B. E. SYLLABUS

MECHANICAL ENGINEERING

VII & VIII SEMESTER

With

Scheme of Teaching

& Examination

DEPARTMENT: MECHANICAL ENGINEERING

Sl. No	Name		Designation
1.	Prof. Gopinath	B.Sc. Engg.	Professor / Adjunct Faculty
2.	Dr. G. Ravichandran	Ph.D.	Professor /Adjunct Faculty
3.	Dr. Shrinivasa Rao B. R.	Ph.D.	Professor/Vice Principal /
4.	Prof. Vinaya B. R.	M.Tech	Asso. Professor/1st year
5.	Dr. Subrahmanya Bhat	Ph.D.	Professor and Dean Student
6.	Dr. Sudesh Bekal	Ph.D.	Professor/ Dean(R&D)
7.	Dr. Shashikanth Karinka	Ph.D.	Professor & HoD
8.	Dr. Srinivasa Pai P.	Ph.D.	Professor/DCOE
9.	Dr. Narasimha Marakala	Ph.D.	Professor
10.	Dr. Muralidhara	Ph.D.	Professor and PG Coordinator
11.	Dr. Mallikappa	Ph.D.	Professor
12.	Dr. Narasimha Bailkeri	Ph.D.	Professor
13.	Mr. Manjunath Shenoy	M.Tech	Associate Professor
14.	Mr. T.R. Venugopal	M.Tech	Associate Professor
15.	Mr. Gururaj Upadhyaya	M.Tech	Associate Professor
16.	Mr. Suresh Shetty	M.Tech	Associate Professor
17.	Mr. Ananthakrishna Somayaji	M.Tech	Associate Professor
18.	Mr. Udaya	M.Tech	Associate Professor
19.	Mr. Ravishankar Bhat	M.Tech	Asst. Prof, Gd III
20.	Mr. P. Venkatesh Murthy	M.Tech	Asst. Prof, Gd III
21.	Mr. Ravindra	M.Tech	Asst. Prof, Gd III
22.	Mr. Austin Dinesh D'Souza	M.Tech	Asst. Prof, Gd III
23.	Mr. Kumar H. S.	M.Tech	Asst. Prof, Gd II
24.	Mr. Adarsh Rai	M.Tech	Asst. Prof, Gd II
25.	Mrs. Rashmi P. Shetty	M.Tech	Asst. Prof, Gd II
26.	Mr. Dilip Kumar K.	M.Tech	Asst. Prof, Gd II
27.	Mr. Ravikiran Kamath B.	M.Tech	Asst. Prof, Gd II
28.	Mr. Nithin Kumar	M.Tech	Asst. Prof, Gd II
29.	Mr. Srinivas Prabhu	M.Tech	Asst. Prof, Gd II
30.	Mr. Veeresh R.K	M.Tech	Asst. Prof, Gd II
31.	Mr. Grynal D'Mello	M.Tech	Asst. Prof, Gd II

32.	Mr. Aneesh Jose	M.Tech	Asst. Prof, Gd I
33.	Mr. Divijesh P.	M.Tech	Asst. Prof, Gd II
34.	Mr. Vishwanath J. S.	M.Tech	Asst. Prof, Gd II
35.	Mr. Ajith M Hebbale	M.Tech	Asst. Prof, Gd I
36.	Mr. Krishna Prasad	M.Tech	Asst. Prof, Gd I
37.	Mr. Manjunath Maiya	M.Tech	Asst. Prof, Gd I
38.	Mr. Sharathchandra	M.Tech	Asst. Prof, Gd II
39.	Mr. Santhosh G.	M.Tech	Asst. Prof, Gd I
40.	Mr. Rajath N. Rao	M.Tech	Asst. Prof, Gd II
41.	Mrs. Kshatriya Akshatha Manjunath	M.Tech	Asst. Prof, Gd I
42.	Mr. Goutham Hebbar	M.Tech	Asst. Prof, Gd I
43.	Mr. Melwyn Rajesh Castelino	M.Tech	Asst. Prof, Gd I
44.	Mr. Vincent Linish D'souza	M.Tech	Asst. Prof, Gd I
45.	Mr. Bhaskar P. Achar	M.Tech	Asst. Prof, Gd I
46.	Mr. Mohan Poojari	M.Tech	Asst. Prof, Gd I
47.	Mr. Vidyasagar Shetty	M.Tech	Asst. Prof, Gd II
48.	Mr. Ragavendra Pai	M.Tech	Asst. Prof, Gd I
49.	Mr. Sunil Kumar Shetty	M.Tech	Asst. Prof, Gd I

DEPARTMENT OF MECHANICAL ENGINEERING

Vision Statement:

To produce Mechanical engineers of the highest quality who are professionally competent and highly qualified to suit the needs of industries and organizations by promoting excellence in teaching, learning and research.

Mission Statement:

The Dept. of Mechanical Engineering is committed to –

- Provide high quality education to the students, to fulfill the requirements of a 'Global Engineer'.
- Constantly strive to improve the teaching-learning methods, in order to deliver good academic programs.
- To respond to the fast evolving scientific and technological challenges in a highly competitive world.
- To inculcate, ethics, integrity, honesty, credibility, social and environmental consciousness.

Programme Educational Objectives (UG)

To satisfy the mission of the mechanical engineering program, the graduates will:

1. Be able to research, design, develop, test, evaluate, and implement engineering solutions to problems that are of a complexity encountered in professional practice.
2. Be able to communicate and perform as an effective engineering professional in both individual and team-based project environments.
3. Consider the ethical implications and societal impacts of engineering solutions.
4. Continuously improve through lifelong learning.

Programme outcomes (UG):

Programme Outcomes (POs) for Department of Mechanical Engineering (U.G)
PO1: ***Engineering knowledge****:* Apply the knowledge of mathematics, science, engineering fundamentals, and an engineering specialization to the solution of complex engineering problems.
PO2: ***Problem analysis***: Identify, formulate, review research literature, and analyze complex engineering problems reaching substantiated conclusions using first principles of mathematics, natural sciences, and engineering sciences.
PO3: ***Design/development of solutions****:* Design solutions for complex engineering problems and design system components or processes that meet the specified needs with appropriate consideration for the public health and safety, and the cultural,

societal, and environmental considerations.
P04: ***Conduct investigations of complex problems:*** Use research-based knowledge and research methods including design of experiments, analysis and interpretation of data, and synthesis of the information to provide valid conclusions.
PO5: ***Modern tool usage:*** Create, select, and apply appropriate techniques, resources, and modern engineering and IT tools including prediction and modeling to complex engineering activities with an understanding of the limitations.
PO6: ***The engineer and society***: Apply reasoning informed by the contextual knowledge to assess societal, health, safety, legal and cultural issues and the consequent responsibilities relevant to the professional engineering practice.
PO7: ***Environment and sustainability***: Understand the impact of the professional engineering solutions in societal and environmental contexts, and demonstrate the knowledge of, and need for sustainable development.
PO8: ***Ethics***: Apply ethical principles and commit to professional ethics and responsibilities and norms of the engineering practice.
P09: ***Individual and team work:*** Function effectively as an individual, and as a member or leader in diverse teams, and in multidisciplinary settings.
PO10: ***Communication:*** Communicate effectively on complex engineering activities with the engineering community and with society at large, such as, being able to comprehend and write effective reports and design documentation, make effective presentations, and give and receive clearinstructions.
PO11: ***Project management and finance:*** Demonstrate knowledge and understanding of the engineering and management principles and apply these to one's own work, as a member and leader in a team, to manage projects and in multidisciplinary environments.
PO12: ***Life-long learning:*** Recognize the need for, and have the preparation and ability to engage in independent and life-long learning in the broadest context of technological change.

Program Specific Outcomes (PSOs):

PSO 1: Ability to identify and use mechanical engineering literature and apply it in written, oral, and graphical communication in technical environments.

PSO2: Ability to apply mechanical engineering principles to write specifications, do fabrication, testing, operation and documentation of basic mechanical systems or processes.

Graduate Attributes:

The Graduate Attributes are the knowledge skills and attitudes which the students have at the time of graduation. These attributes are generic and are common to all engineering programs. These Graduate Attributes are identified by National Board of Accreditation.

Sl. No.	Graduate Attributes
a.	Engineering Knowledge
b.	Problem Analysis
c.	Design / development of solutions
d.	Conduct investigations of complex problems
e.	Modern tool usage
f.	The engineer and society
g.	Environment and sustainability
h.	Ethics
i.	Individual and team work
j.	Communication
k.	Project management and finance
l.	Life-long learning

DEPARTMENT OF MECHANICAL ENGINEERING
SCHEME OF TEACHING AND EXAMINATION

VII SEMESTER B.E. **30 Hours / Week**

Sl. No.	Sub. Code	Subject	Theory/Tuto./Prac./ Self Study	Total Hrs./Week	C.I.E	S.E.E	Credits
1	14ME701	Power Plant Engineering	4+0+0+0	4	50	50	4
2	14ME702	Mechanical Vibrations	3+2+0+0	5	50	50	4
3	14ME703	Industrial Robotics	3+0+2+0	5	50	50	4
4	14ME704	Mechatronics	4+0+0+0	4	50	50	4
5	14ME71X	Elective - IV	3+0+0+0	3	50	50	3
6	14ME72X	Elective - V	3+0+0+0	3	50	50	3
7	14ME705	Project part - I	0+0+3+0	3	50	-	1
8	14ME706	Seminar	0+0+2+0	2	50	-	1
9	14ME707	Dynamics Lab	0+0+2+0	2	50	50	1
TOTAL			**30**	**30**	**450**	**350**	**25**

DEPARTMENT OF MECHANICAL ENGINEERING
SCHEME OF TEACHING AND EXAMINATION

VIII SEMESTER B.E. **25 Hours / Week**

Sl. No.	Sub. Code	Subject	Theory/Tuto./Prac./ Self Study	Total Hrs./Week	C.I.E	S.E.E	Credits
1	14ME801	Heat Transfer	3+2+0+0	5	50	50	4
2	14ME81X	Elective - VI	3+0+0+0	3	50	50	3
3	14ME82X	Elective - VII	3+0+0+0	3	50	50	3
4	14ME8XX	Open Elective	3+0+0+0	3	50	50	3
5	14ME802	Heat Transfer Lab	0+0+2+0	2	50	50	1
6	14ME803	Project - II	0+0+9+0	9	50	50	9
TOTAL			**25**	**25**	**300**	**300**	**23**

	Sl. No.	Sub. Code	Subject	CREDITS
14ME71X	1	14ME711	Foundry Technology	3
	2	14ME712	Control Engineering	3
	3	14ME713	Refrigeration and Air-conditioning	3
	4	14ME714	Design of pressure vessel & piping	3
	5	14ME715	Modeling, Simulation of Engg. Systems	3
	6	14ME716	Total Productive Maintenance	3
	7	14ME717	Advanced Manufacturing Processes	3
	8	14ME718	Human resource management	3

	Sl. No.	Sub. Code	Subject	CREDITS
14ME72X	1	14ME721	I C Engines	3
	2	14ME722	Maintenance & Reliability Engineering	3
	3	14ME723	Computer Integrated Manufacturing	3
	4	14ME725	Materials Management	3
	5	14ME726	Product Design and Development	3
	6	14ME727	Design of Aircraft structures	3
	7	14ME728	Plastic Part Design & Manufacturing	3

	Sl. No.	Sub. Code	Subject	CREDITS
14ME81X	1	14ME811	Industrial Tribology	3
	2	14ME812	Tool Engineering and Design	3
	3	14ME813	Non-destructive Testing	3
	4	14ME814	Composite Materials Technology	3
	5	14ME815	Marketing Management	3
	6	14ME816	Corrosion Engineering	3

	Sl. No.	Sub. Code	Subject	CREDITS
14ME82X	1	14ME822	Artificial Intelligence and Expert System	3
	2	14ME823	Fluid Power Systems	3
	3	14ME824	Energy Conservation & Management	3
	4	14ME825	Bio- mass Energy Systems	3
	5	14ME826	Micro –Electro Mechanical Systems	3

POWER PLANT ENGINEERING

Sub Code : 14ME701 **Credits : 04**
Hrs/Week : 4+0+0+0 **Total Hours: 52**

Course Learning Objectives:

This Course will enable students to

1. Get the idea and understand the steam power plant and its working
2. Know steam generation using high pressure boilers
3. Understand and explain diesel power plant and hydro power plant, its working
4. Know and understand gas turbine power plant and nuclear power plant its working
5. Understand and calculate power station estimation and its economics.

Prerequisites

Student should have the knowledge of the fundamentals of Engineering Mathematics, Engineering physics and Basic thermodynamics.

UNIT – I

Chapter-1: Steam Power Plant

Different types of fuels used for steam generation, Equipment for burning coal in lump form, stokers, different types, Equipment for preparation and burning of pulverized coal, unit system and bin system. Pulverized fuel furnaces, cyclone furnace, Coal and ash handling

10 Hours

UNIT – II

Chapter-1 Contd: Generation of steam using forced circulation, high and super critical pressures, a brief account of Benson and L'mont steam generators

Chimneys: Natural, forced, induced and balanced draft, Calculations involving height of Chimney to produce a given draft.

Cooling towers and Ponds.

Accessories for the steam generators: Super heaters, De-super heater, Economizers, air pre heaters and re heaters. **10 Hours**

UNIT - III

Chapter-2: Diesel Engine Power Plant:

Applications of Diesel Engines in Power field, Method of starting diesel engines, cooling and lubrication system for the diesel engine. Intake and exhaust system, general layout, advantages and disadvantages over steam power plant.

Chapter-3: Hydro-Electric Plants

Storage and Pondage, flow duration and mass curves, hydrographs, low, medium and high head plants, pumped storage plants, Penstock, water hammer, surge tanks, power house general layout, advantages and disadvantages over thermal power plant.

12 Hours

UNIT – IV

Chapter-4: Gas turbine Power Plant:
Advantages and disadvantages of gas turbine plant, open turbine plants with intercooling, reheating and regeneration. Closed gas turbine power plant.

Chapter-5: Nuclear Power Plant
Principles of release of nuclear energy, fusion and fission reactions, nuclear fuels used in the reactors, Multiplication and thermal utilization factors, Elements of the nuclear reactor, moderator, control rod, fuel rods, coolants, Brief description of reactors of the following types Pressurized water reactor, boiling water reactor, sodium graphite reactor, fast breeder reactor and gas cooled reactor, radiation hazards, shielding, radioactive waste disposal.

10 Hours

UNIT – V

Chapter-6: Power station estimation:
Choice of site for power station, load duration curve, load factor, capacity factor, use factor, diversity factor, demand factor, effect of variable load on power plant, selection of the number and size of units. **6 Hours**

Chapter-7: Economics of power generation:
Cost of energy production, selection of plant and generating equipment and operating characteristics of power plants, tariffs for electrical energy.

4 Hours

Course Outcomes:

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

C-14ME701.1. Acquire knowledge of the steam power plant and its working
C-14ME701.2. Illustrate steam generation using high pressure boilers
C-14ME701.3. Explain the working of diesel and hydro power plants.
C-14ME701.4. Elaborate about gas turbine and nuclear power plant and its working
C- 4ME701.5. Explain the concept of power station estimation and its economics.

Course Articulation Matrix

CO	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 10	PO 11	PO 12	PSO 1	PSO 2
C-14ME701.1	M	M	M	L	M	H	H	L	M	L	L	L	M	M
C-14ME701.2	H	M	M	M	M	H	H	L	M	M	L	L	M	M
C-14ME701.3	M	M	M	L	M	H	H	L	M	L	L	L	M	M
C-14ME701.4	M	M	M	M	M	H	H	L	M	M	L	L	M	M
C-14ME701.5	H	L	L	L	M	M	L	M	L	L	L	M	L	L

L : Low M: Medium H : High

TEXT BOOKS:

1. Power plant Engineering, P.K.Nag Tata McGraw Hill,3rd Edition, 2007
2. Power plant Engineering by Domakundawar,Dhanpath Rai Sons,2005

REFERENCE BOOKS:

1. *E-Book* Power plant Engineering by R.K.Rajput. LaxmiPublication, New Delhi.2011
2. Principles of Energy conversion, A W.Culp Jr. McGraw Hill, 2nd Edition,1996
3. Non-conventional Energy sources by G.D.Rai Khanna Publishers, 2011

E-BOOKS:

1. Power plant Engineering P.K.Nag Tata McGraw Hill,3rd Edition, 2002
2. Power Plant Technology by M.M. EI-Wakil McGraw Hill,1 Edition

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MECHANICAL VIBRATIONS

Sub Code : 14ME702 **Credits : 04**
Hrs/Week: 3+2+0+0 **Total Hours : 52**

Course Learning Objectives:

The course will enable the students to

1. Know the fundamentals of mechanical vibrations and understand the basic concepts, principles and theory.
2. Understand the significance of damping in real world systems which are subjected to vibrations.
3. Realize the importance of forced vibrations and the different theoretical methods available to simulate it and study their responses and its effect in real world systems.
4. Get a feel of what two degree of freedom systems mean and their characteristics and to know the importance of vibration measurement and its applications.
5. Apply numerical methods to solve multi-degree of freedom system problems.

Prerequisites: The subject requires the student to know the fundamentals of Mechanics of Materials and Engineering Mechanics (ECE).

UNIT - I

Introduction:
Types of Vibrations, Simple Harmonic Motion, and Principle of superposition applied to simple harmonic motions, Beats and simple problems.

Undamped Free Vibrations:
Single Degree of Freedom systems, Natural frequency of undamped free vibrations, Parallel and series combination of springs-equivalent stiffness, effect of mass of spring on natural

frequency, Problems on identification of natural frequency of different systems, Torsional vibrations. **10 Hours**

UNIT - II

Damped Free Vibrations:
Single degree of freedom systems, Different types of damping, Concept of critical damping and its importance, Study of response of viscous damped systems for cases of under-damping, critical-damping and over-damping, Logarithmic Decrement, Problems on rectilinear and rotary systems. **10 Hours**

UNIT - III

Forced Vibrations:
Single Degree of Freedom Systems, Forced Vibration of spring-mass-damper system, transient and steady state solution, Reciprocating and rotating unbalance, Force transmitted to the base due to harmonic excitation-Force Transmissibility, Vibrations due to support motion-Motion Transmissibility, vibration isolation. 1**2 Hours**

UNIT - IV

Analysis of two Degrees of Freedom Systems:
Introduction, principal modes of vibration, masses on tightly stretched strings, double pendulum, combined rectilinear and angular modes, system with damping, undamped forced vibrations with harmonic excitation, undamped dynamic vibration absorber, problems. Vibrometers and Accelerometers, Whirling of shafts with and without air damping, Discussion on speeds above and below critical speed of shaft, Numerical problems.

10 Hours

UNIT - V

Numerical methods for multi degree freedom systems:
Introduction, Influence coefficients, Maxwell's reciprocal theorem, Dunkerley's equation, Orthogonality of Principal modes, Method of Matrix Iteration and orthogonality principle.Holzer's Method, Stodola Method. **10 Hours**

Course Outcomes:

Upon completion of this course, graduates will be able to,

C-14ME702.1. Explain the basics and fundamentals of mechanical vibrations.

C-14ME702.2. Know different types of damping and its effect on vibrations.

C-14ME702.3. Appreciating the need and importance of vibration analysis in mechanical systems subjected to harmonic, periodic and non-periodic excitations and obtain its responses and understand its significance in real world systems.

C-14ME702.4. Ability to use mathematical modelling to linear vibratory systems of different complexities and understanding different aspects of vibration measurements.

C- 4ME702.5. Appreciating the use of numerical methods for finding solutions to multi-degree freedom system problems.

Mapping of POs & COs:

PO's / COs	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 10	PO 11	PO 12	PSO 1	PSO 2
C-14ME702.1	H	H	M	L	L	L	L	L	L	L	L	L	L	L
C-14ME702.2	H	H	M	L	L	L	L	L	L	L	L	L	M	L
C-14ME702.3	M	H	M	L	L	L	L	L	L	L	L	M	H	L
C-14ME702.4	M	H	M	L	L	L	L	L	L	L	L	M	M	L
C-14ME702.5	H	H	M	L	L	L	L	L	L	L	L	L	L	L

L : Low M: Medium H : High

TEXT BOOKS:

(1) *Mechanical Vibrations*, S. S. Rao, Pearson Education Inc, 4th Edition, 2003rd
(2) *Mechanical Vibrations*, V. P. Singh, DhanpatRai& Company Pvt. Ltd., 3rd Edition, 2006.
(3) *Mechanical Vibrations*, G. K. Groover, Nem Chand and Bros., Rookee, India, Seventh Edition, 2003.
(4) *Mechanical Vibrations*, William Seto, Schaum's Outline Series, McGraw Hill, 1983

REFERENCE BOOKS:

(1) *Mechanical Vibrations*, S. Graham Kelly, Schaum's Outline Series, Tata McGraw Hill, Special Indian Edition, 2007.
(2) *Theory and Practice of Mechanical Vibrations*, J. S. Rao and K. Gupta, New Age International Publications, New Delhi, 2001.
(3) *Elements of Vibration Analysis*, Leonard Meirovitch, Tata McGraw Hill, Special Indian Edition, 2007.
(4) *Mechanical Vibrations*, J. B. K. Das and Srinivasa Murthy, Sapna Book House, Fifth Edition, 2009.
(5) *Theory of Vibration with Applications*, W. T. Thomson and Marie Dillon Dahleh, Pearson Education, 5th Edition, 2007.

MOOC/NPTEL Resources:

1. http://nptel.ac.in/courses/112103111/
2. http://nptel.ac.in/courses/112103112/
3. https://ocw.mit.edu/courses/mechanical-engineering/2-003sc-engineering-dynamics-fall-2011/mechanical-vibration/

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INDUSTRIAL ROBOTICS

Sub Code : 14ME703 **Credits : 04**
Hrs/Week : 3+0+2*+0 **Total Hours : 52***

*** 2 hours of Active learning = 1 hour of theory.**

Course Learning Objectives:

This Course will enable students to study the:

1. Anatomy of industrial robot.
2. Robot kinematic analysis.
3. Robot trajectory planning and control.
4. vision systems used in robots.
5. Robot Programming.

UNIT – I

Introduction to robotics

Definition, anatomy of robot, classification configurations, robot links and joints, robot specifications, resolution accuracy and repeatability, simple numerical problems, robot drive systems, hydraulic, pneumatic and electric drive systems, wrist and its motions, end effectors, types of end effectors, mechanical grippers, methods of constraining parts in grippers, types of gripper mechanisms, simple numerical problems, vacuum cups, magnetic grippers, adhesive grippers, hooks, scoops and other gripper devices, tool as end effectors, examples. Introduction to Drones. **6 Hours**

Active learning of robot configuration. **6 Hours***

UNIT – II

Robot motion analysis

Direct kinematics and inverse kinematics, 3D homogeneous transformations, rotation, translation and displacement matrix, composite rotation matrix, rotation matrix about an arbitrary axis, links, joints and their parameters, Denavit-Hertenberg (D-H) representation, application of D-H matrices to different robot configurations. **9 Hours**

Active learning of 3D Transformations and direct kinematics for 3R robot **14 Hours***

UNIT – III

Robot control and trajectory planning

Basic control systems and models, transfer function with examples, transfer function for spring-mass-damper system, transient response of a second order system, transfer function of a robot joint, different types of controllers, proportional (P) controller, integral (I) controller, derivative (D) controller, PID controller, simple numerical problems.

Trajectory planning, definition, steps in trajectory planning, joint space techniques, use of a p-degree polynomial as interpolation function, cubic polynomial trajectories, linear function

with parabolic blends, joint space verses Cartesian space trajectory planning, simple numerical problems on joint space trajectory planning. **10 Hours**

UNIT – IV

Machine Vision

Machine vision, functions of machine vision system, sensing and digitizing, imaging devices, analog to digital signal conversion, quantization and encoding, simple numerical problems, image storage, image processing and analysis, image data reduction, segmentation, feature extraction, object recognition, robotic machine vision applications, inspection, identification, visual surveying and navigation. **8 Hours**

UNIT - V

Robot Programming

Introduction to robot programming, robot cell layout, work cell control and interlocks, manual programming, lead through and walkthrough programming, off-line programming, robot programming languages, examples, Programming with graphics, example.

6 Hours

Hands-on robot programming. **6 Hours***

Course Outcomes:

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

C-14ME703.1. Understand robot anatomy.
C-14ME703.2. Solve direct kinematics and inverse kinematics problems for different robot configurations
C-14ME703.3. Understand and solve trajectory planning and control schemes for robots.
C-14ME703.4. apply machine vision systems in robotics.
C- 4ME703.5. Understand different types of robot cell layouts and able to write robot programs for different tasks.

Course Articulation Matrix

CO	PO1	PO2	PO3	PO4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 10	PO11	PO 12	PSO 1	PSO 2
C-15ME703.1	H	M	M	M	L	L	L	L	H	L	L	H	H	M
C-15ME703.2	H	H	H	H	M	L	L	L	H	L	L	H	M	H
C-15ME703.3	H	H	H	H	M	L	L	L	H	L	L	H	M	H
C-15ME703.4	M	M	M	M	M	L	L	L	M	L	L	M	M	M
C-15ME703.5	M	M	M	M	H	L	L	L	M	L	L	M	M	M

L: Low **M**: Medium **H**: High

TEXT BOOKS:

1. *Robotics and Control,* R. K. Mittal, I. J. Nagrath, Tata-McGraw-Hill Publications, 2007.
2. *Industrial Robotics,*Mikell P. Groover, Mitchel Weiss, Roger N. Nagel, Nicholas G. Odrey, McGraw-Hill Publications, International Edition, 2008.

REFERENCE BOOKS:

1. *Robotics: Control, Sensing, Vision, Intelligence,*Fu K. S., Gonzelez R. C., Lee C. S. G., , McGraw Hill Book Co., International edition, 2008.
2. Robotics for Engineers, Yorem Koren, McGraw-Hill Publication, International edition, 1987
3. *Introduction to Robotics: Mechanics and Control,* Craig, J. J., Pearson Prentice-Hall Publications, 3rd edition, 2005.
4. *Fundamentals of Robotics, Analysis and Control*, Schilling R. J., Prentice-Hall Publications, Eastern Economy edition, 2007
5. Robotics, AppuKuttan K. K., I.K. International Publications, First Edition, 2007
6. *Robot Technology Fundamentals,* James G. Keramas, Cengage Learning, 1999
7. Introduction to Unmanned Aircraft Systems Edited by Richard K. Barnhart, Stephen B. Hottman, Douglas M. Marshall, Eric Shappee, CRC Press, 2012.

MOOC/NPTEL Resources:

1. http://nptel.ac.in/courses/112101099/3

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MECHATRONICS

Sub Code : 14ME704	**Credits 04**
Hrs/Week : 4+0+0+0	**Total Hours 52**

Pre-requisites:

Following are the pre-requisites:

- Engineering mechanics and mechanics of materials
- Electronic circuits - analysis and design
- Mathematics - Calculus, differential equations

Course Learning Objectives:

This Course will enable students to

1. Understand basic mechatronic systems, mechanical components, actuators, sensors and also with controllers of mechatronic systems.
2. Understand the key elements of a measurement system, sensors, and optical encoders.

3. To familiarize with the various types mechanical switches, Solid state switches, drives and controls, characteristics and models of various electromechanical actuators.
4. Gaining knowledge of pneumatic elements like valves, FRL units and the pneumatic actuators.
5. Provide sound understanding of signal conversion i.e. ADC to DAC and vice versa, amplifiers, comparators and basic architecture of PLC system.
6. Understand architecture of 8085 microprocessors, micro controller, logic gates, and flip-flops

UNIT – I

Introduction: Introduction to Mechatronic systems, Measurement systems, control systems, microprocessor based controllers, Mechatronics approach. Examples and discussions on typical mechatronic systems.

Review of Transducers and Sensors: Introduction to Transducers and sensors, their classification, light sensors, proximity sensors and Hall-effect sensor, encoders, selection of sensors. **10 Hours**

UNIT – II

Drives and controls: *Mechanical system*: Anti Friction guide ways, timer belt and pulley, high speed precession bearings **Electrical Actuation Systems:** Actuators and actuator system, classification, Mechanical switches, Solenoids, relays, solid-state switches, Motors-DC & AC motors, Stepper motors, servo motor **12 Hours**

UNIT – III

Pneumatic Systems: Introduction, Basic structure of pneumatic systems, filter, lubricator, regulator, Valves – Classification, Pressure control valve, Flow control valve, Direction control valve. Types of cylinders, air motors, air compressors, Symbols of Pneumatic elements and application circuits. **10 Hours**

UNIT – IV

Signal conditioning: Introduction to signal conditioning, Operational amplifier, Inverting, Non- inverting, Summing, Integration, Differential amplifier, protection, filtering, wheat stone bridge, Analog –Digital Converter & Digital- Analog Converter, Multiplexers, Data acquisition system. **10 Hours**

UNIT – V

Microprocessors: Logic gates, flip flops. Introduction to microprocessor, microprocessor based digital control, Basic elements of control system, 8085 A microprocessor architecture terminology such as CPU, memory & address, ALU, assembler data registers, Fetch cycle, write cycle, state, Bus, interrupts, Microcontrollers. Differences b/w microprocessor & micro controllers. Classification of micro controllers.

Introduction to IoT (Internet of Things) - Business and IT perspective, Evolution of Cloud Computing, Cloud and virtualization, Cloud services requirements. **10 Hours**

Course Outcomes:

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

C-14ME704.1. Acquire knowledge about basic mechatronic systems, actuators, sequential control system and optical encoders.

C-14ME704.2. Outline various types of mechanical switches, Solid state switches, drives and controls, characteristics and models of various electromechanical actuators.

C-14ME704.3. Summarize about pneumatic elements like valves, FRL units and the pneumatic actuators.

C-14ME704.4. Examine signal conversion i.e. ADC and vice versa, amplifiers and comparators

C- 4ME704.5. Design architecture of 8085 microprocessors, micro controller, logic gates, and flip-flops

Mapping of POs & COs:

Course Outcome	Programme outcome													
	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 10	PO 11	PO 12	PSO 1	PSO 2
C-14ME704.1	L	L	M		H	M	M	L	H			H		M
C-14ME704.2	L	M	H	M	M	H	H		H	L	M	H	M	H
C-14ME704.3	L	M	H	M	M	H	L		H	M	H	H	H	H
C-14ME704.4	L	M	M	L	M	H	H			M	M	H	H	H
C-14ME704.5	L			M		H	M		H	H	H	H	L	M

L : Low M: Medium H : High

TEXT BOOKS:

1. *"Mechatronics "*, W. Bolton, pearson education, third edition. 2013
2. "Microprocessor Architecture, programming and applications with 8085.8085 R.S. Ganokar, Wiley Eastern.1987
3. *Introduction to Mechatronics"*, K. K. Appukuttan,Oxford University press, 2007 edition
4. *Pneumatic systems* S. R Majumdar, Tata Mc.Graw-Hill, Publishing company,ltd. 1997

REFERENCE BOOKS:

1. *Mechatronics*, Nitaigour Premchand Mahilik, Tata Mc.Graw-Hill, Publishing company, Ltd. 2003
2. *Pneumatics Basic level TP101*, Peter Croser and Frank Ebel,Festo Didactic Publications. 2003
3. *Fundamentals of pneumatic control engineering*, J.P. Hasebrink and R.Kobbler, Festo Didactic Publications. 1978

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PROJECT PART - I

Sub Code : 14ME705 **Credits : 01**
Hrs/Week : 0+0+3+0 **Total Hours: 39**

- **Preparing a project - brief proposal including**
- Problem Identification
- A statement of system / process specifications proposed to be developed (Block Diagram / Concept tree)
- List of possible solutions including alternatives and constraints
- Cost benefit analysis
- Time Line of activities
- Identification of a real life problem in thrust areas
- Developing a mathematical model for solving the above problem
- Finalization of system requirements and specification
- Proposing different solutions for the problem based on literature survey
- Future trends in providing alternate solutions
- Detailed design and development plans
- Preparation of part drawings for manufacturing.
- Consolidated report preparation of the above or similar relevant academic activities suited for a particular project as approved by the guide.

Course Outcomes:

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

1. Identify a problem based on literature survey / societal issues and other concerns.
2. Formulate a plan for solving the problem and evaluate all issues concerning it including calculations, simulation, prototype / model development and cost implications.

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SEMINAR

Sub Code : 14ME706 **Credits : 01**
Hrs/Week : 0+0+2+0

Course Outcomes:

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

1. Identify literature pertaining to the topic selected from standard bibliographic databases and search engines.
2. Organize information and prepare a seminar report.
3. Make an oral presentation.

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DYNAMICS LAB

Sub Code : 14ME707 **Credits : 01**
Hrs/Week : 0+0+2+0 **Total Hours: 26**

Part - A

1. Determination of a Pressure distribution in Journal bearing.
2. Determination of Principal Stresses and strains in a member subjected to combined loading using Strain rosettes.
3. Determination of Fringe constant of Photoelastic material using
   a) Circular disc subjected to diametral compression,
   b) Pure bending specimen (Four point bending).
4. Determination of stress concentration using Photoelasticity for simple components like plate with a hole under tension or bending, circular disk with circular hole under compression, 2D Crane hook.

Part - B

5. Determination of natural frequency, logarithmic decrement, damping ratio and damping coefficient in a single degree of freedom vibrating systems. (Longitudinal and torsional)
6. Balancing of Rotating masses.
7. Determination of critical speed of a rotating shaft.
8. Experiments on Gyroscope (Demonstration only).
9. Determination of equilibrium speed, sensitiveness, power and effort of porter/propel Governor.

Course Outcomes:

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

1. Recall the difference between kinetics and dynamics through experiments.
2. Visualize the stresses developed in an object through photo elasticity experiments.
3. Visualize and analyse the flow pressure distribution across and along the Journal bearing.

Course Outcome	Programme Outcomes													
	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO 1	PSO2
C-14ME707.1	H	H	-	-	-	-	-	-	M	L	M	L	M	L
C-14ME707.2	H	H	-	-	-	-	-	-	M	M	M	H	M	L
C-14ME707.3	M	M	L	-	M	-	-	-	-	L	-	L	M	L

Scheme of Examination:

One Question from Part A: 20 marks
One Question from Part B: 20 marks
Viva Voce: 10 marks

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FOUNDRY TECHNOLOGY

Sub code : 14ME711 **Credits : 03**
Hrs/Week: 3+0+0+0 **Total Hours: 39**

Course Learning Objectives:

This Course will enable students to

(1) Understand the different metallurgical aspects of consideration during casting design
(2) Know about fundamentals of solidification and melting technologies.
(3) Analyze about design concepts in gating systems in foundry and special molding techniques used in foundry.
(4) Know about ferrous/ nonferrous materials casting properties and difficulties in casting.
(5) Understand how the modernization and mechanization of foundry can be achieved.

UNIT – I

Foundry Metallurgy: Oxidation of liquid metals, gas dissolution in liquid metals, methods of degassing, fluidity, factors affecting fluidity, fluidity tests, hot tearing, shrinkage of liquid metals. **Casting design:** Introduction to casting design, redesign considerations, design for minimum casting stresses, design for directional solidification, design for metal flow, safety factors, design for low pattern cost.

8 Hours

UNIT – II

Solidification of castings: Crystallization and development of cast structure - nucleation, growth and dendritic growth. Coring and segregation. Concept of progressive and directional solidification,. solidification time and Chvorinov's rule. Structure of castings - refinement and modification of cast structure

Melting Furnaces: Introduction to various types of furnaces. Developments in cupola melting – hot blast cupola, water cooled cupola, balanced blast cupola, cokeless cupola, cupola charge calculations.

8 Hours

UNIT – III

Risering and Gating: Need for risering, general considerations of risering, riser types, riser size and location. Requirements of a riser. Sand, insulating, and exothermic materials used for risers. Riser feeding distance and theory of risering. Riser efficiency,methods to improve riser efficiency. **Gating system** – Classification, theoretical consideration of gating, laws of fluid flow, turbulence in gating system, need for tapered sprue, gating ratio(simple problems). **Special Moulding Techniques:** Principles, materials used, process details and application of no-bake sand systems, vacuum moulding, flaskless moulding, and high pressure moulding.

8 Hours

UNIT – IV

Ferrous Foundry: Melting procedures, casting characteristics, **production,** specification, and properties **of some typical steels, grey cast iron, malleable iron, and spheroidal graphite cast iron castings. Non-Ferrous Foundry:** Melting procedures, casting

characteristics, **production**, specification, and properties **of some typical aluminum, copper, and magnesium based alloy castings.** **8 Hours**

UNIT – V

Modernization and mechanization of foundry: Need for modernization, and mechanization, moulding and core making, melting, pouring, shake out equipment and fettling, dust and fume control, material handling equipments for sand moulds and cores, molten metal and castings, reclamation of sands. Pollution control.

7 Hours

Course Outcomes:

Upon completion of this course, graduates will be able to,

C-14ME711.1. Explain about material melting, pouring and solidification phenomenon.
C-14ME711.2. Appraise about solidification process in castings and explain various melting processes.
C-14ME711.3. Discuss about advanced molding techniques to meet the newer requirements.
C-14ME711.4. Distinguish between various aspects of ferrous foundry.
C- 4ME711.5. Identify the needs for mechanization of foundry industries.

Mapping of POs & COs:

POs / Cos	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 10	PO 11	PO 12	PSO 1	PSO 2
C-14ME711.1	H	L	-	-	-	L	-	L	-	-	L	H	L	-
C-14ME711.2	H	H	M	-	-	-	M	-	-	-	-	H	L	-
C-14ME711.3	H	M	M	-	-	-	L	-	-	-	-	H	L	-
C-14ME711.4	H	L	L	-	-	-	L	-	-	-	M	M	M	-
C-14ME711.5	H	L	H	-	-	M	H	H	-	-	M	H	M	-

L: Low M: Medium H: High

TEXT BOOKS:

1. **Principles of metal casting,** Heine Loper & Rosenthal TMH - 2005
2. **Principle of Foundry Technology**, P. L. Jain, TMH – 2006.

REFERENCE BOOKS:

1. **Castings,** John Campbell, Second edition, Elseivier, 2004
2. **Foundry Technology,** P. N. Rao, 2009
3. **Manufacturing Process,** I, Dr. K. Radha Krishna 5th Edn. Sapna Book House, Bangalore, 2009
4. **Foundry Technology, O.P.Khanna.** Dhanpat Rai Publications. 2011

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CONTROL ENGINEERING

Sub code : 14ME712 **Credits 03**
Hrs/Week: 3+0+0+0 **Total Hours: 39**

Course Learning Objectives:

This Course will enable students to

1. Understand the basic concept of control Engineering.
2. Know how to obtain mathematical model and transfer function of control system.
3. Obtain the response equation of control system.
4. Understand the concept of stability.
5. Obtain the stability of system using various methods.

UNIT - I

Introduction: Control system, open and closed loop control systems, and concept of feedback. **2 Hours**

Mathematical Model: Transfer functions models, Models of mechanical systems, electrical systems, hydraulic systems and thermal systems. **5 Hours**

UNIT - II

Block diagram and signal flow graph: Block representation of system elements, example of the use of block diagrams, Block diagram Reduction, Signal flow graph, Mason's gain formula. **8 Hours**

UNIT – III

System Responses: Types of input signals, First order and second order system response to step input, steady-state error, system types, System stability criteria, Routh criteria. **8 Hours**

UNIT - IV

Frequency Response: Polar and rectangular plots for the frequency response, Nyquist stability criterion, stability analysis. Phase and gain margin. **5 Hours**

System Analysis using logarithmic plots: Bode diagrams: Stability analysis using Bode diagrams, simplified Bode diagrams. **5 Hours**

UNIT - V

System Analysis using Root locus Plots: General rules for construction of Root Locus plots, analysis using root locus plot **5 Hours**

Control action: Basic concept of Proportional control, integral control, derivative control, proportional plus derivation control, PID control. 1 **Hours**

Course Outcomes:

Upon completion of this course, graduates will be able to,

C-14ME712.1. Classify control systems and to derive mathematical model and transfer function of various types of control systems.

C-14ME712.2. Write the block diagrams, reduce the block diagrams to obtain overall transfer function of a control system.

C-14ME712.3. Obtain the response of the first and second order control systems for unit step input and to apply the concept of stability using Routh criterion.

C-14ME712.4. Deduce the stability of control systems using Nyquest criterion and Bode plots

C-14ME712.5. Draw the root locus plots to determine the system gain and to summarize the fundamentals of different control actions.

Mapping of POs & COs:

CO	PO1	PO2	PO3	PO4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 10	PO 11	PO 12	PSO1	PSO2
C-14ME712.1	H	M	L			M		L				M		M
C-14ME712.2	H	L		L	L							H		M
C-14ME712.3	H	M		L	L							H		M
C-14ME712.4	H	M		L	L							H	M	M
C-14ME712.5	H	M		L	L							H	M	M

TEXT BOOKS:

1. **Katsuhiko Ogata** (2004) " Modern Control Engineering" *Prentice Hall of India Ltd.*, New Delhi
2. **I. J. Nagarath and M. Gopal**,(2002) "Control system" *New Age International Publisher*

REFERENCE BOOKS:

1. **Harrison H.L. and Bollinger J.G.** (1968) "Automatic controls", 2nd edition, *International Text Book Co.* U.S.A.
2. **Gopal M** (2005) " Modern Control Systems", *New Age International Publisher*
3. **Benjamin.Kuo.C.** (1995) "Automatic Control Systems", EEE, 7th Edition *Prentice Hall of India Ltd.* New Delhi
4. **Appukuttan K. K.** Control Engineering , Oxford university publication, 2009

MOOC/NPTEL Resources:

1. http://nptel.ac.in/courses/108101037/

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REFRIGERATION AND AIR-CONDITIONING

Sub Code : 14ME713 **Credits : 03**
Hrs/Week : 3+0+0+0 **Total Hours : 39**

Course Learning Objectives:

This Course will enable students to

1. Know the basic principles of refrigeration by relating it to refrigeration cycles.
2. Understand working of vapour compression and vapour absorption refrigerating system are understood.
3. Calculate the cooling loads in an Air conditioning system.
4. Design and analyze the ducts used in air conditioning systems.
5. Know balancing of components for refrigeration systems.

UNIT – I

REFRIGERATION: Principles, ideal cycle, Bel, Coleman and Boot strap air cycles, COP calculations. Refrigerants – ECO friendly refrigerants.

7 Hours

UNIT – II

VAPOUR COMPRESSION SYSTEM: Thermodynamic analysis, performance of system under varying operating conditions, cascade refrigeration, multistage refrigeration working principles.

5 Hours

VAPOUR ABSORPTION AND other SYSTEMS: Ammonia - water system, Lithium Bromide – water system. Use of enthalpy –concentration charts, steam jet refrigeration and solar refrigeration systems **5 Hours**

UNIT – III

AIR CONDITIONING: Psychrometry, psychrometer, psychometric processes, air conditioning cycles, cooling and reheat cycles, by-pass factor – humidification. **4 Hours**
COOLING LOAD: Effective temperature, comfort conditions, sensible heat factor ratio, number of air changes, cooling/heating load calculations.

4 Hours

UNIT – IV

Duct DESIGN AND AIR DISTRIBUTION: Considerations, methods of duct design air distribution systems, fans and air conditioning systems control. **7 Hours**

UNIT – V

BALANCING OF COMPONENTS: Condensers, air cooled, water cooled and evaporative condensers, selection, evaporates – flooded, dry expansion , shell and tube and double pipe,

compressors – reciprocating, rotary and centrifugal types. Expansion devices, cooling towers. **7 Hours**

Course Outcomes:

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

C14ME713.1. Recall the basic principles of refrigeration.

C14ME713.2. Explain the working of vapour compression and vapour absorption refrigerating systems.

C14ME713.3. Calculate the cooling loads in an Air conditioning system.

C14ME713.4. Design the ducts used in air conditioning systems.

C14ME713.5. Evaluate the significance of different components for refrigeration systems.

Course Articulation Matrix:

CO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
C14ME713.1	H	H	H	L	L	L	L	L	L	M	L	M	H	M
C14ME713.2	H	H	H	H	M	M	H	L	L	H	L	H	H	H
C14ME713.3	H	H	H	H	M	M	H	L	L	H	L	H	H	H
C14ME713.4	H	H	H	L	L	L	M	L	L	M	L	H	H	M
C14ME713.5	H	H	H	M	L	L	M	L	L	H	L	H	H	M

L : Low M: Medium H : High

TEXT BOOKS:

1. Manohar Prasad, “Refrigeration and Air Conditioning” Wiley Eastem Limited, 1983..

REFERENCE BOOKS:

1. Arora S.C. and Domkundwar S., “Refrigeration and Airconditioning”, Dhanpat Rai and Sons, New Delhi, 1997.
2. Stocker, “Refrigeration and Air Conditioning’, Tata McGraw Hill Publishing Company Ltd", 1981.
3. Roy J Dossat, “Principles of Refrigeration” S I Version, Wiley Easten Limited , 1985.

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DESIGN OF PRESSURE VESSEL & PIPING

Sub Code : 14ME714	**Credits : 03**
Hrs/Week : 3+0+0+0	**Total Hours : 39**

Course Learning Objectives:

This Course will enable students to

1. Know the methods of determining stresses.
2. Estimate stresses due to structural and temperature loads in pressure vessel components.
3. Calculation of stress concentration in a cylindrical vessel due to elliptical and circular hole.
4. Solve and analyse structural problems related to buckling loads and tubes under external pressure.
5. Understand and design piping layouts.

UNIT - I

INTRODUCTION

Methods for determining stresses - Terminology and Ligament Efficiency - Applications.

8 Hours

UNIT – II

STRESSES IN PRESSURE VESSELS

Introduction - Stresses in a circular ring, cylinder - Membrane stress Analysis of Vessel Shell components - Cylindrical shells, spherical sheels, torispherical heads, conical head - Thermal stresses - Discontinuity stresses in pressure vessels. **8 Hours**

UNIT – III

DESIGN OF VESSELS

Design of tall cylindrical self supporting process columns - supports for short vertical vessels – stress concentration - at a variable thickness transition section in a cylindrical vessel, about a circular hole, elliptical openings. Theory of reinforcement - pressure vessel design.

8 Hours

UNIT – IV

BUCKLING AND FRACTURE ANALYSIS IN VESSELS

Buckling phenomenon - Elastic Buckling of circular ring and cylinders under external pressure - collapse of thick walled cylinders or tubes under external pressure - effect of supports on Elastic Buckling of cylinders - Buckling under combined External pressure and axial loading - Control and significance of Fracture Mechanics in Vessels - FEM application.

8 Hours

UNIT – V

PIPING Introduction - Flow diagram - Piping layout and piping stress Analysis.

7 Hours

Course Outcomes:

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

C14ME714.1. Recall the fundamentals of piping systems.

C14ME714.2. Calculate stresses due to structural and temperature loads in pressure vessel components.

C14ME714.3. Calculate stress concentration in a cylindrical vessel due to elliptical and circular hole.

C14ME714.4. Solve structural problems related to buckling loads and tubes under external pressure.

C14ME714.5. Develop piping layouts.

Mapping of POs & COs:

CO	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 10	PO 11	PO 12	PSO 1	PSO 2
C14ME714.1	M	M	H	M	M	L	M	L	L	L	L	L	M	H
C14ME714.2	H	H	M	M	H	M	L	M	L	L	L	M	H	M
C14ME714.3	M	M	H	M	M	L	M	L	L	L	L	M	H	H
C14ME714.4	M	M	M	M	H	M	M	L	L	L	L	L	M	M
C14ME714.5	M	H	H	M	M	H	M	M	L	L	L	M	H	H

L : Low M: Medium H : High

TEXT BOOKS:

1. John F. Harvey, “Theory and Design of Pressure Vessels ", CBS Publishers and Distributors, 1987.

REFERENCE BOOKS:

1. Henry H. Bedner, " Pressure Vessels, Design Hand Book ", CBS Publishers and Distributors, 1987.
2. Stanley, M. Wales, " Chemical Process Equipment, Selection and Design. Buterworths series in Chemical Engineering *", 1988.*

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MODELING & SIMULATION OF ENGINEERING SYSTEMS

Sub Code : 14ME715 **Credits : 03**
Hrs/Week : 3+0+0+0 **Total Hours: 39**

Course Learning Objectives:

This Course will enable students to

1. Know basic concepts of mathematical modeling.
2. Design hydraulic system and RLC electrical system.
3. Design of first and second order systems which includes time and frequency domain.
4. Frequency response of first and second order systems.
5. Analyze the properties of feedback systems.

UNIT – I

Fundamental Concepts in Mathematical Modeling: Abstraction - linearity and superposition - balance and conservation laws and the system - boundary approach. **8 Hours**

UNIT – II

Lumped Element Modeling: Mechanical systems-Translational, rotational. Hydraulic systems. Thermal systems, RLC Electrical Systems. **8 Hours**

UNIT – III

Modeling of First- , order and Second-order Systems: Governing equations for free and forced j responses - transient response specifications - experim.ental determination laplace transform, Time Domain, Frequency Domain and State Space: **8 Hours**

UNIT - IV

Frequency response of Linear, Time invariant systems - frequency response of first-order and second-order systems - state space formulations of systems, problems relating frequency response to pole location –transient response-poles and frequency response. Feedback systems: **8 Hours**

UNIT - V

Systems with feedback - block diagrams - properties of feedback systems - relative stability-phase and gain margins. **7 Hours**

Course Outcomes:

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

C-14ME715.1. Explain the basic concepts of mathematical modeling.

C-14ME715.2. Design hydraulic and RLC electrical systems.

C-14ME715.3. Model first and second order systems in time and frequency domain.
C-14ME715.4. Obtain frequency response of first and second order systems.
C-14ME715.5. Analyze the properties of feedback systems.

Mapping of POs & COs:

CO	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 10	PO 11	PO 12	PSO1	PSO2
C-14ME715.1	M	M	H	M	L	L	M	M	H	M	M	M	L	L
C-14ME715.2	H	M	M	H	L	L	L	L	H	M	M	M	L	L
C-14ME715.3	H	M	H	H	L	L	L	L	H	M	H	M	M	M
C-14ME715.4	M	M	M	H	L	L	L	L	H	H	H	M	M	M
C-14ME715.5	M	M	M	H	L	L	M	L	H	H	H	M	M	M

L : Low M: Medium H : High

TEXT BOOK:

1. Philip D Cha, James J Rosenberg and Clive L Dym, 'Fundamentals of Modeling and Analyzing Engineering Systems', Cambridge University, 2000.

REFERENCE BOOKS:

1. *Woods, Robert L, and Lawrence Kent L, 'Modeling and Simulation* of *Dynamic Systems', Prentice Hall*, 1997.
2. *Amalendu Mukherjee, Ranjit Karmakar, 'Modeling and Simulation* of *Engineering _- Systems through Bondgraphs', Narosa, 2000.*
3. *Close Frederick, 'Modeling and Analysis* of *Dynamic Systems', Wiley.*

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TOTAL PRODUCTIVE MAINTENANCE

Sub Code : 14ME716 **Credits : 03**
Hrs/Week : 3+0+0+0 **Total Hours : 39**

Course Learning Objectives:

This Course will enable students to

1. Appreciate the importance of maintenance by understanding its history.
2. Understand tero technology and types of losses.
3. Understand the implementation of TPM.
4. Know to eliminate the losses and measure maintenance effectiveness.
5. Implement the pitfall approach of TPM in case studies.

UNIT – I

Types of Maintenance – Preventive Maintenance, Predictive Maintenance, Reliability

Centered Maintenance, Concept of Reliability, Availability and Maintainability
History and Impact of TPM, Maintenance to Productive maintenance, Definition, Features and Working of TPM, Benefits of TPM **8 Hours**

UNIT – II

Terotechnology – introduction, main functions, elements of Life-cycle cost and trade-off, essence of terotechnology
Equipment six big losses - breakdown loss, setup loss, Idling and Minor stoppages, design speed loss, start-up loss, defect and rework losses **8 Hours**

UNIT – III

Total Productive Maintenance - Zero breakdowns, Zero Defects and TPM, maximizing equipment effectiveness, eight pillars of TPM, TPM small group activities, TPM organization, management decision, educational campaign, creation of organizations, establishment of basic policies and goals, formation of master plan. TPM implementation **8 Hours**

UNIT – IV

Eliminating six big losses, autonomous maintenance and maintenance skills training, measuring maintenance effectiveness **8 Hours**

UNIT – V

Implementation of TPM – Discussion of real life case studies, TPM-Bajaj Way – 10 pillar approach, pitfalls of TPM and lessons on TPM **7 Hours**

Course Outcomes:

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

14ME716.1. Recall the importance of maintenance by understanding its history.
14ME716.2. Illustrate tero technology and types of losses.
14ME716.3. Discuss the implementation of TPM.
14ME716.4. Identify the losses and its elimination and measure maintenance effectiveness.
14ME716.5. Discuss the pitfalls in TPM implementation through case studies.

Mapping of POs & COs:

Course Outcome	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 10	PO 11	PO 12	PSO 1	PSO 2
14ME716.1	M	H	H	L	H	M	H	H	H	H	H	H	H	H
14ME716.2	M	H	M	M	H	H	H	M	H	H	H	H	M	H
14ME716.3	M	H	H	H	H	H	M	M	H	H	H	H	M	H
14ME716.4	H	H	M	M	H	H	M	M	H	H	H	H	L	M
14ME716.5	M	H	H	M	H	H	M	M	H	H	H	H	M	M

L : Low M: Medium H : High

TEXT BOOKS:

1. Total Productive Maintenance by Jyoti Mehrotra, Allied Publishers Ltd., 1998.
2. Seiichi Nakajima, Introduction to TPM, Productivity Press, Chennai, 1992

REFERENCE BOOKS:

1. Training Material – M/s Baja Auto Ltd., Pune
2. TPM - http://www.rsareliability.com/TPM%20Materials.pdf
   Other resources from the internet

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ADVANCED MANUFACTURING PROCESSES

Sub Code : 14ME717 **Credits 03**
Hrs/Week : 3+0+0+0 **Total Hours: 39**

Course Learning Objectives:

This Course will enable students to

1. Understand the basics of micro micromachining.
2. Know the process characteristics and advantages of micro electro discharge machining.
3. Understand the applications of High speed machining and dry, semi dry machining.
4. Understand hybrid thermal machining and laser assisted machining.
5. Understand the applications of sensor assisted machining.

UNIT - I

Tool-based Micro machining – Conventional machining
Introduction, micro cutting, micro milling, micro tool geometry, effect of feed rate on cutting force for different tool geometry, micro turning, turning of microstructure array, Turning of brittle materials, micro grooving and micro threading, micro drilling, burr formation in micro drilling, effect of induced low frequency vibration on micro drilling, fabrication of micro drills by Wire electro discharge grinding (WEDG), Fly- cutting, burr formation mechanism, cutting mode in micromachining, burr minimization, micro shaping, micro grinding. **7 Hours**

UNIT – II

Tool-based Micro Machining – Nonconventional machining
Micro Electro Discharge machining, Typical input and output influence factors for micro-EDM, Process Characteristics, Advantages and Drawbacks, Work Materials for Micro-EDM, Machinable Shapes, Applicable Ranges, Wire Electro-discharge Grinding, basic process for micro nozzle fabrication, Electrochemical micro machining , principle, process characteristics

advantages and drawbacks, work material for electrochemical micromachining, machinable shapes, applicable ranges, case study. Micro Ultrasonic Machining, process characteristics advantages and drawbacks, work material for Micro Ultrasonic Machining, machinable shapes, applicable ranges, case study. **8 Hours**

UNIT – III

High speed machining (HSM), definition of basic features of HSM, physical aspects of HSM, HSM technology and appliances, HSM spindle with tool clamping system, basic application of HSM Technology, machining of thin-walled parts using HSM.

Dry and Semi-dry machining, Dry machine tools and equipment, dry machining operations, introduction to near-dry machining, minimal quantity lubrication (MQL) media and mixture spraying systems, near-dry machine tools and machining operations.

Hard part machining (HM), definition of basic features of HM, physical aspects of HM, applications of HM Technology, surface finish produced by hard part machining.

High performance and high efficiency machining, high-performance cutting (HPC), machine tools and tooling for high performance cutting, simplified machining operations in HPC, multitasking and one-pass machining, multitasking machines and tooling. **8 Hours**

UNIT – IV

Hybrid thermal machining and thermally assisted machining processes

Hybrid thermal machining processes: Electro erosion dissolution machining, electro-discharge grinding, abrasive electro-discharge machining, EDM with ultrasonic assistance, electrochemical discharge grinding, brush-erosion dissolution mechanical machining

Laser Assisted Machining (LAM), definition of basic features of LAM, schematic diagram of LAM, Plasma Assisted Machining (PAM), definition of basic features of LAM, effect of surface temperature on cutting force. **8 Hours**

UNIT – V

Sensor assisted Machining

Sensors and System Architecture: Sensing objective during machining, multiple-sensor drive machining process control system, monitoring methods in manufacturing, sensor application verses level of precision and error-control parameters, sensors used for monitoring metal cutting and grinding operations, construction of direct spindle integrated with measuring ring and force sensors, tool monitoring systems, intelligent monitoring system.

Practical Examples of Monitoring Systems for Metal Cutting Applications: Monitoring systems on turning centres, drilling process monitoring using sensors for torque and force measurements within the tool holder and current sensor, Tool-condition monitoring systems, the tool-breakage and tool-wear detection system, the collision-monitoring system, Typical applications of the acoustic emission principle for tool-condition monitoring, Method of dimensional error compensation in precision hard turning, Fundamental structure of the sensor-based intelligent manufacturing system, Hardware structure of the intelligent machining centre, Sensor-assisted intelligent machining system.

Touch-trigger Probing and Laser Measuring Systems: Examples of on-machine probing for tool and part measurements, 3D touch probes for machine tools, Radio transmission (a) and inductive transmission systems, Trigger signal transmission for touch probes using optical

transmission, tool setting probing systems for CNC lathes, high precision pull-down arm (HPPA) and high precision removable arm (HPRA), Laser system for monitoring of tool breakage, high speed scanning probe and its use in measurements of cylinder bores, in-line inspection using vision sensors. 8 **Hours**

Course Outcomes:

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

14ME717.1. Compare micro-machining with conventional machining.
14ME717.2. Know the process characteristics and advantages of micro electro discharge machining.
14ME717.3. Elaborate on the applications of High speed machining both dry and semi dry machining.
14ME717.4. Examine hybrid thermal machining and laser assisted machining.
14ME717.5. Distinguish between the applications of sensor assisted machining.

Mapping of POs & COs:

Course Outcome	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 10	PO 11	PO 12	PSO 1	PSO 2
14ME717.1	M	H	H	L	H	M	H	H	H	H	H	H	H	H
14ME717.2	M	H	M	M	H	H	H	M	H	H	H	H	M	H
14ME717.3	M	H	H	H	H	H	M	M	H	H	H	H	M	H
14ME717.4	H	H	M	M	H	H	M	M	H	H	H	H	L	M
14ME717.5	M	H	H	M	H	H	M	M	H	H	H	H	M	M

L : Low M: Medium H : High

TEXT BOOKS:

1. *Advanced Machining Processes of Metallic Materials*, Wit Grzesik, Elsevier Publications, 2008
2. *Machining – Fundamentals and recent advances*, J. Paulo Davim, Springer-Verlag Publications, 2008

REFERENCE BOOKS:

1. *Advanced Machining Processes*, Hassan El-Hofy, McGraw-Hill Publications, 2005
2. Micromachining of Engineering Materials, Joseph McGeough, Marcel Dekker Publications**,** 2002
3. *MEMS/NEMS – Handbook: Techniques and Applications, Volume 3, Manufacturing Methods*, Cornelius T. Leondes, Springer-Verlag Publications, 2005

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HUMAN RESOURCE MANAGEMENT

Sub Code : 14ME718 **Credits 03**
Hrs/Week : 3+0+0+0 **Total Hours: 39**

Course Learning Objectives:

1. To develop a meaningful understanding of HRM theory, functions and practices.
2. To apply HRM concepts and skills across various types of organizations.
3. To understand the concepts of e-HRM.

UNIT - I

Human Resource Management & HRP:
Introduction, meaning, nature, scope of HRM. Major functions of HRM, Personnel Management vs Human Resource Management, job design, job evaluation, job analysis, job specification, job enlargement, job enrichment. Role of HR Manager.HR Planning. Process HRP. **8 Hours**

UNIT – II

Recruitment: Definition, Sources and Methods of Recruitment
Selection: Definition and Process of Selection. Cost benefit analysis of selection.
Placement: Meaning, Induction/Orientation, Internal Mobility, Transfer, Promotion, Demotion
and Employee Separation. Performance Appraisal methods **8 Hours**

UNIT - III

Training and development: Training v/s development, stages in training, Training Methods, Executive Development, Methods and Development of Management Development, Career and Succession Planning.
Compensation: employee remuneration, rewards, Wage and Salary Administration, Bonus, fringe benefits.
Internal Mobility, External Mobility, Trade union Act (Amendment) 2001.
7 Hours

UNIT - IV

Employee Grievances: Employee Grievance procedure. Discipline procedure
Collective bargaining; Characteristics, Necessity, Forms
Safety & Health; Industrial accidents, Safety
Quality circle; Meaning, Structure **8 Hours**

UNIT - V

IHRM. Managing IHRM. e-HR Activities, Global recruitment, selection, expatriates

e-HRM; Aspects of e-HRM,e-Job design & Analysis, Ethical issues in employment

8 Hours

Course Outcomes:

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

C14ME718.1: Understand the concept of HRM and its implementation
C14ME718.2: Understand the knowledge about recruitment.
C14ME718.3: Understand the need of training of development
C14ME718.4: Use the HRM skills across various types of organizations.
C14ME718.5: Understand the concepts of e-HRM.

Course Articulation Matrix:

CO	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 10	PO 11	PO 12	PSO	
													1	2
C14ME718.1	L	M	L	L	L	M	L	M	L	L	L	M	L	L
C14ME718.1	M	L	L	L	L	M	L	H	L	L	L	L	L	L
C14ME718.1	L	L	L	L	L	M	L	M	L	L	L	L	L	L
C14ME718.1	M	L	L	L	L	L	L	M	M	L	L	L	L	L
C14ME718.1	M	L	L	L		L	L	M	L	M	L	L	L	L

L : Low M: Medium H : High

TEXT BOOKS:

1. Essentials of Human Resource Management & Industrial Relations-P Subba Rao, Third Revised Edition

REFERENCE BOOKS:

1. Human Resource Management - John M. Ivancevich, 10/e, McGraw Hill.
2. Human Resource Management-Flippo
3. Human Resource Management - Lawrence S. Kleeman, Biztantra , 2012.
4. Human Resource Management – Aswathappa K HPH

MOOC/NPTEL Resources:

1. http://edx.nimt.ac.in/courses/course-v1:nimtX+PGDM1212+2017_H1/about
2. http://nptel.ac.in/courses/122105020/

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INTERNAL COMBUSTION ENGINES

Sub Code : 14ME 721 **Credits: 03**
Hrs/Week : 3+0+0+0 **Total Hours : 39**

Course Learning Objectives:

This Course will enable students to:

1. Identify the thermal sciences related to IC engine; know combustion processes involved in S.I Engine and different variables affecting it.
2. Demonstrate combustion process in C.I Engine and different variables affecting it also how methods of swirl generation lead to better combustion.
3. Distinguish the various emissions from SI & CI engine and highlight the various control techniques used.
4. Illustrate engine modification for the use of fuels like LPG, Hydrogen & alcohols.
5. Summarize the recent developments in engine and Measurement of different engine parameters.

UNIT – I

SPARK IGNITION ENGINES:
Spark ignition Engine mixture requirements - Feedback Control Carburettors -Fuel - Injection systems - Monopoint and Multipoint injection - Stages of combustion - Normal and Abnormal Combustion-Factors affecting knock - Combustion Chambers

7 Hours

UNIT – II

COMPRESSION IGNITION ENGINES
States of combustion in C.I. Engine - Direct and indirect injection systems - Combustion chambers - Fuel spray behaviour - spray structure, spray penetration and evaporation - Air motion - Turbocharging

7 Hours

UNIT – III

POLLUTANT FORMATION CONTROL:
Pollutant - Sources and types - formation of NOx - Hydro-carbon Emission Mechanism - Carbon Monoxide Formation - Particulate emissions - Methods of controlling Emissions-Catalytic converters and Particulate Traps-Methods of measurements and Driving cycles. Evolution and implementation of Bharath Stage norms.

9 Hours

UNIT – IV

ALTERNATIVE FUELS
Alcohol, Hydrogen, Natural Gas and Liquefied Petroleum Gas, bio-diesel - Properties, Suitability, Engine Modifications, Merits and Demerits as fuels.

9 Hours

UNIT – V

RECENT TRENDS

Learn Burn Engines - Gasoline Direct Injection Engine - Homogeneous charge, Fuel Cells - working, properties, Merits and demerits. Introduction to Electric drives and Hybrids.

Compression Ignition - Measurement techniques: Bosch Smoke meter, Hartridge smoke meter, Measurement of Brake Power by dynamometers. Future Of IC Engines

7 Hours

Course Outcomes:

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

C-14ME721.1 Explain the combustion process in S.I Engine and different variables affecting it.

C-14ME721.2 Know about combustion process in C.I Engine and different variables affecting it and methods of swirl generation.

C-14ME721.3 Identify sources of pollutants in engine and controlling emissions.

C-14ME721.4 Know the process of production of alcohols and understand the engine modification for use of LPG and Hydrogen.

C-14ME721.5 Identify recent developments in engine and engine measurements.

Course Articulation Matrix:

CO	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 10	PO 11	PO 12	PSO 1	PSO 2
C-14ME721.1	L	M	L	L	H	H	H	M	H	L	M	H	H	M
C-14ME721.2	L	M	L	L	H	H	H	M	H	L	M	H	M	L
C-14ME721.3	M	H	H	H	H	H	H	M	H	M	M	H	H	M
C-14ME721.4	M	H	H	M	H	H	H	H	H	M	M	H	H	M
C-14ME721.5	H	H	H	L	H	H	H	M	H	M	M	H	H	M

L: Low M: Medium H: High

TEXT BOOKS:

1. John B. Heywood, “Internal Combustion Engine Fundamentals ", McGraw Hill, 1988.
2. Charles Fayette Taylor ‘The Internal-combustion Engine in Theory and Practice, MIT PRESS Massachusetts Institute of Technology

REFERENCE BOOKS:

1. M.L Mathur and R.P.Sharma, " Internal Combustion Engine".
2. Rowland S.Benson and N.D.Whitehouse, " Internal combustion Engines ", Vol.I and II, Pergamon Press, 1983.
3. Duffy Smith, "Auto fuel Systems ", the Good Heart Willox Company, Inc., 1987.
4. Ryan O Hayre, Suk – Woncha, Whitney colella, Fritz B.Prinz, "Fuel Cell Fundamentals", Second Edition, John Wiley Publication,2009.

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MAINTENANCE & RELIABILITY ENGINEERING

Sub Code : 14ME 722 **Credits : 03**
Hrs/Week: 3+0+0+0 **Total Hours: 39**

Course Learning Objectives:

This Course will enable students to

1. Get an idea on different types of maintenance done.
2. Develop interest in maintenance planning and control over maintenance.
3. Understand the cost analysis involved during maintenance.
4. Gain knowledge on reliability engineering.
5. Present importance of reliability and its implementation in mechanical applications.

UNIT - I

Introduction:
Need for maintenance, objectives, functions and importance of maintenance systems, Type of maintenance systems – planned, breakdown, preventive, predictive, design-out, corrective, opportunistic, Total Productive Maintenance
Condition based maintenance – condition monitoring
Computers in maintenance – introduction, features and benefits **9 Hours**

UNIT – II

Maintenance planning and Scheduling: Planning of maintenance, manpower allocation, long range planning, short range planning, planning techniques and procedures, estimation of maintenance work, maintenance control, scheduling, repair order control, manpower requirement, maintenance job analysis, spare parts control. **8 Hours**

UNIT – III

Economics in Maintenance: Maintenance costs, repair, replacement, repair complexity, finding out most optimal Preventive Maintenance frequency, Numerical problems are

required Diagnostic maintenance – wear monitoring, temperature monitoring, vibration monitoring, lubricant analysis. **7 Hours**

UNIT – IV

Introduction to Reliability – definition, failure data analysis – introduction, failure data, MTTF, MTBF, Hazard model – introduction, Weibull model, some important distributions Numerical problems required. **7 Hours**

UNIT – V

System reliability - introduction, series, parallel, mixed configuration, series-parallel, parallel-series configurations, and methods of solving complex systems. Reliability improvement – introduction, improvement of components, redundancy – types, optimization, reliability cost trade off Maintainability and Availability – introduction, reliability and maintainability trade off. **8 Hours**

Course Outcomes:

Upon completion of the course, graduates will be able to:

C-14ME722.1 Know the need for maintenance and condition monitoring.
C-14ME722.2 Categorize maintenance planning and scheduling.
C-14ME722.3 Outline economics in maintenance and explain diagnostic maintenance.
C-14ME722.4 Apply reliability concepts and models.
C-14ME722.5 Evaluate system reliability and know about maintainability and availability.

Mapping of POs & COs:

Course Outcome	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 10	PO 11	PO 12	PSO 1	PSO 2
14ME722.1	H	H	H	L	H	M	H	H	H	H	H	H	H	H
14ME722.2	H	H	H	M	H	H	H	M	H	H	H	H	M	H
14ME722.3	H	H	M	H	H	H	M	M	H	H	H	H	M	H
14ME722.4	M	H	M	M	H	H	M	M	H	H	H	H	L	M
14ME722.5	M	H	M	M	H	H	M	M	H	H	H	H	M	M

L : Low M: Medium H : High

TEXT BOOKS:

1. Reliability and Maintenance Engineering by R. C. Mishra, New Age International, 2006.
2. Maintenance Engineering and Management by R.C.Mishra and K.Pathak, Prentice Hall of India, 2012.
3. Maintenance Engineering Handbook by Higgins and Morrow, Tata McGraw Hill, 1985.
4. Reliability Engineering by L.S.Srinath, Affiliated East West Press Pvt. Ltd., 2005.

REFERENCE BOOKS:

1. Mechanical Fault Diagnosis and Condition Monitoring by R.A.Collacott, McGraw Hill, 1985.
2. Management of Industrial Maintenance by Kelley A., and Harris, M.J., Newnes-Butter worth.
3. Maintenance Engineering Handbook by Morrow, 2002.

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COMPUTER INTEGRATED MANUFACTURING

Sub Code : 14ME723 **Credits03**
Hrs/Week : 3+0+0+0 **Total Hours: 39**

Course Learning Objectives:

This Course will enable students to

1. Understand the process of usage of automation in manufacturing systems.
2. To know the basic elements and also to analyze the production elements.
3. To know how to analyze the automated assembly system.
4. To know the different methods of quality control using computer.
5. Understand the uses and applications of different material handling and storage systems.

UNIT – I

Computer Integrated Manufacturing System: Introduction, Types of automation, Manufacturing support systems, Automation in production systems, Automated manufacturing systems, Computerized manufacturing support systems, Reasons for automating, Production concepts & mathematical models, Automation strategies.

9 Hours

UNIT – II

Transfer Lines and Similar Automated Manufacturing Systems: Fundamentals of automated production lines, System configurations, Work part transfer mechanisms, Storage buffers, Storage buffers between two stages of the production line, Control functions, Applications of Automated production lines**.**

Analysis of Automated Flow: Analysis of transfer lines with no internal storage, Analysis of transfer lines with storage buffers. **8 Hours**

UNIT – III

Automated Assembly System: Fundamentals of automated assembly systems, System configurations, Parts delivery at workstations, Sign for automated assembly.

Quantitative analysis of assembly systems: Parts delivery at workstations, multi-station automated assembly systems and single station automated assembly systems and partial automation **9 Hours**

UNIT – IV

Computer Aided Quality Control: Contact inspection methods, Non-contact inspection methods, Co-ordinate measuring machine, Automated Storage/Retrieval Systems, Automated guided vehicle systems Types & Applications of AGVs, Vehicle guidance technology, Vehicle management and safety.

7 Hours

UNIT – V

Material Handling Systems: Automated storage/retrieval systems (AS/RS) – Introduction, Types & Applications, Reasons for installing AS/RS, Carousel storage system.
Industry Visit – Visit to automated production lines.

6 Hours

Course Outcomes:

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

C-14ME723.1 Describe automation in production systems, manufacturing systems and computerized support systems.

C-14ME723.2 Describe and apply just in time production system concepts in different industrial areas and to pursue higher education.

C-14ME723.3 To know the use of engineering design and modelling techniques towards flow lines, robotics, numerical control and the integration of computer control/usage in manufacturing.

C-14ME723.4 Apply different computer aided quality control methods for inspecting quality of the product.

C-14ME723.5 To understand the functions of the different material handling systems used in industries.

Mapping of POs & COs:

Course Outcome	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 10	PO 11	PO 12	PSO 1	PSO 2
C14ME723.1	H	H	M	H	M	M	L	M	H	H	H	H	M	M
C14ME723.2	M	M	M	M	M	M	L	M	H	H	H	H	L	M
C14ME723.3	M	M	M	M	M	M	L	M	H	H	H	H	M	M
C14ME723.4	M	L	M	M	M	-	L	M	M	H	H	M	M	M
C14ME723.5	-	L	L	L	M	-	L	M	M	H	H	M	M	L

L: Low M: Medium H: High

TEXT BOOKS:

1. M.P. Grover. "Automation, Production Systems & Computer Integrated Manufacturing" Prentice Hall, third edition, 2008.

2. Groover Mikell P. and Zimmer Emory W. (2003) "Computer Aided design and Manufacturing" Prentice Hall Publications, New Delhi

REFERENCE BOOKS:

1. CAD/CAM Principles and Applications, Rao P.N. Tata McGraw Hill, Second Edition, 2004.
2. Principles of Computer Integrated Manufacturing- Vajpayee S.Kant. Prentice Hall of India, New Delhi,1999.

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MATERIALS MANAGEMENT

Sub Code : 14ME725 **Credits 03**
Hrs/Week : 3+0+0+0 **Total Hours 39**

Course Learning Objectives:

This Course will enable students to

1. Understand basics of material management and its relationship with organizational functions.
2. Know the concepts of material planning and budgeting.
3. Know the knowledge related to inventory control
4. Understand the principles of purchasing and legal aspects of purchasing.
5. Know the importance of store keeping.

UNIT – I

Introduction Meaning, definition, functions of materials management, Concept of integrated material management, Relationship of material management with other Organizational functions. **8 Hours**

UNIT – II

Material Planning & Budgeting: Need for material planning, Factors affecting material planning, Techniques of material planning; Material classification, codification and standardization; Material budgeting - meaning and need, techniques of material budgeting. **8 Hours**

UNIT – III

Inventory Control: Need and meaning of inventory, types of inventory, functions of inventory control, Inventory costs, Inventory control tool - ABC, VED, XYZ and FSN: Economic order Quantity and replenishment of stocks. Physical control of inventory: Fixed order, Two bin and Kardex systems - Material requirement planning (MRP-I) Spare parts control for maintenance purposes. Evaluation of inventory control performance. Concept of Just-in-Time (JIT). Use of computers for inventory control. **8 Hours**

UNIT – IV

Purchasing: Purchasing principles, procedures and systems, Functions of purchasing, Make-or-buy decision, Vendor development and vendor rating. Factors affecting purchase decisions, Legal aspects of purchasing, Documentation and procedure for import.

8 Hours

UNIT – V

Storage: Functions and importance of store keeping, types of stores, store accounting and store verification, Legal aspects of store keeping, Management of surplus, scrap and obsolete items. Importance of material handling in store keeping, handling equipment.

7 Hours

Course Outcomes:

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

C-14ME725.1 Illustrate the importance of material management and its relationship with other organizational functions.

C-14ME725.2 Apply the concepts of material planning and budgeting.

C-14ME725.3 Make use of principles of inventory control.

C-14ME725.4 Explain the principles of purchasing and examine the legal aspects of purchasing.

C-14ME725.5 Identify the importance of store keeping.

Mapping of POs & COs:

CO	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO10	PO 11	PO 12	PSO 1	PSO 2
C-14ME725.1	M	M	H	M	L	L	M	M	H	M	M	M	L	L
C-14ME725.2	H	M	M	H	L	L	L	L	H	M	M	M	L	L
C-14ME725.3	H	M	H	H	L	L	L	L	H	M	H	M	M	M
C-14ME725.4	M	M	M	H	L	L	L	L	H	H	H	M	M	M
C-14ME725.5	M	M	M	H	L	L	M	L	H	H	H	M	M	M

L : Low M: Medium H : High

TEXT BOOK:

1. Materials Management by M.M Verma, S. Chand and Sons

REFERENCE BOOKS:

1. Material Management - An Integrated Approach by Gopal Krishnan and Sundaresan : Prentice Hall
2. Purchasing and materials management by Dobbler and Burt; Tata McGraw Hill
3. Inventory control by Starr and Miller

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PRODUCT DESIGN AND DEVELOPMENT

Sub Code : 14ME726	**Credits : 03**
Hrs/Week : 3+0+0+0	**Total Hours : 39**

Course Learning Objectives:

This Course will enable students to

1. Learn basics of visual design.
2. Understand the importance of form transition.
3. Know the functions of colour graphics.
4. Understand product detailing which includes temporary and permanent joints.
5. Know about products development.

UNIT - I

VISUAL DESIGN:
Basic elements and concept of visual design: line color, Balance proportion, Size shape mass, unity and variety, Special relationships and composition in two and three dimensions.

8 Hours

UNIT - II

FORM & COLOR Elementary forms their characteristics and significance in design. Form transition, Form in relation to ergonomics, material and manufacturing process, color as an element of design, color clarification dynamics, interrelation of colors, colors and traditions; Psychological use of color form and material. **8 Hours**

UNIT - III

PRODUCT GRAPHICS: Meaning and objectives of product graphics. Basic principles of graphic design, Visual communication aspects of product graphics, Graphics of displays and control panels, **8 Hours**

UNIT - IV

PRODUCT DETALING: Standard fastening and joining details in different materials; Temporary and permanent joints: Detailing for plastic products, Detailing for fabricated products in sheet metal. **8 Hours**

UNIT - V

PRODUCTS DEVELOPMENT: Definition and objective, Role of designer in product development. Manufacturing and economic aspects of product development, Product promotions, product developments. **7 Hours**

Course Outcomes:

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

C-14ME726.1	Learn basics of visual design.
C-14ME726.2	Demonstrate the importance of form transition.
C-14ME726.3	Know the functions of colour graphics.

C-14ME726.4 Illustrate product detailing which includes temporary and permanent joints.

C-14ME726.5 Summarize about product development.

Mapping of POs & COs:

CO	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 10	PO11	PO 12	PSO 1	PSO 2
C-14ME726.1	H	M	H	M	L	L	L	L	M	M	L	L	M	M
C-14ME726.2	H	H	H	H	L	H	L	H	H	M	L	L	M	M
C-14ME726.3	H	M	H	M	L	L	L	H	H	M	L	L	L	M
C-14ME726.4	H	H	M	H	L	L	L	L	M	H	L	L	M	M
C-14ME726.5	M	M	M	M	L	H	L	L	H	M	L	L	H	H

L : Low M: Medium H : High

TEXT BOOK:

1. Mayall W.H., "Industrial Design for Engineers" London Liifee Books Ltd. 1967

REFERENCE BOOKS:

1. Dale Huchingson R "New Horizons for Human Factors in Design" McGraw Hill Company 1981
2. Industrial Design-Mayall.
3. Engineering Design- Svensson.
4. Engineering Design-Matousek
5. Mccormick K.J. (Ed) "Human Factor Engineering" 4th edition McGraw Hill BookCompany Ltd. USA 1992

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DESIGN OF AIRCRAFT STRUCTURES

Sub Code : 14ME727 **Credits 03**
Hrs /Week: 3+0+0+0 **Total Hours: 39**

Course Learning Objectives:

This Course will enable students to

1. Get an exposure to the aircraft design, loads and materials.
2. Understand the Basics of Aircraft Systems and Aircraft Structures.
3. Industry Practices on Design of Aircraft Structures.
4. Understand the applicability of Design aspects in Aircraft Design.
5. Relate the theoretical knowledge with the design of Aircraft Structures.

UNIT – I

Chapter 1 - Overview of the Aircraft Design Process

Introduction, Phases of Aircraft Design, Aircraft Conceptual Design Process, Conceptual Stage, Preliminary Design, Detailed Design, Design Drivers, Take of weight estimation using design example: ASW aircraft.

Airworthiness- Definition, Airworthiness Regulations, Regulatory Bodies, US FAR and Subparts of FAR Part 25,Type certification, General Requirements, Requirements Related to Aircraft Design - Performance and Stability Requirements, Airframe (strength) Requirements, Landing Requirements, Fatigue and Damage tolerance requirements, Emergency Provisions, Emergency Landing requirements. **4 Hours**

Chapter-2 -Aircraft Loads

Aerodynamic Loads, Inertial Loads, Loads due to engine, Actuator Loads, Maneuver Loads, V-n diagrams, Gust Loads, Ground Loads, Ground conditions, Miscellaneous Loads. Simple numerical examples. **2 Hours**

Chapter 3- Aircraft Structures Description

Types of Structural members of Fuselage and wing section and empennage, Splices, Types of structural joints, splices and fuselage floor structure.

1 Hour

UNIT – II

Chapter 4-Aircraft Materials and properties

Introduction, Basic construction, Material forms-Metallic materials and forms. Alloy designations. Mechanical Properties- strength, static, stress strain curves, Fatigue properties, crack growth. **3 Hours**

Chapter 5- Static and Fatigue Failures

Principal stresses, principal strains, Mohr's circle for stress and strain, Fatigue Failures, Fatigue theory, Introduction to Low cycle Fatigue, Stress Life and Strain Life Techniques, Mean stress effects, Multi-axial Effects, Introduction to high cycle fatigue. **4 Hours**

UNIT – III

Chapter 6-Theroy of bars ,Beams, Shafts and Columns

Axially loaded structures, Methods of analysis-Method of joints and Method of sections, Space truss.

Beam theory, Section properties, Deflection of beams, Symmetric and Unsymmetric bending, Plastic bending, Shear stress in beams, Shear center, Torsion of Solid Sections, Torsion of Thin walled-open and closed sections, Columns Theory-Euler equation, Effective column length, Plasticity effects, Thin walled columns-Crippling, Beam columns. **8 Hours**

UNIT – IV

Chapter 7- Box Beams

Box Beams- Introduction, Shear flow due to shear, Shear flow due to torsion-Bredt Baths, Single and Multicell Boxes. **4 Hours**

Chapter -8 Buckling of Thin Sheets

Buckling of thin sheets, Buckling of flat plate in compression and shear, Buckling of curved plates in compression and shear, buckling of stiffened panels-post buckling, effective width, Concept of diagonal tension, buckling under combined loads. **8 Hours**

UNIT – V

Chapter 9- Aircraft Structural Joints

Introduction, Fasteners, Splices, and Eccentric joints-Bolt Group Analysis, Lug Analysis(Lugs loaded axially only), Tension Fitting and clips, Welded joints, Bonded joints.

3 Hours

Chapter10- Advanced materials, Vibrations and Flutter

Introduction to Comp Materials, Matrices, Fibers, Forms, Characteristics of composite materials, Brief overview of static and dynamic aero elasticity (definition and importance only) **2 Hours**

Course Outcomes:

At the end of this course the student shall be able to:

C-14ME727.1 Describe different phases of aircraft design and differentiate between various methodologies used in aircraft design based on different types of loads acting on the aircraft.

C-14ME727.2 Describe basic construction and material forms of aircraft structures, differentiate between different normal metals, alloys, composite materials and their application in different structures and solve problems related to Principal stresses and strain. Describe static and fatigue stress effects, describe thermo mechanical Fatigue and high cycle fatigue and describe Multi axial stress effects.

C-14ME727.3 Analyze axially loaded structures using method of joints and method of sections, deflection of beams, symmetric unsymmetric and plastic bending cases, describe the state Euler's equation for columns, determine effective column length and analyze the crippling effect on columns.

C-14ME727.4 Describe and apply the concept of shear flow, the concept of diagonal tension, the concept of Euler's buckling, the significance of buckling of thin plates, the concept of diagonal tension and buckling under combined loads

C-14ME727.5 Classify different aircraft structural joints, analyze bolt groups for strength and other considerations, analyze bonded joints and lugs and analyze tension fittings and clips.

Mapping of POs & COs:

CO	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 10	PO 11	PO 12	PSO 1	PSO 2
C-14ME727.1	L	M	M	L	L	L	H	L	H	L	L	L	L	M
C-14ME727.2	H	H	M	H	M	M	H	L	M	L	H	M	H	L
C-14ME727.3	H	H	H	H	M	L	H	L	L	L	L	L	M	M
C-14ME727.4	H	H	H	H	M	L	H	L	L	L	L	L	H	M
C-14ME727.5	M	M	M	M	L	L	H	L	H	L	M	L	H	M

L : Low M: Medium H : High

TEXT BOOKS:

1. Aircraft Design-A Conceptual Approach by Daniel P.Raymer, AIAA Education, series,6th Edition
2. Airframe Structural Design by Michael Niu, Conmilit Press, 1988,2nd Edition.
3. Airframe Stress Analysis and Sizing by Michael Niu, Conmilit Press, 1999,3rd Edition
4. Aircraft Structures for engineering students by T. H. G. Megson, Butterworth-Heinemann, Third Edition

REFERENCES BOOKS:

1. The Elements of Aircraft Preliminary Design – Roger D. Schaufele, Aries Publications, 2000.
2. An Introduction to Aircraft Certification; A Guide to Understanding Jaa,Easa and FAA by Filippo De Florio, Butterworth-Heinemann

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PLASTIC PART DESIGN & MANUFACTURING

Sub Code : 14ME728	**Credits : 03**
Hrs/Week : 1+0+2+0	**Total Hours : 39**

Course Learning Objectives:

This course will enable students to:

1. Know about plastics and their processing.
2. Understand the design considerations in molding.
3. Observe and understand the various processes in a tool room.
4. Apply design concepts in various kinds of dies and die casting.
5. Study defects & identify solutions in die casting and die assembly techniques.

UNIT – I

Introduction: Plastics, advantages and disadvantages. Properties of plastics.
Thermoplastic Processing methods: Injection molding, extrusion, thermoforming, blow molding, roto molding.
Part requirements for Design: Mechanical, thermal, chemical, weather / environment, appearance, life expectancy, dimensional tolerances, processing, production quantities, cost, assembly, activity **7 Hours**

UNIT – II

General Design Considerations: Wall thickness, draft angle, rib design, boss design, part radii, part text, undercuts, living hinges, gate position.

Injection Mold part defects and solutions: Brittleness, warped parts, flashing, burn marks, weak weld lines, sink or voids, part sticking, dimensional inconsistency
Part assembly Techniques: Fastening, press fits, snap fit.
Welding techniques: Induction, ultrasonic etc
Adhesive and solvent
Finishing of plastics: Electroplating, painting, surface treatment, machining

8 Hours

UNIT - III

Visit to tool-room: Die manufacturing & die assembly

Visit: Injection mold shop

Injection molding process, process parameters, defects & safety / hazards

8 Hours

(Reports of industry visits have to be submitted, evaluated for internal assessments)

UNIT – IV

Die casting Part Design and Manufacturing: Introduction, die casting, advantages of die casting, and properties of die casting alloys
Die casting process: Hot chamber die casting and cold chamber die casting
Design considerations for part: Machinability, corrosion and acid resistance, weight and cost, appearance, surface treatment, dimensional tolerances / stability, processing, production quantities, cost, assembly, activity
General Design Considerations: Wall thickness, draft angle, rib design, boss design, part radii, part text, undercuts, living hinges, gate position.

8 Hours

UNIT - V

Die Cast part defects and solutions: Brittleness, warped parts, flashing, weak weld lines, sink or voids, part sticking, dimensional inconsistency.
Part assembly Techniques: Fastening, press fit, other assembly techniques.
Finishing of Die cast parts: Electroplating, painting, surface treatment, machining,
Visit: Die casting shop: Die casting machine, die casting machine parameters, safety / hazard

8 Hours

(Reports of industry visits have to be submitted, evaluated for internal assessments)

Course outcomes:

Upon completion of the course, students will be able to:

C-14ME728.1 Explain plastics and their processing.
C-14ME728.2 Illustrate design considerations in molding.
C-14ME728.3 Recollect the processes observed in the tool room and present a report.
C-14ME728.4 Design various kinds of dies.
C-14ME728.5 Explain defects in die casting and generate solutions and understand the assembly techniques.

Mapping of POs & COs:

CO	PO1	PO2	PO3	PO4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 10	PO 11	PO 12
C-14ME728.1			M	H		L	M		L			
C-14ME728.2		M	H		H	L	H					
C-14ME728.3		L	M				M			H		
C-14ME728.4		M	H	H	H	L	M					
C-14ME728.5		M	M	M		M	H			L		

L: Low M: Medium H: High

TEXTBOOKS:

1. Edward Magrab, "Integrated product and process design and Development", CRC Press, 2009.
2. Corrodo Poli, "Design for Manufacturing: A structured approach", Butterworth-Heinemann, 2001.
3. K G Cooper, "Rapid Prototyping Technology", Marcel Dekker, Inc. 2001

REFERENCE BOOK:

1. Lal G.K, Vijay Gupta, Venkata Reddy N, "Fundamentals of Design and Manufacturing", Narosa Book Distributors Private Limited, 2010.

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HEAT TRANSFER

Sub Code : 14ME801 **Credits : 04**
Hrs/Week : 3+2+0+0 **Total Hours : 52**

Course Learning Objectives:

This Course will enable students to

1. Get the idea of laws related to modes of heat transfer and steady state heat conduction equations.
2. Know the importance of application of fins in heat transfer equipments and also understand unsteady conduction.
3. Know the importance of boundary layer and solve problems related to free and forced convection.
4. Understand radiation and laws governing them.
5. To design heat exchangers and study boiling, condensation and basics of mass transfer.

Prerequisites: The student must have learnt about Calculus, Physics, Fluid Mechanics, and fundamentals of Basic and Applied Thermodynamics.

UNIT - I

INTRODUCTORY CONCEPTS AND DEFINITIONS:
Modes of heat transfer; Basic laws governing conduction, convection, and radiation heat transfer; Thermal conductivity; convective heat transfer coefficient; Radiation heat transfer coefficient; combined heat transfer mechanism.

CONDUCTION-BASIC EQUATIONS:
General form of three dimensional heat conduction equation in rectangular, coordinate. Discussion (no derivation) on three dimensional conduction in cylindrical and spherical coordinate systems. Boundary conditions of first, second and third kinds.

ONE-DIMENSIONAL STEADY STATE CONDUCTION:
Steady state conduction in a slab, in a cylinder and in a sphere without heat generation. Overall heat transfer coefficient for a composite medium; thermal contact resistance; critical thickness of insulation **10 Hours**

UNIT – II

HEAT CONDUCTION THROUGH FINNED SURFACES
Steady state conduction in fins of uniform cross section long fin, fin with insulated tip and fin with convection at the tip; fin efficiency. Conduction in solids with variable thermal conductivity.

ONE-DIMENSIONAL TRANSIENT CONDUCTION:
Conduction in solids with negligible internal temperature gradients (Lumped system analysis); Use of transient Temperature charts (Heisler's Charts) for transient conduction in slab, long cylinder and sphere; use of transient temperature charts for transient conduction in semi-infinite solids. **10 Hours**

UNIT- III

RADIATION HEAT TRANSFER:
Thermal radiation; Definitions of various terms used in radiation heat transfer; Stefan-Boltzman law, Kirchoff's law, Planck's Law and Wein's displacement law' Radiation heat exchange between two parallel infinite black surfaces, between two parallel infinite gray surfaces; Effect of radiation shield; Intensity of radiation and solid angle; Lambert's Law; Radiation heat exchange between two finite surfaces - configuration factor or view factor.

CONCEPTS AND BASIC RELATIONS IN BOUNDARY LAYERS:
Flow over a body-Velocity boundary layer; Critical Reynolds number; General expressions for drag coefficient and drag force; Thermal boundary layer; general expression for local and average heat transfer coefficient; Nusselt number. Expressions for friction factor for hydro dynamically developed laminar flow through tubes.

11 Hours

UNIT - IV

FORCED CONVECTION:
Application of dimensional analysis for forced convection problems. Physical significance of Reynolds, Prandtl, Nusselt and Stanton numbers. Use of various correlations for hydro -dynamically and thermally developed flows; use of correlations for flow over a flat plate, over a cylinder and across

FREE OR NATURAL CONVECTION:
Application of dimensional analysis for free convection- physical significance of Grashoff number; Use of correlations for free convection from or to vertical, horizontal and inclined flat plates, vertical and horizontal cylinders. **10 Hours**

UNIT – V

CONDENSATION AND BOILING:
Types of condensation; Nusselt's theory for laminar condensation on a vertical flat surface-expressions for film thickness and heat transfer coefficient; use of correlations for condensation on inclined flat surfaces, horizontal tube and horizontal tube banks; Reynolds number for condensate flow; Regimes of pool boiling-Pool boiling correlations.

HEAT EXCHANGERS:
Classification of heat exchangers; overall heat transfer coefficient, fouling and fouling factor; LMTD and NTU methods of analysis of heat exchangers.

INTRODUCTION TO MASS TRANSFER: Similarity between Heat and Mass Transfer, Fick's Law of diffusion. **11 Hours**

Course Outcomes:

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

C-14ME801.1 Explain the different modes of Heat Transfer, their governing laws and understand the basics of steady state conduction.

C-14ME801.2 Learn the principles of heat transfer through finned surfaces and transient conduction.

C-14ME801.3 Understand the concepts and basic relations of boundary layer and Radiation heat transfer

C-14ME801.4 Know the principles of free and forced convection heat transfer.

C-14ME801.5 Learn the principles of boiling and condensation, heat exchangers and basics of mass transfer.

Mapping of POs & COs:

CO	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 10	PO 11	PO12	PSO 1	PSO 2
C-14ME801.1	H	M	M					M				M	M	M
C-14ME801.2	H	H	M	M					M				M	M

C-14ME801.3	H	H	H	M	M	H	H	M	M	M			M	M
C-14ME801.4	H	H	M	M										M
C-14ME801.5	H	H	M	M		M	M							M

L : Low M: Medium H : High

TEXT BOOKS:

1. Heat Transfer, Holman J.P., Ninth Edn. Tata McGraw –Hill, 2007
2. Shah, R. K. and Seculic, D. P.,"Fundamentals of Heat Exchanger Design", Wiley India, 2012.
3. Krieth - Fundamentals of Heat Transfer, 4th Edition, Harper & Law, 1986.
4. Heat & Mass Transfer by R.K.Rajputh, S. Chand& Co (P) Ltd, 2014
5. Heat & Mass Transfer by S.C.Arora & S. Domkundvar, DhanapatRai Co (P) Ltd, 2013.
6. Heat Transfer - A Basic approach by M NecatiOzisik, McGraw Hill International edition 1988.
7. Doeblin, Measurement Systems Application and Design – Mc Graw Hill education, 5th Edition, 2003.
8. Numerical Heat Transfer and Fluid Flow.Hemisphere Publishing corporation, Taylor and Francis Group New York, 1980.

REFERENCE BOOKS:

1. Cengel, Y., "Introduction to Thermodynamics and Heat Transfer", 2nd Edition, McGraw Hill, 2007.
2. Rogers, G. and Mayhew, Y., "Engineering Thermodynamics and Heat Transfer", 4th Ed., Addison-Wesley, 2002.
3. Incropera, F.P., Dewitt, D.P., Bergman, T. L. and A. S. Lavine, "Principles of Heat and Mass Transfer", 7th Ed. (International Student Version), John Wiley & Sons, 2012.
4. Cengel, Y. A. and Ghajar, A. J., "Heat and Mass Transfer", 4th Edn., Tata McGraw Hill Education Pvt. Ltd., New Dehi, 2011.
5. Fundamental of Heat and Mass Transfer, Incropera and Dewitt, 5th Edn., John Wiley & Sons, 2002.

MOOC/NPTEL Resources:

1. http://nptel.ac.in/courses/112101097/

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HEAT TRANSFER LAB

Sub Code : 14ME802 **Credits 01**
Hrs/Week : 0+0+2+0 **Total Hours: 26**

The students are required to carry out any 10 experiments from the following list.

1. Determination of Thermal conductivity of a Metal rod.
2. Determination of overall heat transfer coefficient of a Composite Wall.
3. Determination of Effectiveness on a metallic fin.
4. Determination of Heat Transfer co-efficient in a free convection wall.
5. Determination of Heat Transfer co-efficient in a forced convention flow through a pipe.
6. Determination of emissivity of a surface.
7. Determination of Stefan Boltzman constant.
8. Determination of LMTD and effectiveness in a parallel flow and counter flow Heat exchanger.
9. Experiments on Boiling of liquid and condensation of vapour.
10. Performance Test on a Vapour Compression Refrigerator.
11. Performance test on a Vapour Compression Air-conditioner.
12. Experiment on Transient conduction Heat Transfer.

Course Outcomes:

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

C-14ME802.1 Demonstrate the basic laws of heat transfer and calculate thermal conductivity, radial heat transfer rate for different materials and liquids.

C-14ME802.2 Evaluate heat transfer coefficients in natural and forced convection and also find heat transfer rate in refrigeration and Air conditioning system.

C-14ME802.3 Analyze heat transfer rate in Radiation heat transfer and find Emissivity of a given surface.

Mapping of POs & COs:

CO	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 10	PO 11	PO 12	PSO 1	PSO 2
C-14ME802.1	H	H	M	M		M	M		H	M			M	M
C-14ME802.2	H	M	M			M	M		M	M		L		M
C-14ME802.2	H	H	H			M	H	M	M					M

Scheme of Examination:
Students are required to carry out **Two** experiments in Semester End Exam
Experiment 1: 20 marks
Experiment 2: 20 marks
Viva Voce: 10 marks
Total: 50 Marks

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PROJECT – II

Sub Code : 14ME803 **Credits: 09**
Hrs/Week : 0+0+9+0

The project work involves the following:

- **A report highlighting the design finalization [based on functional requirements & standards (if any)]**
- **Fabrication, assembly, testing and performance analysis of the designed project**
- **A presentation including the following:**
  - Implementation Phase (Hardware / Software / both)
  - Testing & Validation of the developed system
  - Learning in the Project
- **Consolidated report preparation**

Objectives of the course on project work:

To expose engineering students to technology development at workplaces and appraise them regarding shop-floor problems.

To provide practical experience in solving open ended problems in real work setting so as to cause transfer of college based knowledge and skills to solve practical problems and thereby develop confidence in the students in the analysis, synthesis and evaluation of practical problems leading to creative thinking Programme.

During this work bench involvement, students will be given 3-4 practical problems. The problems assigned should be of mutual interest to the students and the industry. The problem may belong to 3 or 4 different functional areas. To illustrate, following are some of the suggestions:

Design of a prototype¨ Programming of CNC machines¨ Calibration and testing of instruments ¨ Productivity Improvement Studies¨ Pollution control related problems¨ Capacity Planning and Capital Budgeting¨ Safety Management¨ Optimum utilization of resources¨ Conflict Management methodology. The industrial organizations where students are to be sent for problem solving project-oriented work bench involvement may be selected well in advance¨ The faculty of the department is expected to visit the selected industries and identify suitable problems to be handled by students. It will be desirable that problems be matched with the interests of students.

It is recommended that a group of 5-6 students be guided by one faculty member during this period.

SCHEME OF EVALUATION: Project demonstration, Viva voce
Total marks: 100 Marks

The distribution of marks shall be proportioned based on the type of the project and it is based on fulfilling the following requisites.

The evaluation of students is proposed to be done by internal faculty with active involvement of industrial personnel. The evaluation may be based on following criteria:

Punctuality and Attendance ¨ Interpersonal relations

Sense of Responsibility

Clarity of concepts, principles and procedures

Self expression/communication skills

Report Writing Skills

Creativity/conceiving new and unusual ideas

Problem-solving skills

At the end of the project work course students are required to submit a working model of the equipment they have designed and developed or if it is a theoretical or experimental work, they are expected to study a detailed analysis and findings from their work.

Course Outcomes:

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

1. Develop a model / prototype through simulation, fabrication and assembly.
2. Perform testing and analysis through experiments.
3. Preparation of a technical report and defending the solution for the problem through a oral presentation

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INDUSTRIAL TRIBOLOGY

Sub Code : 14ME811 **Credits : 03**
Hrs/Week : 3+0+0+0 **Total Hours: 39**

Course Learning Objectives:

This Course will enable students to

1. To recollect the phenomenon of friction and the theories of friction. To discuss the effect of friction on component life.
2. To give details about the selection of materials and surface treatment methods such as heat treatment, carburizing, nitriding, and surface coating techniques such as hard facing and vapour deposition method that improve the wear resistance of the surface.
3. Explain about the types of lubricants, their properties and method to determine the properties. To obtain the equation of flow through pipe and through parallel plates.
4. Explain the mechanism of pressure development in oil film. To derive the Reynolds equation and discuss its importance.
5. To provide details about hydrostatic lubrication. To derive the equations used to determine the load carrying capasity, oil flow and power loss in hydrostatic step bearing.

UNIT – I

Introduction: introduction to Tribology, introduction to micro/ nano tribology, Friction: introduction, laws of friction, types of friction – sliding, rolling, friction of metals, friction of ceramics, polymers, stick-slip, topography of engineering surfaces, contact between surfaces.

5 Hours

UNIT – II

Wear – introduction, types of wear mechanisms – adhesive, abrasive, fatigue, impact, corrosive wear, wear of materials – metals and alloys, ceramics, polymers, wear measurement, Effect of speed, temperature and pressure, Commonly used bearing materials, properties of typical bearing materials. **5 Hours**

UNIT – III

Lubrication and lubricants – Properties of lubricants, viscosity, Newton's Law of viscosity, Hagen-Poiseuille law, Flow between parallel stationary planes, viscosity measuring apparatus, effect of temperature and pressure on viscosity, Friction forces and power loss in lightly loaded bearing, Tower's Experiments. **10 Hours**

UNIT – IV

Hydrodynamic lubrication– Mechanism of pressure development Reynold's equation in two dimensions, Pressure distribution, Load carrying capacity, Coefficient of friction, frictional resistance in a fixed shoe and pivoted shoe bearing, influence of end leakage, numerical problems, Idealized full journal bearings, Partial journal bearing, Numerical problems.

14 Hours

UNIT – V

Hydrostatic lubrication – introduction, Hydrostatic step bearing – load carrying capacity, oil flow, stiffness, and numerical problems**.** **5 Hours**

Course Outcomes:

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

C-14ME811.1 Interpret frictional behavior in metals and non metals.
C-14ME811.2 Discuss different types of wear and apply various surface treatment methods.
C-14ME811.3 Recall the concepts related to the flow of fluids and illustrate the use of lubrication and lubricants.
C-14ME811.4 Discuss the different types of lubrication and types of bearings, their design and performance.
C-14ME811.5 Derive analytical expressions related to the design and performance of hydrostatic bearings.

Course Articulation Matrix :

CO	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 10	PO 11	PO 12	PSO 1	PSO 2
C-14ME811.1	L	M	L	M	M	-	M	-	-	-	-	-	M	H
C-14ME811.2	L	M	M	H	M	-	M	-	-	-	-	-	M	H
C-14ME811.3	H	H	M	H	H	-	H	-	-	-	-	-	M	M
C-14ME811.4	H	H	H	H	H	-	H	-	-	-	-	-	M	M
C-14ME811.5	H	H	M	M	H	-	H	-	-	-	-	-	M	M

L : Low M: Medium H : High

TEXT BOOKS:

1. Introduction to Tribology of Bearings – B.C.Majumdar, S. Chand & Company Ltd., New Delhi, 2008.
2. Principles and Applications of Tribology – Bharat Bhushan, John Wiley and Sons Inc., 1999.
3. Tribology in Industries – Sushil Kumar Srivastava, S. Chand & Co. Ltd., New Delhi, 2001.

REFERENCE BOOKS:

1. Lubrication of bearings – Theoretical Principles and Design, Redzimovskay E.I., Oxford Press Company
2. Engineering Tribology, Prasanta Sahoo, PHI Learing Pvt. Ltd., New Delhi
3. Fundamentals of Tribology, S.K. Basu, S.N. Sengupta and B.B. Ahuja, PHI Learing Pvt. Ltd., New Delhi

MOOC/NPTEL Resources:

1. http://nptel.ac.in/courses/112102015/

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TOOL ENGINEERING AND DESIGN

Sub Code : 14ME812 **Credits : 03**
Hrs/Week : 3+0+0+0 **Total Hours : 39**

Course Learning Objectives:

This Course will enable students to

1. Understand single point cutting tool and the materials used for cutting tool.
2. Design single point cutting tool and milling cutter, reamer tools.
3. Know about jigs and fixtures and various parts of jigs and fixtures.
4. Solve problems related to design and fixtures.
5. Know about design of press tools and press working terminologies

UNIT – I

Theory of Metal cutting – Mechanics of chip formation, nomenclature of single point tool, designation of cutting tools, orthogonal and oblique cutting, types of chips produced, tool wear and tool life
Cutting tools – materials, properties, classification, selection, multipoint cutting tools – milling cutters, drills. **8 Hours**

UNIT – II

Design of Single point tool – types of cutting tools, chip breakers, design of shank section for single point tool to account for strength and rigidity
Design of multipoint tools – milling cutter, drill and reamer **8 Hours**

UNIT - III

Design of Jigs and Fixtures – difference between a jig and a fixture, function of jigs and fixtures, design procedures for drill jig and fixtures, principles of location, different types of locators, principles of clamping, types of clamps, drill bushes and plates, types of drill bushes, bush materials. **7 Hours**

UNIT – IV

Design of drill jigs – types of drill jigs, jig and machine relationship, jig body and jig feet
Design of fixtures – milling fixture, turning fixture, grinding fixture and broaching fixture **8 Hours**

UNIT – V

Design of Press tools – press operations, press tool components, press working terminology, types of dies, design of blanking die, design of drawing die, design of bending die

Course Outcomes:

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

C-14ME812.1 Explain single point cutting tool and the materials used for cutting tool.
C-14ME812.2 Design single point cutting tool and milling cutter, reamer tools
C-14ME812.3 Know about jigs and fixtures and various parts of jigs and fixtures.
C-14ME812.4 Solve problems related to design and fixtures.
C-14ME812.5 Know about design of press tools and press working terminologies

Mapping of POs & COs:

Course Outcomes	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
13ME812.1	H	M	H	M	L	L	M	M	H	M	M	M	L	L
13ME812.2	H	M	M	H	L	L	L	L	H	M	M	M	L	H
13ME812.3	H	M	H	H	L	L	L	L	H	M	H	M	M	M
13ME812.4	H	M	M	H	L	L	L	L	H	H	H	H	M	H
13ME812.5	M	M	M	H	L	L	M	L	H	H	H	M	M	M

L : Low M: Medium H : High

TEXT BOOKS:

1. A text book of Production Engineering – P. C. Sharma, S. Chand & Co. Ltd., Latest Edition.
2. Tool Design – Donaldson, LeCain and Goold, Tata McGraw-Hill Publishing Co. Ltd., 2000
3. ASTME – Fundamentals of Tool Design

REFERENCE BOOKS:

1. Production Technology – HMT – Tata McGraw Hill Publishing Ltd.
2. Jigs and Fixtures – Kempster, ELBS
3. Metal Cutting Principles – M.C.Shaw, Oxford Clarendon Press, 1984.
4. Fundamentals of Machining and Machine Tools – Boothroyd, D.G. and Knight, W.A., Mercel Dekker, 1989.

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NON DESTRUCTIVE TESTING

Sub Code : 14ME813 **Credits 03**
Hrs/Week : 3+0+0+0 **Total Hours: 39**

Course Learning Objectives:

This Course will enable students to

1. Outline the benefits obtained from NDT and describe the principles of Liquid Penetrant Inspection, Magnetic Particle Inspection.
2. Describe the principles of Eddy Current Inspection, Computed Tomography and Thermal inspection
3. Explain Ultrasonic Inspection with major variables in ultrasonic inspection and summarize various ultrasonic waves.
4. Describe the principles of Radiographic Inspection, Electron radiography, Neutron radiography, Xero-radiography and summarize application of radiographic inspection in industry.
5. Explain the principles Acoustic Emission Inspection and summarize the AE sensors and preamplifiers, instrumentation principles, applications of AEI.

UNIT – I

Introduction to Non Destructive Testing, Selection of ND methods, Visual Inspection, Leak testing – brief introduction, Liquid Penetrant Inspection – principle, advantages, limitations and applications, Magnetic Particle Inspection – methods of generating magnetic fields, types of magnetic particles, suspension liquids, steps in inspection, advantages, limitations and applications. **9 Hours**

UNIT – II

Eddy Current Inspection – principle, operation, operating variables, procedure, inspection coils, detectable discontinuities, advantages and limitations.
Industrial Computed Tomography – basic principles, capabilities and comparison with other NDT methods, applications
Thermal inspection – principles, equipment, inspection methods, applications **11 Hours**

UNIT - III

Ultrasonic Inspection – basic equipment, advantages, limitations, applications, characteristics of ultrasonic waves, major variables in ultrasonic inspection, basic inspection methods – pulse echo, transmission, transducer elements, couplants, search units, inspection standards **10 Hours**

UNIT – IV

Radiographic Inspection – principles, limitations, radiation sources – X rays, γ rays, recording media, film types and selection, interpretation of radiographs, image quality, penetrameters Electron radiography, Neutron radiography, Xero-radiography, application of radiographic inspection in industry **8 Hours**

UNIT – V

Acoustic Emission Inspection – principle, comparison of AE with other inspection methods, applications, AE waves and propagation, AE sensors and preamplifiers, instrumentation principles, applications **7 Hours**

Course Outcomes:

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

C-14ME813.1 Outline the benefits obtained from NDT and describe the principles of Liquid Penetrant Inspection and Magnetic Particle Inspection.

C-14ME813.2 Describe the principles of Eddy Current Inspection, Computed Tomography and Thermal inspection

C-14ME813.3 Explain Ultrasonic Inspection and its applications.

C-14ME813.4 Illustrate the principles of Radiographic Inspection, Electron radiography, Neutron radiography, Xero-radiography and their applications.

C-14ME813.5 Summarize the principles of Acoustic Emission Inspection and its applications.

Course articulation Matrix

Course Outcomes	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
13ME813.1	M	M	H	M	L	L	M	M	H	M	M	M	L	L
13ME813.2	H	M	M	H	L	L	L	L	H	M	M	M	L	L
13ME813.3	H	M	H	H	L	L	L	L	H	M	H	M	M	M
13ME813.4	M	M	M	H	L	L	L	L	H	H	H	M	M	M
13ME813.5	M	M	M	H	L	L	M	L	H	H	H	M	M	M

TEXT BOOKS:

1. NDE and Quality Control, Vo.17, ASM Hand book, 9th Edition, 1989.
2. Practical Non-Destructive Testing, Baldev Raj, T.Jayakumar, M.Thavasimuthu, Narosa Publishers.
3. Non Destructive Test and Evaluation of Materials, J.Prasad and C G K Nair, Tata McGraw Hill.

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COMPOSITE MATERIALS TECHNOLOGY

Sub Code : 14ME814 **Credits 03**
Hrs/Week: 3+0+0+0 **Total Hours: 39**

Course Learning Objectives:

This Course will enable students to

1. Able to explain the basics and types of composite materials.
2. Explain the manufacturing of metal matrix and ceramic matrix composites.
3. Explain the manufacturing and testing of FRP composites.
4. Understand design factors and fabrications of composites design.
5. Understand the mechanics of laminate composites.

UNIT - I

INTRODUCTION

Limitations of conventional materials - Definition of composite materials – Types of composites. **4 Hours**

properties and characteristics of different types of composites, Reinforcement of matrix materials, Applications of different types of composites **3 Hours**

UNIT - II

MATERIALS

Types of Fibres materials – Types of polymer matrix- Metal matrix and Ceramic matrix - Coupling agents, fillers and additives - Metal Matrix and Ceramic matrix materials, Coupling agents, Fillers and additives. **4 Hours**

Techniques used to manufacture Metal matrix and ceramic composites**.** **3 Hours**

UNIT - III

MANUFACTURING

Fundamentals - bag moulding - compression moulding pultrusion-filament winding - other manufacturing process. **4 Hours**

Quality inspection and non-destructive testing.

3 Hours

UNIT – IV

DESIGN

Fabrication of Composites, cutting, machining. **4 Hours**

Drilling, joint design, mechanical and adhesive bonding, joining, tooling, fabrication equipment. **3 Hours**

UNIT – V

MECHANICS AND PERFORMANCE

Introduction to micro-mechanics-unidirectional lamina - laminates - interlaminar stresses.

6 Hours

Static mechanical properties - fatigue properties - impact properties - enviromental effects - fracture mechanics and toughening mechanisms, damage prediction, failure modes.

5 Hours

Course Outcomes:

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

C-14ME814.1 Compare conventional materials with composite materials.
C-14ME814.2 Explain the manufacturing of MMC's and CMC's.
C-14ME814.3 Explain the manufacturing and testing of FRP composites.
C-14ME814.4 Outline the role of design in composites and its fabrication.
C-14ME814.5 Evaluate the mechanics and performance of composite materials.

Mapping of POs & COs:

CO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
C-14ME814.1	M	L		L		L	L	L				L		M
C-14ME814.2	M	L	L	L		L	L	L				L		M
C-14ME814.3	M	L	L	L		L	L	L				L		M
C-14ME814.4	M	L	M	L		L	L	L				L		M
C-14ME814.5	H	M	M	M								L		L

L : Low M: Medium H : High

TEXT BOOKS:

1. Ronald Gibson, “Principles of Composite Material Mechanics ", Tata McGraw Hill, 1994.

2. Micael hyer, " Stress Analysis of Fiber - Reinforced Composite Materials ", Tata McGraw Hill, 1998.

REFERENCE BOOKS:

1. P.K.Mallicak, " Fiber-reinforced composites ", Monal Deklar Inc., New York, 1988.
2. B.D. Agarwal and L.J.Broutman, " Analysis and Performance of Fiber Composites ", John Wiley and Sons, New York, 1980.
3. F.L.Matthews & R.D.Rawlings, " Composite Materials, Engineering and Sciences ", Chapman & hall, London.

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MARKETING MANAGEMENT

Sub Code : 14ME815 **Credits 03**
Hrs/Week : 3+0+0+0 **Total Hours : 39**

Course Learning Objectives:

This Course will enable students to

1. Understand and learn the marketing concepts and their application to profit-oriented and non-profit oriented organizations.
2. Able to apply the marketing concepts to analyze the buying behavior & marketing segments to solve these problems.
3. Understand and learn the need for a customer orientation in product pricing & marketing research in the competitive global business environment;
4. Able to develop an understanding and acquiring skills in how to successfully design and implement marketing plans and strategies.
5. Understand and learn the concept of sales, advertising &distribution of marketing mix and its application in traditional and novel environments characterized by emerging information technologies.

UNIT – I

BASICS

Definition, Marketing Process, Dynamics, Needs, Wants & Demands, Marketing Concepts, Environment, mix, types, philosophies, Selling Vs. Marketing, organisation, Industrial Vs. Consumer Marketing, Consumer goods, Industrial goods, Product hierarcy. **8 Hours**

UNIT – II

BUYING BEHAVIOUR & MARKET SEGMENTATION

Cultural, Demographic factors, Motives, types, Buying decisions, segmentation factors, Demographic,
Psychographic & Geographic Segmentation, Process, Patterns. **8 Hours**

UNIT - III

PRODUCT PRICING & MARKETING RESEARCH

Objectives, pricing, Decisions and Pricing methods, Pricing Management. Introduction, Uses, process of Marketing Research. **8 Hours**

UNIT - IV

MARKETING PLANNING & STRATEGY FORMULATION

Components of a marketing plan, strategy formulations and the marketing process, implementation, Portfolio analysis, BCG, GEC grids. **8 Hours**

UNIT - V

ADVERTISING, SALES PROMOTION & DISTRIBUTION

Characteristics, Impact, goals, types, Sales promotion-Point of Purchase, Unique Selling proposition.

Characteristics, Wholesaling, Retailing, channel design, logistics, Modern Trends in retailing.

7 Hours

Course Outcomes:

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

14ME815.1. Apply marketing concepts to profit-oriented and non-profit oriented organizations.
14ME815.2. Analyse the buying behavior of customers & role of marketing segments.
14ME815.3. Illustrate the role of product pricing & marketing research in the competitive global business environment;
14ME815.4. Develop an understanding and acquiring skills to successfully design and implement marketing plans and strategies.
14ME815.5. Explain the role of sales, advertising & distribution in marketing.

Mapping of POs & COs:

CO	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 10	PO 11	PO 12	PSO 1	PSO 2
C-14ME815.1	L	H		M	M	H	H	M	M	H	H	M	L	L
C-14ME815.2		M	L	L	H	M	M	H	M	M	H	M	M	M
C-14ME815.3	M	M	H	H	H	M	H	M	L	H	M	M	M	L
C-14ME815.4	H	H	M	M	M	H	H	M	H	H	M	H	L	H
C-14ME815.5		M	L	M	M	M	M	M	M	H	H	H	M	M

L: Low M: Medium H: High

TEXT BOOK:

1. Govindarajan.M. 'Modern Marketing Management', Narosa Publishing House, New Delhi, 1999.

REFERENCE BOOKSS:

1. Philip Kolter, " Marketing Management: Analysis, Planning, Implementation and Control ", 1998.
2. Green Paul.E. and Donald Tull, " Research for Marketing Decisions ", 1975.
3. Ramaswamy.V.S. and S.Namakumari, " Marketing Environment: Planning, Implementation and Control the Indian Context ", 1990
4. Jean Plerre Jannet Hubert D Hennessey Global Marketing Strategies.

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CORROSION ENGINEERING

Sub Code : 14ME816 **Credits 03**
Hrs/Week : 3+0+0+0 **Total Hours 39**

Course Learning Objectives:

This Course will enable students to

1. Understand the basics of costs and classification of corrosion.
2. Know the types of corrosion.
3. Understand the corrosion in high temperature materials.
4. Apply various prevention methods for corrosion.
5. Understand the various corrosion test methods.

UNIT - I

Introduction

Definition; Significance; Costs of corrosion; Corrosion Science & Engg; Corrosin damage; Classification of corrosion; Electrochemical aspects of corrosion; Polarization and passivity; Environmental effects; Corrosion rate expressions; Electrode potentials; Potential – pH (Pourbaix diagrams). **8 Hours**

UNIT – II

Forms of Corrosion

Uniform corrosion and Atmospheric corrosion; Galvanic corrosion; Crevice corrosion; Filiform corrosion; Pitting corrosion; Inter granular corrosion; Selective leaching; Erosion-Corrosion Cavitation damage; Stress corrosion; Impingement Attack; Inlet tube corrosion; Corrosion fatigue; Hydrogen blistering; Hydrogen Embrittlement. **8 Hours**

UNIT – III

a) High Temperature Corrosion

Mechanism and kinetics; High Temperature materials

b) Corrosion in mineral acids;

Corrosion of steel, stainless steels, Cu, Ni; Al. **8 Hours**

UNIT – IV

Corrosion Prevention Methods

Materials Selection; Design; Alteration of the environment; Cathodic and Anodic protection; Protective coatings. **8 Hours**

UNIT – V

Corrosion Testing

Planned Interval Tests, A few specific tests for corrosion rate measurement; Tafel extrapolation test; Linear polarization test; AC impedance.

7 Hours

Course Outcomes:

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

C-14ME816.1 Summarize the basics of corrosion and its classification.
C-14ME816.2 Analyze different forms of corrosion.
C-14ME816.3 Examine the corrosion in high temperature materials.
C-14ME816.4 Evaluate various methods for corrosion prevention.
C-14ME816.5 Apply various corrosion testing methods.

Mapping of POs & COs:

Course Outcomes	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
14ME816.1	M	M	H	M	L	L	M	M	H	M	M	M	L	L
14ME816.2	H	M	M	H	L	L	L	L	H	M	M	M	L	L
14ME816.3	H	M	H	H	L	L	L	L	H	M	H	M	M	M
14ME816.4	M	M	M	H	L	L	L	L	H	H	H	M	M	M
14ME816.5	M	M	M	H	L	L	M	L	H	H	H	M	M	M

L : Low M: Medium H : High

TEXT BOOKS:

1. Corrosion Engineering by Mars G. Fontana; 3rd. Edition; McGraw Hill International Edition
2. Principles and prevention of corrosion; Danny A. Jones, Maxwell Macmillan, International Edition.
3. Corrosion and corrosion control – H.H. Uhlig and R.W. Revie, 3rd. Edition, John Wiley & Sons.

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ARTIFICIAL INTELLIGENCE AND EXPERT SYSTEMS

Sub Code : 14ME822 **Credits 03**
Hrs/Week : 3+0+0+0 **Total Hours: 39**

Course Learning Objectives:

This Course will enable students to

1. Understand the basics of artificial intelligence.
2. Know the concepts related to forward vs backward reasoning.
3. Understand statistical and probabilistic reasoning.
4. Understand system expert shells.
5. Understand the concept f machine learning

UNIT – I

ARTIFICIAL INTELLIGENCE: Introduction, definition, underlying assumption, importance of AI, AI and related fields.

SPACE REPRESENTATION: Defining a problem. Production systems and its characteristics, Search and Control strategies – Generate and Test, Hill Climbing, Best – first Search, Problem reduction, Constraint Satisfaction, Means – Ends Analysis. **10 Hours**

UNIT – II

KNOWLEDGE REPRESENTATION ISSUES: Representations and Mappings, Types of knowledge – Procedural Vs Declarative, Logic programming. Forward Vs Backward reasoning, Matching.

USE OF PREDICATE LOGIC: Representing simple facts, Instance and Isa relationships, Syntax and Semantics for Prepositional logic, FQPL and properties of Wffs, Conversion to Clausal form, Resolution, Natural deduction. **10 Hours**

UNIT – III

STATISTICAL AND PROBABILISTIC REASONING: Symbolic reasoning under uncertainty, Probability and Bayes' theorem, Certainity factors and Rule based systems, Bayesian Networks, Shafer Theory, Fuzzy Logic. **8 Hours**

UNIT – IV

EXPERT SYSTEMS: Structure and uses, Representing and using domain knowledge, Expert System Shells. Pattern recognition Learning classification patterns, recognizing and understanding speech. Introduction to knowledge Acquisition, Types of Learning.

7 Hours

UNIT – V

TYPICAL EXPERT SYSTEMS: MYCIN, Variants of MYCIN, PROSPECTOR, DENDRAL, PUFF, ETC.

INTRODUCTION TO MACHINE LEARNING: Perceptrons, Checker Playing Examples, Learning Automata, Genetic Algorithms, Intelligent Editors. **8 Hours**

Course Outcomes:

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

C-14ME822.1 Know about artificial intelligence.
C-14ME822.2 Dissect knowledge representation issues and apply predicate logic.
C-14ME822.3 Interpret statistical and probabilistic reasoning.
C-14ME822.4 Develop expert system shells.
C-14ME822.5 Outline the concepts of machine learning and typical expert systems.

Mapping of POs & COs:

CO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
C-14ME822.1	H	M	H	H	L	L	L	L	M	M	L	L	M	L
C-14ME822.2	M	H	H	H	L	H	L	M	H	M	L	L	M	L
C-14ME822.3	H	M	H	M	L	L	L	H	H	M	L	L	M	L
C-14ME822.4	H	H	M	H	L	L	L	L	M	H	L	L	M	M
C-14ME822.5	M	M	M	M	L	H	L	L	H	M	L	L	H	H

L : Low M: Medium H : High

TEXT BOOKS:

1. Artificial Intelligence, Elaine Rich & Kevin Knight, M/H 1983.
2. Introduction to AI & ES, Dan W. Patterson, Prentice Hall of India, 1999.

REFERENCE BOOKS:

1. Principles of Artificial Intelligence, Springer Verlag, Berlin, 1981.
2. Artificial Intelligence in business, Science & Industry, Wendy B. Ranch
3. A guide to expert systems, Waterman, D.A., Addison – Wesley inc. 1986
4. Building expert systems, Hayes, Roth, Waterman, D.A. Addison – Wesley, 1983

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FLUID POWER SYSTEMS

Sub Code : 14ME823 **Credits 03**
Hrs/Week: 3+0+0+0 **Total Hours: 39**

Course Learning Objectives:

This Course will enable students

1. To understand the basic concept of Fluid power system.
2. To understand the working principle of various parts of hydraulic system.
3. To design the circuit for various applications of hydraulic system.
4. To understand the working principle of various parts of pneumatic system

UNIT - I

FLUID POWER PRINCIPLES AND FUNDAMENTALS

Introduction to Fluid power - Advantages and Applications - Fluid power systems -Types of fluids - Properties of fluids - Basics of Hydraulics - Pascal's Law -Principles of flow -Work, Power and Torque, Types of Hydraulic fluid petroleum based, synthetic & water based. Properties of fluids, Fluid reservoir, Fluid filter**,** Basic structure of hydraulic and pneumatic, advantages and disadvantages of hydraulic system. **4 Hours**

PUMPS: Types, classification, principle of working & constructional details of vane pump, gear pumps, radial & axial piston pumps, Power and efficiency calculations, characteristic curves, selection of pumps for hydraulic power transmission. **4 Hours**

UNIT - II

ACTUATORS: Linear & Rotary actuators, Hydraulic motors, - Types, vane, gear, axial piston, & radial piston. Types of cylinder & its mountings, calculations of piston velocity, thrust under static applications. Design consideration for cylinders, Intensifier. **8 Hours**

UNIT - III

CONTROL OF FLUID POWER: Necessity of pressure control, directional control, flow control valves, Principle of pressure control valves, direct operated, pilot operated, relief valves pressure reducing valve, sequence valve. **FLOW CONTROL VALVES:** Principle of operation, pressure compensated, temperature compensated flow control valves, meter in & meter out flow control circuits, bleed off circuits. **DIRECTION CONTROL VALVES :** Check valves, types of D.C. Valves : Two way two position, four way three position, four way two position valves, open center, closed center, tandem center valves, method of actuation of valves, manually operated, solenoid operated, pilot operated etc**.** **8 Hours**

UNIT - IV

DESIGN OF HYDRAULIC CIRCUITS: Meter in, meter out circuits, Pressure control for cylinders, Flow divider circuits. Circuit illustrating use of pressure reducing valves, sequencing valve, counter balance valves, unloading valves with the use of electrical controls, accumulators etc

ACCUMULATORS: Types & functions of accumulators, applications circuits. **8 Hours**

UNIT – V

PNEUMATICS: Introduction to pneumatic power sources, Comparison of Pneumatics with Hydraulic power transmission. Air preparation units: Filter Regulators & Lubricators. Actuators, linear and rotary actuators, air motors, pressure regulating valves. **Directional control valves**: two way, three way & four way valves, solenoid operated, push button; & lever control valves. **Flow control valves,** Check valves, methods of actuation, mechanical, pneumatic & electrical etc. Simple Pneumatic circuits for industrial applications & automation. **7 Hours**

Course Outcomes:

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

C-14ME823.1 Recall the application of Pascal law in fluid power and to know about hydraulic fluids.
C-14ME823.2 Compare the working of various types of hydraulic pumps and actuators.
C-14ME823.3 Analyze the construction and working of various types of hydraulic valves.
C-14ME823.4 Design and draw the circuit diagram of hydraulic systems for various applications.
C-14ME823.5 Evalaute the construction and working of various elements of pneumatic system and to draw simple pneumatic circuits.

Mapping of POs & COs:

CO	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 10	PO 11	PO 12	PSO 1	PSO 2
C-14ME823.1	H	H	H	M	H	L	H	M	L	M	L	L	M	M
C-14ME823.2	L	H	H	L	H	L	H	M	M	M	L	L	M	M
C-14ME823.3	L	M	H	M	H	L	H	M	M	M	L	L	H	H
C-14ME823.4	L	L	H	H	H	L	H	M	M	M	L	L	H	H
C-14ME823.5	M	M	H	H	H	L	H	M	M	M	L	L	H	H

L: Low M: Medium H: High

TEXT BOOKS:

1. **Fluid Power with application's** - Anthony Esposito, Fifth edition, Pearson Education, Inc 2007.
2. Hydraulic and Pneumatic controls by R Srinivasan, Tata McGHraw Hill Publishing, 2011,Second edition.
3. **Oil Hydraulic systems – Principles and Maintenance** - S.R. Majumdar, Tata McGraw Hill Publishing Company Ltd. 2001.
4. **Pneumatic systems** - S. R Majumdar, Tata McGHraw Hill Publishing Co. – 2005.

REFERENCE BOOKS:

1. **Pneumatics Basic Level TP 101-** by Peter Croser & Frank Ebel, Festo Didactic publication - 1999.
2. **Fundamentals of Pneumatic Control Engineering** - J P Hasebrink & R Kobbler, Festo Didactic publication, 3rd edition – 1989.
3. **Pneumatic Control for Industrial Automation** - Peter Rohner & Gordon Smith, John Wiley Sons publication – 1989.
4. **Power Hydraulics** - Michael J Pinches & John G Ashby, Prentice Hall – 1989

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ENERGY CONSERVATION AND MANAGEMENT

Sub Code : 14ME824 **Credits 03**
Hrs/Week : 3+0+0+0 **Total Hours 39**

Prerequisites:
Student should have the knowledge of the fundamentals of Engineering Mathematics, Engg physics, Basic thermodynamics.

Course Learning Objectives:

This Course will enable students to
1. Know fossil fuel reserves in India, energy requirements in future, the need for energy conservation and management and energy conservation methods.
2. Understand pollution due to power plants, greenhouse effect, global warming
3. Get the idea of energy auditing
4. Explain about heat recovery devices and energy storage systems and cogeneration concepts..
5. Understand various duties and responsibilities of energy manager and latest developments in energy management, role of BEE in India.

UNIT – I

Chapter 1: Energy scenario
Commercial and Non-commercial energy, primary energy resources, commercial energy production, final energy consumption, Indian energy scenario**.**

4 Hours

Chapter 2: Energy conservation
Energy security, energy conservation and its importance, energy strategy for the future, Energy Conservation Act 2001 and its features ,simple energy conservation methods applicable to domestic, transport, agricultural and industrial, sectors.

4 Hours

UNIT - II

Chapter 3:Pollution due to power plants, green house effect, global warming, renewable energy sources**.**

4 Hours

Chapter 4: Energy Auditing: Elements and concepts, Types of energy audits, Instruments used in energy auditing**.**

4 Hours

UNIT - III

Chapter 5 : Energy conservation in Boilers and furnaces, Energy conservation in steam and condensate system

4 Hours

Chapter 6: fuels and combustion, stoichiometric air calculations and heat balance calculations for boilers and furnaces. **4 Hours**

UNIT – IV

Chapter 7 Waste Heat Recovery: Potential, benefits, waste heat equipments-recuperators, heat wheels, heat pipe,, waste heat boilers, heat pumps.

4 Hours

Chapter 8: Energy Storage: Benefits, pumped –hydro storage, compressed air energy storage, battery storage. Cogeneration: Concepts, Types of cogeneration systems.

3 Hours

UNIT- V

Chapter 9 Energy management Organizational set up for energy management, functions of energy manager, energy management information systems.

4 Hours

Chapter 10

Latest developments Kyoto protocol Latest developments Kyoto protocol, carbon trading, carbon fund, energy rating, green rating, life cycle assessments, role of bureau of energy efficiency in India. **4 Hours**

Course Outcomes:

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

C-14ME824.1. Know about fossil fuel reserves in India and energy requirements in future and the need for energy conservation and management and methods of energy conservation.

C-14ME824.2. Acquire knowledge about pollution due to power plants, greenhouse effect and global warming

C-14ME824.3. Evaluate issues related to energy conservation in boilers and furnaces.

C-14ME824.4. Illustrate about heat recovery devices and energy storage systems and concept of cogeneration.

C- 4ME824.5. Discuss about the duties and responsibilities of energy manager and latest developments in energy management in India.

Course Articulation Matrix

CO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
C-14ME824.1	M	L	L	L	L	L	L	L	M	M	M	M	M	L
C-14ME824.2	M	L	L	L	L	M	H	L	L	H	M	M	M	L
C-14ME824.3	M	M	M	M	M	M	L	-	L	M	M	M	M	L
C-14ME824.4	M	M	M	M	M	L	M	-	L	M	H	H	M	M
C-14ME824.5	L	L	L	L	L	L	L	H	L	H	H	H	L	L

TEXT BOOKS:

1. Energy management, WR Murphy and G Mc Kay Oxford university Press(2009)
2. Energy Management Handbook - 7th Edition - Wayne C. Turner , Steve Doty , Wayne C. Truner 2009

REFERENCE BOOKS:

1. Design and Management for energy conservation by Callaghn P W , Pergamon, oxford ,1981
2. Energy conservation in Process Industry—W.F.Kenny(1984)
3. Energy Engineering and Management- Amlan Chakrabarti-Prentice hall India 2011
4. Energy Management Principles C Smith-Pergamon Press,New York 1981
5. Bureau of energy efficiency Hand outs New Delhi

E-BOOK

Energy management handbook by Wayne C. Turner & Steve Doty. -- 6th ed. p. cm. ISBN: 0-88173-542-6 (print)

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BIO MASS ENERGY SYSTEMS

Sub Code : 14ME825 **Credits 03**
Hrs/Week : 3+0+0+0 **Total Hours 39**

Course Learning Objectives:

This Course will enable students to

1. Understand basics of biomass energy sources and biomass conversion methods.
2. Know the various physical and agrochemical conversion.
3. Understand biomethanization and use of biogas for power generation.
4. Know about preparation of biodiesel and use of biodiesel in IC engines.
5. Apply various thermodynamic cycles in Bio power plants.

UNIT – I

INTRODUCTION: Biomass energy sources, energy content of various Bio – fuels, Energy plantation, origin of Biomass photo synthesis process, Biomass Characteristics, sustainability of Biomass. **4 Hours**

BIOMASS CONVERSION METHODS: Agrochemical, Thermochemical, Biochemical (flowchart) & Explanation. **4 Hours**

UNIT – II

PHYSICAL & AGROCHEMICAL CONVERSION: Briquetting, Pelletization, Agrochemical, fuel Extraction, Thermo chemical Conversion: Direct combustion for heat, Domestic cooking & heating. **4 Hours**

BIOMASS GASIFICATION: Chemical reaction in gasification, Producergas& the constituents, Types of gasifiers. Fixed bed gasifiers, Fluidized bed gasifiers. Liquefaction: Liquefaction through pyrolysis & Methanol synthesis, application of producer gas in I C Engines. **4 Hours**

UNIT – III

BIO METHANIZATION: Anaerobic digestion, Basic principles, factors influencing Biogas yield, classification of Biogas digester, floating gasholder & fixed dome type. (Working Principle with diagram), Calculations for sizing the Biogas plant. **4 Hours**

BIOGAS FOR POWER GENERATION: Ethanol as an automobile fuel, Ethanol production & its use in engines. **4 Hours**

UNIT - IV

BIO - DIESEL: Bio Diesel from edible & non-edible oils, Production of Bio diesel from Honge & Jatropha seeds, use of bio diesel in I C engines, Engine power using Bio diesel, Blending of Bio diesel, Performance analysis of diesel engines using bio diesel. Effect of use of bio diesel in I C engines. **7 Hours**

UNIT – V

BIO POWER PLANTS: Bio Power generation routes, Basic Thermodynamic cycles in Bio power generation; Brayton cycle, Sterling cycle, Rankine cycle, Co-generation cycle. Biomass based steam power plant. **8 Hours**

Course Outcomes:

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

C-14ME825.1 Know about basics of biomass energy sources and conversion methods.
C-14ME825.2 Differentiate between various physical and agrochemical conversion methods.
C-14ME825.3 Demonstrate about biomethanization and use of biogas for power generation.
C-14ME825.4 Illustrate the preparation of biodiesel and use of biodiesel in IC engines.
C-14ME825.5 Explain the concept of thermodynamic cycles in Bio power plants.

Mapping of POs & COs:

CO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
C-14ME825.1	M	L	L	L	L	L	L	L	M	M	M	M	M	L
C-14ME825.2	M	L	L	L	L	M	H	L	L	H	M	M	M	L
C-14ME825.3	M	M	M	M	M	M	L	-	L	M	M	M	M	L
C-14ME825.4	M	M	M	M	M	L	M	-	L	M	H	H	M	M
C-14ME825.5	L	L	L	L	L	L	L	H	L	H	H	H	L	L

L : Low M: Medium H : High

TEXT BOOKS:

1. Bio Gas Technology, B.T. Nijaguna. New Age International- New Delhi.2001-02
2. Energy Technology, S. Rao & B. B. Parulekar – Khanna Publishers, Delhi-1999.
3. Non Conventional Energy Sources, G. D. Rai - Khanna Publishers. Delhi.

REFERENCE BOOKS:

1. Greenhouse Technology for Controlled Environment, G.N. Tiwari, Alpha Science International Ltd., Pangbourne.England.
2. Renewable Energy Resources, John.W.Twidell, Anthony. D. Weir, EC BG-2001.
3. BioMass, Deglisc. X and P. Magne, Millennium Enterprise, New Delhi.

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MICRO-ELECTRO-MECHANICAL SYSTEMS

Sub Code : 14ME826 **Credits : 03**
Hrs/Week : 3+0+0+0 **Total Hours: 39**

Course Learning Objectives:

This Course will enable students to

1. Understand basics of MEMS and market for MEMS.
2. Know the various materials for micromachining and additives used.
3. Understand various techniques of micromachining.
4. Understand some basic concepts of micromechanics.
5. Know the basics of thermal and fluidic MEMS.

UNIT – I

Micro-Electro-Mechanical Systems, introduction and overview, Principles of MEMS, Silicon as a Mechanical Material, Benefits of MEMS, Scaling and performance, Cost reduction, complexity, Issues to consider, MEMS Markets, Overview of MEMS applications. **8 Hours**

UNIT – II

Micromachining Techniques – Overview, Capabilities and limitations of micromachining, Materials for micromachining, Substrates, Additive films and materials, Micromachining terms, General properties of common semiconductors, Mechanical properties, Native oxides of silicon, Typical silicon wafer types, Micromachining Techniques – Bulk Micromachining, Wet etching of silicon, Isotropic etching, Anisotropic etching, EDP, KOH, TMAH, Etch stop layers, Masking, Mask erosion around edges, bulk micromachining process flow, Electrochemical etching, Etch stop, Porous silicon, One-sided wafer etching, Vapor phase etching (XeF_2), Dry etching, SF_6, DRIE, Bosch process, Cryogenic dry etching, Sidewall roughness, Etch lag, Combined isotropic and anisotropic dry etching, SCREAM, ASIP.

8 Hours

UNIT – III

Micromachining Techniques – Surface Micromachining, Thin film processes, Oxide (thermal, deposited LTO), Nitride (stoichiometric, low-stress), Poly (stress, stress-gradients), Metal, surface micromachining process flow, Release, Wet–Stiction, Dry - Critical point drying, Vapor HF, Microelectronic integration – prior, mixed and post, Electro-deposition, Hybrid Micromachining Process, Wafer bonding, Anodic bonding, Fusion bonding, SOI wafers.

8 Hours

UNIT – IV

Micro-Mechanics, Basic Mechanics, Axial stress & strain, Shear stress & strain, Poisson's Ratio, Commonly used deflection equations, Static beam equations, Static torsion equations, Static plate equations, Cantilever beams, Clamped-clamped beams, Membranes, Springs – folded, torsional, Dynamics, Spring-mass-damper system, resonance, Test structures, Elastic properties, Bent Beam Method for determining Young's modulus, Resonant beam structures - Cantilever beam, Comb drive resonator, Stress/Strain Gauges - Bent beam strain sensor, Cantilever beams, Buckling beam structures, Substrate analysis; Stoney Equation, Basic mechanisms and structures, In-plane rotary mechanisms, Out-of-plane mechanisms, Bistable mechanisms, Mechanical Sensors, Resistive and piezoresistive strain sensors, Semiconductor strain gauges, Capacitive sensing, Micromachined mechanical sensors, Accelerometers - Basic accelerometer concepts, Force-balanced accelerometer concepts, Strain guage accelerometers, Capacitive accelerometers, Gyroscopes, Pressure sensors, Piezoresistive pressure sensors, Capacitive pressure sensors. **8 Hours**

UNIT – V

Electrostatics, Actuation mechanisms , Electrostatic actuation, Parallel plate actuators, Torsional electrostatic actuators, Electrostatic comb drives, Electrostatic cantilever actuators, Electrostatic linear micromotors (scratch drive), Electrostatic rotary micro-motors.

Thermal MEMS - Thermal actuators, Thermal expansion of solids, Bimorph thermal actuators, Bent beam actuators, Thermal array actuators, Volume expansion and phase-change actuators, Thermal sensors, Bolometers, Uncooled bolometers, Air flow sensor.

Fluidic MEMS – Introduction, Basic fluid properties and equations, Types of flow, Bubbles and particles in microstructures, Capillary forces, Fluidic resistance, Fluidic capacitance,

Fluidic inductance, Flow channels, Bulk micromachined channels, Surface micromachined channels, Valves – Passive valve, Active valves, Pumps, Bubble pumps, Membrane pumps, Diffuser pumps, Rotary pumps, Electrohydrodynamic pumps, Electrophoretic pumps, Droplet generators. **7 Hours**

Course Outcomes:

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

C-14ME826.1. Know the basics of MEMS.
C-14ME826.2. Identify different micromachining techniques and additives used.
C-14ME826.3. Compare various techniques of micromachining.
C- 4ME826.4. Apply basic concepts of micromechanics in developing MEMS systems.
C-14ME826.5. Build different types of MEMS system.

Mapping of POs & COs:

COs	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 10	PO 11	PO 12	PSO 1	PSO 2
C-14ME826.1	H	**H**	**H**	**M**	**M**	**L**	**M**	**M**	**L**	**L**	**L**	**L**	**H**	**H**
C-14ME826.2	**M**	**H**	**H**	**H**	**H**	**M**	**M**	**H**	**L**	**L**	**L**	**L**	**H**	**H**
C-14ME826.3	**H**	**H**	**M**	**H**	**M**	**M**	**H**	**L**	**L**	**L**	**L**	**L**	**H**	**H**
C-14ME826.4	**H**	**H**	**M**	**M**	**H**	**L**	**H**	**L**	**L**	**L**	**L**	**L**	**H**	**H**
C-14ME826.5	**M**	**M**	**M**	**H**	**M**	**L**	**M**	**M**	**L**	**L**	**L**	**L**	**M**	**M**

L : Low M: Medium H : High

TEXT BOOKS:

1. *Micromachined Transducers Sourcebook*, Greg Kovacs, McGraw-Hill publications, New York, 1998
2. *Microsystem Design*, Stephen D. Senturia, Kluwer Publications, Boston, 2001

REFERENCE BOOKS:

1. *MEMS/NEMS – Handbook: Techniques and Applications*, Cornelius T. Leondes, Springer-Verlag Publications, 2005.
2. *Fundamentals of Microfabrication*, Marc J. Madou, 2nd Edition, Taylor & Francis Publications, 20.

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