloading, Overloading unary operators, Overloading binary operators, Overloading
binary operators using Friends, Rules for overloading operators, overloading a comma operator, overloading the output operator , Type conversion.

**5 Hours**

**Inheritance:** Introduction, Defining derived classes, Single inheritance, Making a private member Inheritable, Multilevel inheritance, Multiple inheritance, Hierarchical inheritance, Hybrid inheritance, Virtual base classes, Abstract classes.

**3 Hours**

**UNIT – III**

**Pointer, Virtual Functions and Polymorphism:** Introduction, Pointers, Pointers to Objects, this pointer, Pointers to derived classes, type-checking pointers, pointers to members, Virtual functions, Pure virtual functions.

**4 Hours**

**Managing Console I/O and File I/O:** C++ streams, C++ stream classes, examples of formatted and unformatted I/O operations, Classes for file stream operations, Methods of Opening and Closing a File, Examples of Opening file using constructor open(), file modes (simple programming exercises).

**4 Hours**

**Course Outcomes:**
At the end of the course student will be able to
1. Describe the concept of Object-Oriented Programming and basics of C++ to compare C with C++
2. Apply functions and classes to develop simple programs
3. Apply the concept of constructors to dynamically initialize objects
4. Describe the operator overloading, type conversion and inheritance concepts to develop reliable programs.
5. Apply the concept of pointers, polymorphism and C++ stream classes to use with objects.

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<th>Course Outcomes Mapping with Program Outcomes &amp; PSO</th>
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TEXTBOOKS:

REFERENCE BOOKS:

E-Books / MOOC / NPTEL
2. http://nptel.ac.in/courses/106105151/

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DATA STRUCTURE

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Course Learning Objectives:
1. To understand the design, analysis of algorithms, Basic data types and trees with reference to data structure.
2. To illustrate the basic operation on sets and representation of directed graphs.
3. To expound the sorting procedure and understand the Algorithm analysis Techniques.
4. To Comprehend the Algorithm Design Techniques.
5. To Demonstrate the use of Data structures and Algorithm for external storage.

UNIT – I

Design and Analysis of Algorithms: From problems to programs, Data Structures and Abstract Data types. 3 Hours

Basic Data Type and Trees: Data types List, Implementation of lists, stacks Queues, Mappings, Stacks and recursive procedures. Basic terminology, ADT Tree, Implementation of trees, Binary trees. 5 Hours

Basic Operation on Sets: Introduction to sets an ADT with union intersection and difference, A Bit-vector implantation sets, A linked list implementation sets, The dictionary, simple dictionary implementation, the Hash table data structures, Estimating the efficiency of functions, Implementation of the mapping ADT, Priority Queues, Implementation of priority queues. 5 Hours

Directed Graphs: Basic Definitions, Representation for directed graphs, the single
source short path problems, Traversals of Directed Graphs, Directed A cyclic graphs, strong components.

UNIT – II

Sorting: The internal sorting model, simple sorting schemes, Quick sort Heapsort, Binsorting. Algorithm analysis Techniques: Efficiency of algorithms, analysis of receive programs solving Recurrence Equations, A general solution for a large class of Recurrences.
Algorithm Design Techniques: Divide and conquer algorithms, Dynamic programming, Greedy Algorithms, Back tracking, local search algorithms.

UNIT – III

Data structures and Algorithm for external storage: A model of external computation, External sorting, sorting information in files, external search Trees.

Course Outcomes:
At the end of the course student will be able to
1. Analyse algorithms to implement various basic data types and trees.
2. Apply basic operations on sets and representation of directed graphs to build trees for database queries.
3. Analyse the various sorting techniques.
4. Develop and implement various algorithm design techniques
5. Demonstrate the use of Data structures and Algorithms for external storage.

Course Outcomes Mapping with Program Outcomes & PSO

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TEXTBOOK:
REFERENCE BOOKS:
1. Introduction to Data structures and Algorithms with C+ by Glenn. W.Rowe, PHI Publications.1997,

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TOTAL QUALITY MANAGEMENT

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Course Learning Objectives:
This Course will enable students to
1. Understand the meaning of quality and the development of quality terminology and explain the principles of TQM.
2. Compute mean, median, mode and standard deviation and calculate area under the normal distribution and relate it to the quality concept.
3. Compute control limits for a variable chart and draw the X bar and R chart limits for attribute chart and draw p, np, c and u charts.
4. Explain the Acceptance Sampling plans and understand the concept of Design of Experiments

UNIT – I

Introduction: The Meaning of Quality and Quality Improvement; Statistical Methods for Quality Control and Improvement;
TOTAL Quality Management: Definition, Principles of TQM, Gurus of TQM, Benefits of TQM.
Modeling Process Quality: Mean, Median, Mode, Standard deviation, calculating area, Normal distribution tables, Finding the Z score, Central limit theorem, 7 QC tools.
Methods and Philosophy of Statistical Process Control: Chance and assignable causes, Statistical Basis of the Control Charts (basic principles, choices of control limits, significance of control limits, sample size and sampling frequency, rational subgroups, analysis of pattern on control charts, warning limits, Average Run Length-ARL).

15 Hours

UNIT – II

Control Charts for Variables: Control Charts for X-Bar and R- Charts, Type I and Type II errors, the probability of Type II error. 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

**Control Charts for Attributes:** Binomial distribution, Poisson distribution (from the point of view of Quality control) Control Chart for Fraction Nonconforming, Control Chart for number Nonconforming, Control Charts for Nonconformities or Defects, Control Chart for Number of non-conformities per unit. Numerical problems.

**UNIT – III**

**Lot-By-Lot Acceptance Sampling for Attributes:** The acceptance sampling problem, single sampling plan for attributes, Double, Multiple, and Sequential sampling, AOQL, LTPD, OC curves, Numerical problems.

**Introduction to Design of Experiments:** Hypothesis testing, one sample t-test, orthogonal design of experiments, two factor experimental design, numerical problems on the above topics.

**9 Hours**

**Course Outcomes (CO):**

At the end of the course the student will be able to

1. Understand the concept of quality and evolution of quality concepts over the years
2. Apply statistical concepts for solving simple quality problems.
3. Draw and analyze control charts for variables.
4. Understand the basic concepts of Acceptance Sampling and Design of experiments.
5. Draw and analyze the control chart for attributes

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<th>Program Outcomes Mapping with Program Outcomes &amp; PSO</th>
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1: Low 2: Medium 3: High

**SEE Question Paper Pattern:**

- There will be 8 questions of 20 marks each in the question paper categorized into 3 Units as per the syllabi & contact hours. The student will have to answer 5 full questions, selecting 2 full questions each from Unit - I & Unit – II and 1 full question from Unit – III.

**TEXTBOOKS:**

REFERENCE BOOKS:
6. NPTEL course material on Design of Experiments.

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FUNDAMENTALS OF PYTHON PROGRAMMING

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J - The course instructor can implement PBL (Project Based Learning) in this course.

Course Learning Objectives:
1. To write a simple python program with emphasis on syntax and semantics
2. To write simple programs utilizing Lists, Tuples and Dictionaries.
3. To write simple program by choosing appropriate conditional operator.
4. To write simple program consisting of user defined functions.
5. To study the concept of object oriented programming in python.

UNIT – I


Data, Expressions, Statements: Python interpreter and interactive mode; values and types: int, float, boolean, string, and list; variables, expressions, statements, tuple assignment, precedence of operators, comments; modules and functions, function definition and use, flow of execution, parameters and arguments; Illustrative programs: exchange the values of two variables, circulate the values of n variables, distance between two points

Control Flow, Functions: Conditionals: Boolean values and operators, conditional (if), alternative (if-else), chained conditional; Iteration: state, while, for, break, continue, pass; Fruitful functions: return values, parameters, local and global scope, function composition, recursion;

UNIT – II

Strings: Strings: string slices, immutability, string functions and methods, string module; Lists as arrays
Lists: list operations, list slices, list methods, list loop, mutability, aliasing, cloning lists, list parameters; Tuples: tuple assignment, tuple as return value;
Dictionaries: operations and methods; advanced list processing - list comprehension;
Illustrative programs: selection sort, insertion sort, mergesort, histogram
Illustrative programs: square root, GCD, exponentiation, sum an array of numbers, linear
search, binary search

UNIT - III

**Python Object Oriented Programming:** Concept of class, object and instances,
Constructor, class attributes and destructors, Inheritance, overlapping and overloading
operators, Adding and retrieving dynamic attributes of classes.

**Course Outcomes:**
The students should be able to:
1. Examine the Python syntax and semantics for writing effective Python program
   using operators, functions for a given problem statement.
2. Use conditional and switch case statements to write programme in Python to tackle
   any decision-making scenario.
3. Utilize the methods of Strings and Lists for write a programme for a given
   application.
4. Utilize the methods of Tuples and Dictionaries for write a programme for a given
   application.
5. Apply the knowledge OOPs to develop a Python programme using objects and
   classes.

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1: Low 2: Medium 3: High

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  questions, selecting 2 full questions each from **Unit - I** & **Unit – II** and 1 full question
  from **Unit – III**.

**TEXTBOOKS:**
   Press, Taylor & Francis Group.
   Learning
   (http://do1.drchuck.com/pythonlearn/EN_us/pythonlearn.pdf )
4. Allen B. Downey, “Think Python: How to Think Like a Computer Scientist”,
REFERENCE BOOKS:

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OPERATING SYSTEM

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Course Learning Objectives:
1. To introduce the operating systems concepts.
2. To explain the concepts of structure in operating systems.
3. To discuss the process management and treads in operating systems.
4. To understand the memory management and memory allocation in operating systems.
5. To introduce the concept of virtual memory in operating systems with example of UNIX.

UNIT – I

Introduction and Overview Of Operating Systems: Operating system, Goals of an O.S, Operation of an O.S. Resource allocation and related functions, User interface related functions, Classes of operating systems, O.S and the computer system, Batch processing system, Multi programming systems, Time sharing systems, Real time operating systems, distributed operating systems.

8 Hours

Structure of the Operating Systems: Operation of an O.S, Structure of the supervisor, Configuring and installing of the supervisor, Operating system with monolithic structure, layered design, Virtual machine operating systems, Kernel based operating systems, and Microkernel based operating systems.

8 Hours

UNIT – II


7 Hours

Memory Management: Memory allocation to programs, Memory allocation preliminaries, Contiguous and non-contiguous allocation to programs, Memory allocation for program controlled data, kernel memory allocation.

7 Hours
UNIT – III

Virtual Memory: Virtual memory basics, Virtual memory using paging, Demand paging, Page replacement, Page replacement policies, Memory allocation to programs, Page sharing, UNIX virtual memory. Scheduling: Fundamentals of scheduling, Long-term scheduling, Medium and short term scheduling, Real time scheduling, Process scheduling in UNIX.

9 Hours

Course Outcomes:
At the end of the course student will be able to
1. Summarize the overview of operating systems.
2. Describe the structure of operating systems.
3. Analyse the concept of process management, processes and threads.
4. Illustrate memory allocation and management in operating systems.
5. Analyse the concept of virtual memory and scheduling algorithms as implemented in UNIX.

Course Outcomes Mapping with Program Outcomes & PSO

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1: Low 2: Medium 3: High

SEE Question Paper Pattern:
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TEXTBOOKS:

REFERENCE BOOKS:
Prerequisites: PTNM (19EE401)

Course Learning Objectives:
1. To understand the model and obtain solution to the Linear Programming Problems.
2. To Solve the dual of LPP and compare the results of dual and primal. Also apply replacement theory for efficient operations.
3. To Solve transportation and assignment problems and to solve game theory problems
4. Build the network and crash it effectively and efficiently using PERT / CPM methods.

UNIT – I

Introduction: definition, OR models, characteristics and phases of OR.

Linear programming and Graphic Solution: Linear Programming: Formulation of Two variable LPP model, Graphical solution of two variables LPP, special cases in graphic solution: multiple optimal solution, infeasibility and unboundedness, simplex method: conditions and solutions to LPP using Simplex method, Big M method, Special cases in simplex method: multiple optimal, infeasibility, unboundedness, Degeneracy, sensitivity analysis.

Duality: Definition of the dual problem, primal to dual relationships, economic interpretation of duality.

Replacement Theory: Introduction, Replacement policy for equipment which deteriorates gradually, replacement of items that fail suddenly, staff replacement.

UNIT – II

Transportation Model: definition of transportation model, basic Feasible solution by NW Corner method, Least Cost method and MODI method, optimal solutions: stepping stone method, MODI method, the assignment model, traveling salesman problem.

GAME THEORY: Formulation of two - person, zero sum games, solving simple games, the Max-min min-max principles, graphical solution procedure, solving by linear programming.

UNIT – III

PERT & CPM TECHNIQUES: Network representation, critical path computation, construction of the time schedule, variation under probabilistic models, crashing of simple networks, PERT calculations.
Course Outcomes:
At the end of the course student will be able to
1. Articulate a problem statement to determine solution to the Linear Programming Problems.
2. Apply replacement theory to find optimal replacement schedule.
3. Design and solve transportation problems to develop an optimal transportation solution.
4. Formulate and solve game theory problems to propose the best solution.
5. Design and Solve network problems using PERT / CPM methods to develop optimal strategy.

| Course Outcomes Mapping with Program Outcomes & PSO |
|-----------------|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Program Outcomes→ | 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9 | 10 | 11 | 12 | PSO |
| ↓ Course Outcomes |   |   |   |   |   |   |   |   |   |   |   |   |   |
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| 19EEE253.3       | 2 | 3 |   |   |   |   |   |   |   |   |   |   | 1 |
| 19EEE253.4       | 1 | 3 |   |   |   |   |   |   |   |   |   |   | 1 |
| 19EEE253.5       | 1 | 3 |   |   |   |   |   |   |   |   |   |   | 1 |

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TEXTBOOKS:

REFERENCE BOOK:

E Books/ MOOC/ NPTEL
2. https://www.coursera.org/learn/wharton-operations
3. http://nptel.ac.in/courses/112106134/
4. http://nptel.ac.in/courses/112106131/
5. https://onlinecourses.nptel.ac.in/noc17_mg10/preview
INTRODUCTION TO MACHINE LEARNING WITH PYTHON

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J -The course instructor can implement PBL (Project Based Learning) in this course.

Pre-requisite:
Engineering Mathematics I, Engineering Mathematics II, 19EE301-Vector Calculus and Transform techniques, 19EE401-Probability and Numerical Methods, and 19EEE251-Fundamentals of Python Programming

Course Learning Objectives:
1. To analyse the given data set.
2. To perform Linear and non-linear regression techniques using scikit learn package.
3. To perform kNN and DT techniques using scikit learn package.
4. To perform Logistic regression and SVM techniques using scikit learn package.
5. To perform clustering and Design a recommender system

UNIT - I
Regression: Introduction to Regression, Simple Linear Regression, Model Evaluation in Regression Models, Evaluation Metrics in Regression Models, Multiple Linear Regression, Gradient Descent Method, Non-Linear Regression. 15 hours

UNIT – II

UNIT – III
Clustering: Introduction, Introduction to k-Means, Introduction to Hierarchical Clustering, DBSCAN
Recommender Systems: Introduction, Content-based Recommender Systems, Collaborative Filtering. 09 hours

Course Outcomes:
The students should be able to:
1. identify the characteristics of datasets and compare the trivial data for various applications
2. solve regression problems using linear/non-linear regression analysis techniques for various applications.
3. Perform classification using kNN, DT for various applications
4. solve classification problem using Logistic regression and SVM for various applications
5. Perform clustering analysis and design recommender system for various applications.
Course Outcomes Mapping with Program Outcomes & PSO

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TEXTBOOKS:
VII. ELECTRIC VEHICLES TECHNOLOGIES

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The course instructor can implement PBL (Project Based Learning) in this course.

**Course Learning Objectives:**

1. To understand the fundamentals of electric and hybrid electric vehicles, EV policies, standards and EV architecture.
2. To understand control strategies and design principles of series hybrid vehicle drive train.
3. To know the design principles & control strategy of parallel and series-parallel hybrid drive train.
4. To study the control principles of plug-in hybrid electric vehicles.
5. To understand fundamentals of regenerative breaking and CAN fundamentals.

**UNIT – I**

**Electric Vehicles:** Configurations of electric vehicles (EVs), Performance of EVs, Tractive Effort in Normal Driving, Energy Consumption. EV Policies & Standards.

**Hybrid Electric Vehicles:** Concept of Hybrid Electric Drive Trains, Architectures of Hybrid Electric Drive Trains, Series Hybrid Electric Drive Trains, Parallel Hybrid Electric Drive Trains.

**Design Principle of Series (Electrical Coupling) Hybrid Electric Drive Train:** Operation Patterns, Control Strategies, Design Principles of a Series (Electrical Coupling) Hybrid Drive Train, Design Example.

15 Hours

**UNIT – II**

**Parallel (Mechanically Coupled) Hybrid Electric Drive Train Design:** Drive Train Configuration and Design Objectives, Control Strategies, Parametric Design of a Drive Train.

**Design and Control Methodology of Series–Parallel (Torque and Speed Coupling) Hybrid Drive Train:** Drive Train Configuration, Drive Train Control Methodology, Drive Train Parameters Design.


15 Hours

**UNIT – III**


5 Hours

**CAN Communication:** CAN Fundamentals, CAN message frames, Typical Automotive
Networks,

**Energy Management Strategies:** Introduction to energy management strategies used in hybrid and electric vehicles, classification of different energy management strategies, comparison of different energy management strategies.

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

1. Describe the fundamentals of electric and hybrid electric vehicles to understand EV architecture.
2. Analyze control strategies to design of hybrid vehicle drive train.
3. Analyze control methodology and design of series-parallel hybrid drive train.
4. Describe the control principles of plug-in hybrid electric vehicles to predict the energy requirements.
5. Describe CAN communication and fundamentals of regenerative breaking to compare the energy management strategies.

### Course Outcomes Mapping with Program Outcomes & PSO

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**TEXTBOOK:**

**************
J - The course instructor can implement PBL (Project Based Learning) in this course.

**Course Learning Objectives:**

1. To study fundamentals of Hybrid Electric Vehicles (HEV) and EV powertrain component sizing.
2. To understand advanced HEV architectures and dynamics of HEV powertrain.
3. To understand plug-in hybrid electric vehicles architecture, power management and component sizing.
4. To introduce special hybrid vehicles.

**UNIT – I**


**Advanced HEV Architectures and Dynamics of HEV Powertrain** - Principle of Planetary Gears, Toyota Prius and Ford Escape Hybrid Powertrain, GM Two-Mode Hybrid Transmission, Dual-Clutch Hybrid Transmissions, Hybrid Transmission Proposed by Zhang et al. Renault IVT Hybrid Transmission, Timken Two-Mode Hybrid Transmission, Tsai’s Hybrid Transmission, Hybrid Transmission with Both Speed and Torque Coupling Mechanism, Toyota Highlander and Lexus Hybrid, E-Four-Wheel Drive, CAMRY Hybrid, Chevy Volt Powertrain, Dynamics of Planetary-Based Transmissions

15 Hours

**UNIT – II**

**Plug-in Hybrid Electric Vehicles** - Introduction to PHEVs, PHEV Architectures, Equivalent Electric Range of Blended PHEVs, Fuel Economy of PHEVs, Power Management of PHEVs, PHEV Design and Component Sizing, Component Sizing of EREVs, Component Sizing of Blended PHEVs, HEV to PHEV Conversions, Other Topics on PHEVs, Vehicle-to-Grid Technology

15 Hours

**UNIT – III**

**Special Hybrid Vehicles** - Hydraulic Hybrid Vehicles, Off-road HEVs, Diesel HEVs, Electric or Hybrid Ships, Aircraft, Locomotives, Other Industrial Utility Application Vehicles, HEV Applications for Military Vehicles

9 Hours

**Course Outcomes:**

At the end of the course student will be able to

1. Describe the fundamentals of HEV and planetary gears to estimate EV powertrain component sizing.
2. Analyze advanced HEV architectures and speed - torque coupling mechanism to understand hybrid transmissions of different manufacturers.
3. Describe the architecture of plug-in hybrid electric vehicles to understand power management.
4. Analyze the component sizing and concept of vehicle-grid technology.
5. Compare and contrast various special hybrid vehicles.
Syllabus of V & VI Semester B.E./Electrical & Electronics Engineering

Course Outcomes Mapping with Program Outcomes & PSO

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1: Low 2: Medium 3: High

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- There will be 8 questions of 20 marks each in the question paper categorized into 3 Units as per the syllabi & contact hours. The student will have to answer 5 full questions, selecting 2 full questions each from Unit - I&II and 1 full question from Unit – III.

TEXTBOOK:
- Hybrid Electric Vehicles-Principles and Applications With Practical Perspectives, Chris Mi, M. Abul Masrur, Wiley, 2011

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POWER ELECTRONICS & DRIVES FOR ELECTRIC VEHICLES

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J - The course instructor can implement PBL (Project Based Learning) in this course.

Course Learning Objectives:
1. To explain the principles of power electronics converters used in HEVs
2. To understand the concept of battery chargers and thermal management of HEV power converters.
3. To study various electric drives used in EVs and their control
4. To analyze design and modeling of traction motors.
5. To introduce vehicular power control strategy & energy management.

UNIT – I

Power Electronics in HEVs
Introduction, Principle of Power Electronics, Rectifiers Used in HEVs, Buck Converter Used in HEVs, Non-isolated Bidirectional DC–DC Converter, Voltage Source Inverter, Current Source Inverter, Isolated Bidirectional DC–DC Converter, DC–DC Converters Applied in Hybrid Electric Vehicle Systems, PWM Rectifier in HEVs, EV and PHEV Battery Chargers, Emerging Power Electronics Devices, Circuit Packaging, Thermal Management of HEV Power Electronics

15 Hours
UNIT – II

Electric Drives and Control in HEVs
Introduction, Induction Motor Drives and Control, Permanent Magnet Motor Drives, Switched Reluctance Motors, Doubly Salient Permanent Magnet Machines, BLDC Motor and Control, Design and Sizing of Traction Motors, Thermal Analysis and Modeling of Traction Motors

15 Hours

UNIT – III

Vehicular Power Control Strategy and Energy Management
A Generic Framework, Definition, and Needs, Methodology to Implement, Benefits of Energy Management, Modeling and Simulation of HEV Power Electronics

9 Hours

Course Outcomes:
At the end of the course student will be able to
1. Analyze various power electronics converters used in HEVs.
2. Describe various converters for EV battery charging, emerging power electronics devices and thermal management.
3. Analyze the operation and control of various electric drives used in HEVs.
4. Select, design, model and perform thermal analysis of traction motors.
5. Analyze vehicular power control strategy to model & simulate HEV power converters.

Course Outcomes Mapping with Program Outcomes & PSO

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1: Low 2: Medium 3: High

SEE Question Paper Pattern:
- There will be 8 questions of 20 marks each in the question paper categorized into 3 Units as per the syllabi & contact hours. The student will have to answer 5 full questions, selecting 2 full questions each from Unit - I & Unit – II and 1 full question from Unit – III.

TEXTBOOKS:

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J - The course instructor can implement PBL (Project Based Learning) in this course.

Course Learning Objectives:
1. To understand working of various energy storage devices
2. To introduce the concept of fuel cells
3. To analyze fuel cell hybrid electric drive train design
4. To compare various energy storage systems and modeling
5. To discuss battery charge control and management

UNIT – I


9 Hours

UNIT – II


16 Hours

UNIT – III


14 Hours

Course Outcomes:
At the end of the course student will be able to
1. Describe various energy storage technologies used in EVs
2. Analyze operating principle and characteristics of fuel cells to be used in EVs
3. Analyze and design various hybrid electric drive train configurations
4. Compare and model various energy storage devices used in HEV
5. Analyze battery charge control and charge management of storage devices.
Course Outcomes Mapping with Program Outcomes & PSO

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TEXTBOOKS:

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ELECTRIC VEHICLE BATTERY CHARGING METHODS AND TOPOLOGIES

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J - The course instructor can implement PBL (Project Based Learning) in this course.

Course Learning Objectives:
1. To understand fundamentals and selection of storage devices for electric vehicles
2. To study the electric vehicle battery parameters and analyze effect on battery efficiency
3. To explain electric vehicle battery charging technologies
4. To understand electric vehicle battery discharging behavior.
5. To understand electric vehicle battery performance and thermal management.

UNIT – I


ELECTRIC VEHICLE BATTERY CAPACITY: Battery Capacity, The Temperature Dependence of Battery Capacity, State of Charge of a VRLA Battery, Capacity Discharge Testing of VRLA Batteries, Battery Capacity Recovery, Definition of NiMH Battery Capacity, Li-ion Battery Capacity, Battery Capacity Tests, Energy Balances for the Electric Vehicle

UNIT – II

ELECTRIC VEHICLE BATTERY CHARGING: Charging a Single VRLA Battery, Charge Completion of a Single VRLA Battery, Temperature Compensation During Battery Charging, Charging NiMH Batteries, Rate of Charge Effect on Charge Acceptance Efficiency of Traction, Battery Packs, Environmental Influences on Charging, Charging Methods for NiMH Batteries, Charging Technology, Battery Pack Corrective Actions


ELECTRIC VEHICLE BATTERY DISCHARGING: Definition of VRLA Battery Capacity, Definition of NiMH Battery Capacity, Discharge Capacity Behavior, Discharge Characteristics of Li-ion Battery, Discharge of an Electric Vehicle Battery Pack, Cold-Weather Impact on Electric Vehicle Battery Discharge

UNIT – III

ELECTRIC VEHICLE BATTERY PERFORMANCE:

Course Outcomes:
At the end of the course student will be able to
1. Explore concepts and selection of storage devices for electric vehicles.
2. Analyze the electric vehicle battery parameters and battery efficiency.
3. Explore electric vehicle battery charging technologies
4. Analyze electric vehicle battery discharging behavior.
5. Analyze electric vehicle battery performance and thermal management.
Course Outcomes Mapping with Program Outcomes & PSO

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TEXTBOOK:
1. Electric vehicle battery systems by Sandeep Dhameja, Newnes Publishing, 2002

MODELING AND CONTROL OF HYBRID ELECTRIC VEHICLES

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J - The course instructor can implement PBL (Project Based Learning) in this course.

Course Learning Objectives:
1. To model hybrid electric vehicle system components
2. To model energy storage system
3. To study hybrid electric vehicle vibration, noise & control
4. To analyze the performance of HEVs

UNIT – I


15 Hours

UNIT – II

Core Temperature, Battery System Efficiency  


UNIT – III


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

1. Analyze and model mechanical components of hybrid electric vehicle system.
2. Analyze and model electrical components of hybrid electric vehicle system.
3. Model and estimate parameter of energy storage system.
4. Analyze and control hybrid electric vehicle vibration & noise.
5. Analyze performance of HEV and HEV simulate system.

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TEXTBOOK: