B. E. SYLLABUS

MECHANICAL ENGINEERING

V & VI 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 (PO) 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.
PO4: ***Conduct investigations of complex problems****:* Use research-based knowledge and research methods including design of experiments, analysis and interpretation of data, and synthesis of the information to provide valid conclusions.
PO5: ***Modern tool usage****:* Create, select, and apply appropriate techniques, resources, and modern engineering and IT tools including prediction and modeling to complex engineering activities with an understanding of the limitations.
PO6: ***The engineer and society***: Apply reasoning informed by the contextual knowledge to assess societal, health, safety, legal and cultural issues and the consequent responsibilities relevant to the professional engineering practice.
PO7: ***Environment and sustainability***: Understand the impact of the professional engineering solutions in societal and environmental contexts, and demonstrate the knowledge of, and need for sustainable development.
PO8: ***Ethics***: Apply ethical principles and commit to professional ethics and responsibilities and norms of the engineering practice.
PO9: ***Individual and team work****:* Function effectively as an individual, and as a member or leader in diverse teams, and in multidisciplinary settings.
PO10: ***Communication****:* Communicate effectively on complex engineering activities with the engineering community and with society at large, such as, being able to comprehend and write effective reports and design documentation, make effective presentations, and give and receive 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):

PSO1: 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

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

Sl. No.	Subject Code	Subject	Theory/Tuto./Prac./ Self Study	Total Hrs./Week	C.I.E	S.E.E	Credits
1	15ME501	Fluid Machinery	3+2+0+0	5	50	50	4
2	15ME502	Design of Machine Elements-I	3+2+0+0	5	50	50	4
3	15ME503	Dynamics of Machinery	4+0+0+0	4	50	50	4
4	15ME504	Metrology & Measurements	4+0+0+0	4	50	50	4
5	15ME505	Industrial Management & Entrepreneurship	3+0+0+0	3	50	50	3
6	15ME51X	Elective I	3+0+0+0	3	50	50	3
7	15ME506	Fluid Machinery Lab.	0+0+3+0	3	50	50	2
8	15ME507	Metrology & Measurements Lab.	0+0+2+0	2	50	50	1
9	15ME508	Immersive Group Workshop (IGW)	-	5 Day Workshop	-	-	0
10	15IL001	Employability Skill Development-I	1+0+0+0	1	50	0	0
		TOTAL	**30**	**30**	**450**	**400**	**25**

DEPARTMENT OF MECHANICAL ENGINEERING
SCHEME OF TEACHING AND EXAMINATION

VI 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	15ME601	Operations Research	4+0+0+0	4	50	50	4
2	15ME602	Design of Machine Elements-II	3+2+0+0	5	50	50	4
3	15ME603	Automotive Engineering	3+0+2+0	5	50	50	4
4	15ME604	CAD / CAM	3+0+0+0	3	50	50	3
5	15ME61X	Elective II	3+0+0+0	3	50	50	3
6	15ME62X	Elective III	3+0+0+0	3	50	50	3
7	15ME605	Computer Aided Modeling & Analysis lab	0+0+3+0	3	50	50	2
8	15ME606	CNC & Robotics Lab	0+0+3+0	3	50	50	2
9	15IL002	Employability Skill Development - II	1+0+0+0	1	50	0	0
TOTAL			**30**	**30**	**450**	**400**	**25**

ELECTIVE - I

	Sl. No.	Sub. Code	Subject	CREDITS
15ME51X	1	15ME511	Operations Management	3
	2	15ME512	Material selection for Engg. Design	3
	3	15ME513	Total quality Management	3
	4	15ME514	Metal forming Theory & Practice	3
	5	15ME515	Advanced strength of materials	3
	6	15ME516	Computer Aided Design (CAD) tool: UG NX	3

ELECTIVE - II

	Sl. No.	Sub. Code	Subject	CREDITS
15ME61X	1	15ME611	Non Traditional Machining	3
	2	15ME612	Management Information System	3
	3	15ME613	Design For manufacturing & Assembly	3
	4	15ME614	Rapid Prototyping Technology	3
	5	15ME615	Design Practices of Jigs & Fixture	3
	6	15ME616	Design of Thermal Systems	3
	7	15ME617	Renewable sources of Energy	3
	8	15ME618	Introduction to Aircraft Design	3
	9	15ME619	Product Design & Development	3

ELECTIVE - III

	Sl. No.	Sub. Code	Subject	CREDITS
15ME62X	1	15ME621	Gas Dynamics & Jet Propulsion	3
	2	15ME622	Project Management	3
	3	15ME623	Machine Tool Design	3
	4	15ME624	Finite Element Method	3
	5	15ME625	Computational Fluid Dynamics	3
	6	15ME626	Organizational Behavior	3
	7	15ME627	Introduction to piping engineering	3
	8	15ME628	Welding Technology	3

FLUID MACHINERY

Sub Code : 15ME501 **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 energy transfer in power generating and power absorbing turbo machines.
2. Understand the features and working of impulse and reaction turbines (Pelton, Francis and Kaplan turbines)
3. Know the working principle of steam (Impulse and reaction) turbines and Axial flow compressors
4. Understand the principle of operation of centrifugal compressors and pumps; also study the parameters affecting their performance.
5. Study the thermodynamic analysis of compression and expansion processes and their efficiencies (Polytropic, stage and overall efficiencies)

UNIT – I

Introduction, Energy transfer in Turbo function.
Definition of a turbo machine. Parts, Classification, Comparison with positive displacement machine. Euler Turbine equation, alternate form of Euler turbine equation, components of energy transfer, degree of reaction, general analysis of a turbine – effect of blade discharge angle, Utilization factor, Vane efficiency, relationship between utilization factor and degree of reaction, Condition for maximum utilization factor, Optimum blade speed ratio for different types of turbines.
Velocity triangles for different values of degree of reaction.
General analysis of compressors and pumps, effect of blade discharge angle, expression for degree of reaction.

12 Hours

UNIT - II

Hydraulic turbines: Classification, Pelton turbine components, design, turbine efficiency, Francis and Kaplan turbines, Runner shapes for different blade speeds, Theory of draft tube, efficiency of draft tube.

10 Hours

UNIT- III

Steam and gas turbines: Impulse staging, need for compounding, types of compounding, condition for maximum utilization for multistage turbines, effect of blade and nozzle losses, reaction staging, reheat factor in turbines.
Axial flow compressors: Classification, Expression for pressure ratio per stage, work done factor, radial equilibrium conditions, determination of air angle distribution with respect to blade height, using free vortex flow theory, and constant reaction theory, blade design procedure using single air foil theory. **10 Hours**

UNIT - IV

Centrifugal Compressors: Principle of operation, expression for overall pressure ratio, blade angles at impeller eye root and eye tip, slip factor and power input factor, overall pressure ratio, pressure coefficient, width of the impeller channel, compressibility effects, need for pre-whirl vanes, diffuser design, determination of diffuser inlet vane angle, surging and choking.
Centrifugal pumps: Working principle, Terminology, Types of casing, Pump losses, Efficiencies, Work done, Pre-rotation, slip and slip coefficient, Minimum starting speed, Priming, Cavitation, NPSH. Multi stage centrifugal pumps.

10 Hours

UNIT – V

Thermodynamics of Fluid flow and Thermodynamic analysis of compression and expansion processes: Brief discussion of stagnation and static properties and their relations.
Compression process –Work done overall isentropic efficiency, stage efficiency, comparison and relation between them, polytropic efficiency of compression.
Expansion process: Work done, overall isentropic efficiency, stage efficiency, comparison and relation between them, polytropic efficiency of expansion.

10 Hours

Course Outcomes:

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

C-15ME501.1. Acquire knowledge of energy transfer in power generating and power absorbing turbo machines.
C-15ME501.2. Contrast the features and working of impulse and reaction turbines.
C-15ME501.3. Explain the working principle of steam turbines and Axial flow compressors
C-15ME501.4. Explain the principle of operation of centrifugal compressors and pumps; analyze the parameters affecting their performance.
C-15ME501.5. Perform thermodynamic analysis of compression and expansion processes and their efficiencies.

Mapping of POs & COs:

CO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
C-15ME501.1	H	H	M	L	H	M	M	-	-	-	-	-	M	M
C-15ME501.2	M	M	M	H	H	M	M	-	-	-	-	-	M	M
C-15ME501.3	M	M	M	H	H	M	M	-	-	-	-	-	M	M
C-15ME501.4	M	M	M	H	H	M	M	-	-	-	-	-	-	
C-15ME501.5	M	M	-	M	M	M	M	-	-	-	-	-	-	M

L : Low M: Medium H : High

TEXT BOOKS:

1. *An Introduction to energy conversion*, Volume III-Turbo Machinery, V. Kadambi and Manohar Prasad, Wiley Eastern Ltd. 1977
2. *"A Treatise on Turbo machines"*, G. Gopalakrishnan, & D. Prithviraj, Scitech Publications (India) Pvt. Limited.,2002.
3. *"A Textbook of Fluid Mechanics and Hydraulic Machines 9th edition by Dr. R.K. Bansal,* , Laxmi Publications (P) Ltd., 2015

REFERENCE BOOKS:

1. *"Principles of Turbo Machinery"*, D. G. Shepherd, The Macmillan Company 1964
2. *"Gas Turbine Theory"*, H. Cohen, GFC Rogers, & Hill Saravanamuttoo, Thomson Press (India) Ltd., 4th Edition 1998.
3. *"Gas Turbines"*, V. Ganesan, Tata McGraw-Hill Company Limited 2nd Edition 2002.
4. *"Turbines, Compressors & Fans"*, S. M. Yahya, Tata-McGraw Hill Co., 2nd Edition 2002

MOOC/NPTEL Resources:

1. http://nptel.ac.in/courses/112105182/
2. http://nptel.ac.in/courses/112104117/

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DESIGN OF MACHINE ELEMENTS - I

Sub Code : 15ME502	**Credits : 04**
Hrs/Week : 3+2+0+0	**Total Hours : 52**

Pre-requisites

- Mechanics of Materials, Engineering Mechanics, Engineering Mathematics, Engineering Drawing

Course Learning Objectives:

This Course will enable students to

1. Define and explain various terms connected to the design of machine elements-I like static strength, fatigue strength, Impact stresses, theories of failures, rigidity based design, factor of safety, and stress concentration etc.
2. Demonstrate how engineering design make use of the principles learnt in science courses and identify their practical applications.
3. Develop problem-solving skill in design of machine elements with appropriate assumptions and correct methodology. And also able to access and analyze the stress generated under various loading conditions.

4. Analyze the environmental impact of the design and take measures to avoid environmental deterioration.
5. Derive the various stresses in the objects against different loads and design simple machine components.

UNIT - I

Introduction

Meaning of design with special reference to machine design- Definition and understanding of several types of designs. Concept of design, Engineering Materials and their Mechanical properties. Selection of materials, General Design considerations: codes and Standards, Review of basics of mechanics of materials-Types of stresses and strains. Stress-Strain diagrams, Stress Analysis of simple components, Principal Stresses.

Design for Static Strength: Static Strength, Static loads and factor of safety; Theories of failure – Maximum normal stress theory, Maximum shear stress theory, Distortion energy theory; Failure of brittle materials, Failure of ductile materials. Stress concentration, Determination of Stress concentration factor. **10 Hours**

UNIT - II

Design for Fatigue Strength: Introduction- S-N Diagram, Low cycle fatigue, High cycle fatigue, Endurance limit, Endurance limit modifying factors: size effect, surface effect, Stress concentration effects; Fluctuating stresses, Goodman, Modified Goodman and Soderberg's relationship; stresses due to combined loading, cumulative fatigue damage. Design for Impact strength: Introduction, Impact stresses due to axial, bending and Torsional loading, effect of inertia. **10 Hours**

UNIT – III

Shafts and Keys: Torsion of shafts, design for strength and rigidity with steady loading, ASME & BIS codes for design of transmission shafting, shafts under fluctuating loads and combined loads. Keys: Types of keys, Design of keys and design of splines.

12 Hours

UNIT – IV

Threaded Fasteners: Stresses in threaded Fasteners, Effects of initial tension, Effect of compression, Effect of Fatigue loading, Impact loading, shear loading, Design of eccentrically loaded bolted joints.

Design of transmission systems: Design of Rigid & Flexible couplings, Design & Selection of flat and V belts **10 Hours**

UNIT – V

Riveted and Welded Joints – Types, rivet materials, failures of riveted joints, Joint Efficiency, Boiler Joints, Tank and Structural Joints, Riveted Brackets. Welded Joints – Types, Strength of butt and fillet welds, eccentrically loaded welded joints. **10 Hours**

Scheme Examination:

Two questions to be set from each unit and Students shall answer FIVE full questions choosing at least ONE question from each unit.

Course Outcomes:

Upon completion of this course, graduates will have the,

C-15ME502.1. Ability to model, analyze, design, and realize a mechanical system that meets a particular need.

C-15ME502.2. Understanding the static, dynamic, impact and fatigue strengths & their parameters for a material are measured in standardized tests.

C-15ME502.3. Ability to design and analyze shafts with different geometrical features under various loading conditions.

C-15ME502.4. Demonstrate the thorough knowledge of threads and fasteners. Also ability to identify, evaluate and compare the functions of different types of flexible power transmission systems

C-15ME502.5. Ability to design and analyze permanent and detachable joints (riveted, welded, etc.) under concentric and eccentric loading conditions.

Mapping of POs & COs:

Course Outcome	Programme Outcomes													
	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
C-15ME502.1	H	H	H			L		M	H	M	M	M	H	M
C-15ME502.2	L	H	H	M		L		M	H	M	M	M	H	M
C-15ME502.3	L	H	H	M		L		M	H	M	M	M	H	M
C-15ME502.4	L	H	H	M		L		M	H	M	M	M	H	M
C-15ME502.5		H	H	M		L		M	H	M	M	M	H	M

(L = Low , M = Medium , H = High)

DESIGN DATA HAND BOOK:

1. **Design Data Hand** Book by K. Mahadevan and Balaveera Reddy, CBS Publication, 4th Revised edition (1st January 2013)

TEXT BOOKS:

1. Mechanical Engineering Design: Joseph E Shigley and Charles R. Mischke. McGraw Hill International edition, 6th Edition 2003.
2. Design of Machine Elements**:** V.B. Bhandari, Tata McGraw Hill Publishing Company Ltd., New Delhi, 3rd Edition (26th May 2010).

REFERENCE BOOKS:

1. Machine Design: Robert L. Norton, Pearson Education Asia, 5th Edition (16th September, 2013).
2. Design of Machine Elements: M.F.Spotts, T.E. Shoup, L.E. Hornberger, S.R. Jayram and C.V. Venkatesh, Pearson Education, 2006.
3. Machine Design**:** Hall, Holowenko, Laughlin (Schaum's Outlines series). Tata McGraw Hill Publishing Company Ltd., New Delhi, 2007.

E-BOOKS:

1. Design of Machine Elements **by** V.B. Bhandari, Tata McGraw Hill Publishing Company Ltd., New Delhi, 3rd Edition, 2010.
2. Design of Machine Elements by K. Purohit and C.S. Sharma , Prentice Hall of India Pvt. Ltd. 2013.
3. Analysis and Design of Machine Elements by V.K Jadon, I.K. International Publishing House Pvt. Ltd., 2010
4. Design of Machine Elements M.F. Spotts , T.E.Shoup, L.E. Hornberger, S.R. Jayaram, C.V. Venkatesh, 8th Edition, Pearson Education, 2006

MOOC/NPTEL Resources:

1. http://nptel.ac.in/courses/112105124/
2. https://www.coursera.org/learn/machine-design1

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DYNAMICS OF MACHINERY

Sub Code : 15ME503	**Credits : 04**
Hrs/Week: 4+0+0+0	**Total Hours : 52**

Pre-requisites: This subject requires the student to know about the fundamentals of Engineering Mechanics, Engineering Mathematics and Internal Combustion Engines.

Course Learning Objectives:

This Course will enable students to

1. Analyze the forces acting on various links of an engine mechanism and the torque on the crank, Calculate Torque and forces on various links subjected to external forces.
2. Understand the significance of turning moment diagrams calculate maximum fluctuation of energy, co – efficient of fluctuation of speed, obtain an equation for energy stored in a fly wheel.

3. Know the necessity of balancing in high speed engines, balancing of single or several masses in the same plane or in different planes. Determine primary and secondary unbalanced forces in multi cylinder in line engines.
4. Classify the governors, understand the terminologies connected with governors, understand working and force analysis of Porter and Hartnel governors.
5. Derive expressions for displacement, velocity and acceleration for a tangent cam operating on a radial – translating roller follower and for a circular arc cam operating a flat faced follower. Understand the effects of gyroscopic couple on an aeroplane, ship know stability of a four wheel and two-wheel vehicle in a curved path.

UNIT – I

STATIC FORCE ANALYSIS: Reaction between members without friction. Analysis of engine mechanism, four bar mechanism (without friction) and other mechanisms.

10 Hours

UNIT – II

DYNAMICS OF ENGINE MECHANISM: Turning Moment Diagrams and flywheel design.

10 Hours

UNIT – III

BALANCING OF MACHINERY: Static and dynamic balancing: Balancing of single rotating mass in same plane and in different planes - Balancing of several rotating masses in same plane and in different planes- Balancing of reciprocating masses. Inertia effects of crank and connecting rod. Balancing of single cylinder engine, multi cylinder engine, Inline engine (primary & secondary forces), V-type engine and radial engine - Direct and reverse crank methods. Balancing of rigid and flexible rotors.

12 Hours

UNIT – IV

GOVERNORS: Types of governors; force analysis of Porter and Hartnell governors. Controlling force, stability, sensitiveness, isochronisms, effort and power.

8 Hours

UNIT – V

GYROSCOPE: Vectorial representation of angular motion, gyroscopic couple, Effect of gyroscopic couple on ship, plane, two wheelers and four wheelers.

6 Hours

ANALYSIS OF CAMS: Analytical methods for Tangent cam with roller follower and Circular cam operating flat faced follower. **6 Hours**

Course Outcomes:

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

C-15ME503.1. Apply equilibrium conditions on links subjected to external forces and determine the pin forces and torque on different links of a mechanism.

C-15ME503.2. Analyze the workdone per cycle and determine energy stored in a fly wheel and fly wheel size, when used in engine mechanism and punching operations.

C-15ME503.3. Describe and determine the balancing of rotating masses in a system and understand balancing of reciprocating masses in multi cylinder engines.

C-15ME503.4. Classify and differentiate the working principle of governors and perform force analysis of Porter and Hartnell governor.

C- 5ME503.5. Perform analysis of cams and gyroscopes.

Course Articulation Matrix

CO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
C 15ME503.1	H	M	M	L	L	-	-	L	L	M	L	L	M	L
C-15ME503.2	H	M	M	L	L	-	-	L	L	M	L	L	M	L
C-15ME503.3	M	M	M	L	L	-	-	L	L	L	L	L	M	L
C-15ME503.4	M	L	M	L	L	-	-	L	L	L	M	L	M	L
C-15ME503.5	H	L	M	L	L	-	-	L	L	L	L	L	M	M

L: Low M: Medium H: High

TEXT BOOKS:

1. *Theory of Machines* by Shigley, Joseph Edminister, Tata McGraw Hill, 1999
2. *Theory of Machines* by V.P. Singh, Dhanpat Rai Co P Ltd, 2013

REFERENCE BOOKS:

1. *Theory of Machines* by Thomas Bevan, CBS Publishers & Distributors 2005
2. *Design of Machinery* by Robert-L. Norton, McGraw Hill, 2001
3. *Theory of Machines* by Ballaney, Khanna Publication 2013
4. *Theory of Machines* by Rattan, Tata McGraw Hill, 2009
5. *Theory of Machines* by J. K. B. Das and P. L. Srinivas Murthy Sapna Book House, 2003
6. Theory of Machines by Dr. RK Bansal and Dr. JS Brar, Laxmi Publications, 5th Edition, 2013.

MOOC/NPTEL Resources:

1. http://nptel.ac.in/courses/112104114/
2. http://nptel.ac.in/courses/112101096/

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METROLOGY & MEASUREMENTS

Sub Code : 15ME504 **Credits : 04**
Hrs/Week: 4+0+0+0 **Total Hours : 52**

Course Learning Objectives:

This course will enable students to

1. Understand classification and application of various standards used in engineering measurements and various terms related to measurements.
2. Understand working principle, construction, and use of different comparators and angle measuring instruments.
3. Understand the terminology of screw threads and gears and their measurement techniques. Get knowledge to design fits according to IS: 919-1963 and design gauges to inspect the fits.
4. Understand the various elements of a generalized measurement system.
5. Study the working principle, operation and characteristics of different measuring instruments used for the measurement of various physical parameters.

UNIT – I

Standards of measurement: Definition and Objectives of metrology. Standards of length - International prototype meter, Imperial standard yard, Wave length standard, subdivision of standards, line and end standard. Calibration of end bars. Slip gauges, wringing phenomena, Indian Standards (M-81, M-112), and numerical problems on building of slip gauges. Errors in Measurements.

Comparators: Introduction to Comparators, Classification and Characteristics of comparators. Principles of mechanical, optical, electrical & electronic and pneumatic comparators. Working of Sigma, Zeiss, LVDT and Solex comparators. **10 Hours**

UNIT – II

Angular measurements, Bevel Protractor, Sine Principle and use of Sine bars, Sine center, use of angle gauges, (numerical on building of angles) Clinometers.
Interferometer: Principle of Interferometry, autocollimator, Optical flats
Advances in metrology: Basic concepts of lasers, advantages of lasers, laser interferometers, types, applications. Basic concepts of Coordinate Measuring Machines-constructional features, applications.
Screw threads: Terminology, measurements of major diameter, minor diameter, pitch, thread angle. Effective diameter of screw threads by 3-wire methods - Best size wire. Gear terminology- use of gear tooth vernier calliper and gear tooth micrometer. Measuring instruments for screw threads and gears. **12 Hours**

UNIT – III

System of limits, Fits, Tolerances and gauging: Definition of tolerance and its Specification in assembly, concept of limits of size and tolerances, compound tolerances, accumulation of tolerances, definition of fits, types of fits and their designation (IS 919 -1963,). Principle of

inter changeability and selective assembly, hole basis system and shaft basis of system. Design of clearance, transition and interference fit. Design of gauges.

10 Hours

UNIT – IV

Measurement systems: Generalized measurement system. Definition and concept of accuracy, precision, calibration, threshold, sensitivity, repeatability, linearity. Hysteresis and loading effect. Transducers, Transfer efficiency, Primary and Secondary transducers, electrical, Mechanical, electronic transducers, advantages of each type transducers.

Intermediate modifying and terminating devices: Mechanical systems, inherent problems, Electrical intermediate modifying devices, input circuitry, ballast circuit, electronic amplifiers and telemetry. Terminating devices, Mechanical, Cathode Ray Oscilloscope, Oscillography, X-Y Plotters.

10 Hours

UNIT – V

Measurement of Force, Torque and pressure: Principle of analytical balance, platform balance, proving ring. Torque measurement: Prony brake, hydraulic dynamometer. Pressure Measurements- Principle, use of elastic members, Bridgeman gauge, Mcloed gauge, Pirani Gauge. Temperature measurement: Resistance thermometers, thermocouple, law of thermocouple, materials used for construction, pyrometer, Optical Pyrometer. Strain Measurements: Strain gauges, preparation and mounting of strain gauges, gauge factor, methods of strain measurement. **10 Hours**

Course Outcomes:

At the end of the course, student should be able to;

C-15ME504.1. Understanding the definition and objectives of metrology, standards of length –Line, End and Wavelength standards. Know the details of M-87 and M-112 sets of slip gauges and building dimensions using and classifications of errors in measurement.

C-15ME504.2. Gaining the knowledge of characteristics and working principle of various types of comparators. Understanding the principle, working and applications of various angle measuring instruments.

C-15ME504.3. Understanding the terminology of screw threads. Measurement of various thread parameters. Effective diameter, best size wire. Terminology of spur gear, gear tooth parameters. Limits fits, tolerances and different types of assemblies.

C-15ME504.4. Provide sound understanding the Generalized measurement system and its elements. various types of transducers. electrical and electronic modifying devices, their characteristics.

C- 5ME504.5. Gaining the knowledge of analytical and platform balances, and hydraulic dynamometers. various transducers in pressure measuring devices, Various types of gauges, gauge factor. Strain measurement.

Course articulation Matrix:

Course Outcomes	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
C-15ME504.1	L	H	M	L	L	L	M	M	L	L	H	M	M	M
C-15ME504.2	M	H	M	L	L	L	L	M	L	L	M	M	M	M
C-15ME504.3	L	M	H	L	L	L	L	M	L	L	M	M	M	M
C-15ME504.4	M	H	H	L	L	L	L	M	L	L	M	M	M	M
C-15ME504.5	M	H	H	M	L	L	L	M	L	L	M	M	M	M

L: Low M: Medium H: High

TEXT BOOKS:

1. "Mechanical measurements" by Beckwith Marangoni and Lienhard, Pearson Education, 6th Ed., 2006
2. "Engineering Metrology" by R.K.Jain, Khanna Publishers.20/e-2004
3. "Mechanical Measurements" by Thomas G Beckwith, Prentice-Hall, Pearson Education Limited.

REFERENCE BOOKS:

1. "Engineering Metrology" by I.C.Gupta, Dhanpat Rai Publications, 7th Edition, 2012
2. "Measurement Systems Applications and Design" by Ernest O, Doblin, McGRAW Hill Book Co. 5th Ed.,2003
3. "A Textbook of Measurements and Metrology" M.Mahajan, Dhanpat Rai &Co.2014

MOOC/NPTEL Resources:

1. http://nptel.ac.in/courses/112106138/

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INDUSTRIAL MANAGEMENT & ENTREPRENEURSHIP

Sub Code : 15ME505 **Credits 03**
Hrs/Week : 3+0+0+0 **Total Hours 39**

Course Learning Objectives:

This Course will enable students to

1. Learn the history of management & different forms of business organizations.
2. Able to visualize and understand the managerial functions.
3. Able to analyze motivation, communication & leadership skills.
4. Recapitulate and develop entrepreneurial skills to achieve goals.

5. Encapsulate, plan and implement small scale industries projects applying management techniques.

UNIT – I

MANAGEMENT: Introduction – Meaning – nature and characteristics of Management, Scope and Functional areas of management – Management as a science, art of profession, Management & Administration, Roles of Management, Levels of Management, Development of Management Thought – early management approaches, Modern management approaches.

Forms of Business Organization: Types of ownership (Characteristics, merits and demerits of Proprietorship, Partnership, Private limited Company, Public limited Company, Public sector organizations and Co-Operative enterprises), Incorporation of joint stock company, Methods of raising capital. **7 Hours**

UNIT – II

Functions of Management:
Planning [Definition, importance and characteristics of planning, Types of plans, Steps in planning] Organization [Principles of organizing, Types of organization, Characteristics, advantages and disadvantages of Line, Line and Staff, Functional, Matrix, Departmentation type of organization, Management of Change, Management of Conflict, Management by Objectives, Management by Exception, Span of control, Authority, Responsibility and Delegation, Centralization and decentralization**]** **8 Hours**

UNIT – III

Functions of Management:
Controlling [Nature and purpose of control, steps in control process, Critical control points, Types of managerial control, Operations control, Requirements of good control system]

Staffing [Objectives and Functions of human resource management, Sources and Policy of recruitment, Selection and Steps in selection process, Training and development, Performance appraisal]

Leading [Communication process, barriers to effective communication, formal and informal communication, principles of effective communication, motivation, theories of motivation; Herzberg's theory, Maslow's theory, Mcgrager's theory X and theory Y, leadership styles]

9 Hours

UNIT – IV

ENTREPRENEURSHIP: Concept of Entrepreneurship, Evolution of Entrepreneurship, Stages in entrepreneurial process; Role of entrepreneurs in Economic Development; Entrepreneurship in India; Entrepreneurship – its Barriers. Meaning of Entrepreneur; Functions of an Entrepreneur, Types of Entrepreneurs, Intrapreneur - an emerging Class.

Identification of business opportunities: Market Feasibility Study; Technical Feasibility Study; Financial Feasibility Study & Social Feasibility Study.

7 Hours

UNIT – V

SMALL SCALE INDUSTRIES: Definition; Characteristics; Need and rationale; Objectives; Scope; role of SSI in Economic Development. Advantages of SSI, steps to start and SSI, Government policy towards SSI; Different Policies of SSI, Impact of Liberalization, Privatization, Globalization on SSI. Effect of WTO/GATT on SSI, Supporting Agencies of Government for SSI, Ancillary Industry and Tiny Industry (Definition Only)

INSTITUTIONAL SUPPORT: Different Schemes; TECKSOK; KIADB; KSSIDC; KSIMC; DIC Single Window Agency; SISI; NSIC; SIDBI; KSFC.

INTRODUCTION TO LABOR LAWS:

I Law relating to Industrial relations

1 Industrial Disputes Act 1947

Definition, Authorities for the settlement of disputes, a brief overview

II Law Relating to Wages and Monetary Benefits

1Payment of Wages Act, 1936, a brief overview
Constitutional provisions in respect of wages and remuneration.
Minimum wages act 1948, a brief overview
2 Payment of bonus act, 1965, a brief overview
3. Equal remuneration act, 1976, a brief overview
4. Payment of gratuity act, 1972, a brief overview

III Law relating to safety measures.

Fatal accident act 1855, a brief overview

IV Law relating to industrial relations

Factory act 1948, a brief overview

8 Hours

Course Outcomes:

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

- **C-15ME505.1.** Know the history of management & different forms of business organizations.
- **C-15ME505.2.** Outline the managerial functions.
- **C-15ME505.3.** Know the importance of motivation, communication & leadership skills.
- **C-15ME505.4.** Develop entrepreneurial skills to achieve goals.
- **C-15ME505.5.** Plan and develop small scale industries by applying management techniques.

Mapping of POs & COs:

COs	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
C-15ME505.1	L	L	M			L	H	H	M	H	M	M	M	L
C-15ME505.1	M		L	M	H	L	H	M	M	H	M		H	L
C-15ME505.1	H	L	M	H	H	M	H	M	H	M		L	M	L

C-15ME505.1	**M**	**M**	**H**	**H**	**M**	**L**	**H**	**M**	**M**	**H**	**M**	**L**	**H**	**M**
C-15ME505.1	**M**	**M**	**H**	**M**	**H**	**M**	**H**	**W**	**H**	**H**	**H**	**M**	**L**	**M**

L: Low M: Medium H: High

TEXT BOOKS:

1. Industrial and Business Management by Martand T. Telsang, S. Chand & Company Ltd.
2. Industrial Management by Earnest dale, McGraw Hill Publication
3. **Principles of Management** – P.C.Tripathi, P.N.Reddy – Tata McGraw Hill,
4. **Dynamics of Entrepreneurial Development & Management** – Vasant Desai – Himalaya Publishing House
5. **Entrepreneurship Development** – Poornima.M.Charantimath – Small Business Enterprises – Pearson Education – 2006 (2 & 4).
6. **Labor relations law in India (1978)** Agarwal, S L

REFERENCE BOOKS:

1. Principles of Management by Koontz and O'Donnell, TMH
2. **Management Fundamentals** – Concepts, Application, Skill Development – Robers Lusier – Thomson
3. **Entrepreneurship Development** – S.S.Khanka – S.Chand & Co.
4. **Management** – Stephen Robbins – Pearson Education/PHI – 17th Edition, 2003.

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FLUID MACHINERY LAB

Sub Code : 15ME506 **Credits 02**
Hrs/Week : 0+0+3+0 **Total Hours 39**

Course Learning Objectives:

This Course will enable students to

1. Get the knowledge of coefficient of friction of flow in a pipe
2. Calculate coefficient of discharge for various flow measuring devices
3. Find minor losses in flow through pipes
4. Determine the forces developed due to impact of jets on vanes
5. Analyze the performance parameters of turbines, pumps, blowers, compressors.

PART – A

1. Determination of coefficient of friction of flow in a pipe.
2. Determination of minor losses in flow through pipes.
3. Determination of force developed by impact of jets on vanes.
4. Calibration of flow measuring devices.
    a) Orifice plate
    b) Flow nozzle

c) Venturimeter
d) Rotometer
e) V - notch

PART – B

5. Performance testing of Turbines
   a) Pelton wheel
   b) Francis Turbine
   c) Kaplan Turbine
6. Performance testing of Pumps
   a) Single stage and Multi stage centrifugal pumps
   b) Reciprocating pump
7. Performance test of a two stage Reciprocating Air Compressor
8. Performance test on an Air Blower

Course Outcomes:

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

C-15ME506.1. Acquire knowledge of coefficient of friction of flow in a pipe.
C-15ME506.2. Determine coefficient of discharge for various flow measuring devices.
C-15ME506.3. Calculate minor losses in flow through pipes.
C-15ME506.4. Determine the forces developed due to impact of jets on vanes
C-15ME506.5. Analyze the performance parameters of turbines, pumps, blowers, compressors.

Mapping of POs & COs:

CO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
C-15ME506.1	H	M	L	H	M	M	M						M	L
C-15ME506.2	H			H	M		M						M	L
C-15ME506.3	H			H	M		M						L	L
C-15ME506.4	H			H	M		M						L	L
C-15ME506.5	H	H	H	H	H	H	H						M	H

L : Low M: Medium H : High

TEXT BOOK:

1. *"A Textbook of Fluid Mechanics and Hydraulic Machines 9th edition by Dr. R.K. Bansal,* Laxmi Publications (P) Ltd., 2015

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METROLOGY & MEASUREMENTS LAB

Sub code : 15ME507 **Credits 01**
Hrs/Week : 0+0+2+0 **Total Hours: 26**

Course Learning Objectives:

This Course will enable students to:

1. Expertise on linear measuring instruments such as vernier instruments, Gear tooth vernier caliper, screw thread micrometers etc
2. For a given measurement problem student will be able to identify to choose between precision measuring instruments and comparators such as profile projectors, optical measuring devices like tool makers microscopes, sine bars etc with required accuracy
3. Obtain numerical solutions & calibrate a given measuring instrument with required accuracy by referring to standard values given by national physical laboratory for pressure temperature and strain Instruments.

PART-A: METROLOGY

1. Measurements using Optical Projector / Toolmaker Microscope.
2. Measurements of angle using Sine Center / Sine bar / bevel protractor
3. Measurements of alignment using Autocollimator / roller set
4. Measurements of cutting tool forces using
   a) Lathe tool Dynamometer
   b) Drill tool Dynamometer.
5. Measurements of Screw Thread Parameters using two wire or three wire method.
6. Measurements of Surface roughness. Using Tally surf/mechanical Comparator.
7. Measurements of gear tooth profile using gear tooth vernier / gear tooth micrometer.
8. Calibration of micrometer using slip gauges
9. Measurement using Optical Flats

PART-B: MECHANICAL MEASUREMENTS

1. Calibration of Pressure Gauge
2. Calibration of Thermocouple
3. Calibration of LVDT
4. Calibration of Load cell
5. Determination of modulus of elasticity of a mild steel specimen using strain gauges.

PART C: ALLIED MEASUREMENTS (Demonstration)

1. Measurement of Solar Radiation using pyranometer & Sunshine recorder.
2. Weather monitoring using weather station.
3. Measurement of air flow using air flow meter.
4. Measurement of illuminances using Lux meter.
5. Measurement of Electrical parameters using power clamp meters.

6. Air Quality Index Monitoring & Measurement using Digital Particulate measuring device.

Course Outcomes:

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

C-15ME507.1. Explain basic laws of metrology for linear measuring instruments such as vernier instruments, Gear tooth vernier caliper, screw thread micrometers etc

C-15ME507.2. For a measurement problem Students will be able to identify to choose between precision measuring instruments and comparators such as profile projectors, optical measuring devices like tool makers microscopes, sine bars etc with required accuracy

C-15ME507.3. Calibrate a given measuring instrument with required accuracy by referring to standard values given by national physical laboratory for pressure temperature and strain Instruments.

Mapping of POs & COs:

CO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO 11	PO 12	PSO1	PSO2
C-15ME507.1	H	H	H	H	M	H	M	L	H	H	L	M	L	M
C-15ME507.2	H	H	M	H	H	H	H	H	M	M	L	H	L	M
C-15ME507.3	H	L	H	H	H	L	H	L	L	M	H	M	L	M

L: Low M: Medium H: High

TEXT BOOKS:

1. "Mechanical measurements" by Beckwith Marangoni and Lienhard, Pearson Education, 6th Ed., 2006
2. "Engineering Metrology" by R.K.Jain, Khanna Publishers.

REFERENCE BOOKS:

1. "Engineering Metrology" by I.C.Gupta, Dhanpat Rai Publications,
2. "Measurement Systems Applications and Design" by Ernest O, Doblin, McGRAW Hill Book Co.
3. "Mechanical Measurements" by Thomas G Beckwith, Prentice-Hall, Pearson Education Limited.

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OPERATIONS MANAGEMENT

Sub Code : 15ME511 **Credits 03**
Hrs/Week: 3+0+0+0 **Total Hours: 39**

Course Learning Objectives:

This Course will enable students to

1. Understand the functions of various types of business organizations., Recognize the importance of operations function, apply important tools of Decision making in an organization setting.
2. Apply different methods of forecasting and solve numerical problems.
3. Analyze capacity and location planning and plant layout problems and Select best possible capacity, location and layout given the resources and information
4. Understand the nature and scope of, various strategies and techniques of aggregate planning and Master Scheduling. Apply these strategies to arrive at the best aggregate plan and MPS.
5. Discuss Material requirements planning and solve numerical problems. Generate Material requirement plan, with the available information.

UNIT – I

Production and Operations Management: Introduction, Functions within business organizations, the operation management function, Classification of production systems, Productivity, factors affecting productivity,
Decision Making: The decision process, characteristics of operations decisions, use of models - B.E.P and Transportation models, decision making environments. Decision trees.
8 Hours

UNIT – II

Forecasting: Steps in forecasting process, approaches to forecasting, forecasts based on judgment and opinion, analysis of time series data, Regression and Correlation methods, accuracy and control of forecasts, Choosing a forecasting technique, Elements of a good forecast. **8 Hours**

UNIT – III

Capacity, Location and Layout Planning: Importance of capacity decisions, defining and measuring capacity, determinants of effective capacity, determining capacity requirement, developing capacity alternatives, evaluating alternatives.
Design, System an actual capacity. System efficiency and utilization. Determination of Equipment requirement for a single stage production processes. Numerical problems on the above.
Need for location decisions, nature of locations decisions, general procedure for making locations decisions, evaluating locations decisions. Use of Break even analysis and Transportation algorithms for making location decisions. Facilities layout - Need for layout decisions. Minimizing material handling cost in process layout using Load distance analysis, Simple line balancing problems in product layouts. **8 Hours**

UNIT – IV

Aggregate Planning & Master Scheduling: Aggregate planning - Nature and scope of aggregate planning, strategies of aggregate planning, techniques for aggregate planning - graphical and charting techniques, Mathematical techniques. The master production schedule, Master scheduling process, Master scheduling methods. **8 Hours**

UNIT – V

Material Requirement Planning (MRP): Dependent versus independent demand, an overview of MRP - MRP inputs and outputs, MRP processing: An overview of MRP-II, JIT manufacturing and ERP, benefits and limitations of MRP. Capacity requirement planning.

7 Hours

Course Outcomes:

At the end of this course the students will be able to

C-15ME511.1. Explain the functions of various types of business organizations, apply important tools of decision making in an organization setting.
C-15ME511.2. Apply different methods of forecasting.
C-15ME511.3. Analyze capacity and location planning and plant layout problems.
C-15ME511.4. Apply strategies to arrive at the best aggregate plan and MPS.
C-15ME511.5. Discuss and generate material requirement plan, with the available information.

Course Articulation Matrix

CO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO 10	PO 11	PO 12	PSO1	PSO2
C-15ME511.1	M	M	H	M	L	L	M	M	H	M	M	M	L	L
C-15ME511.2	H	M	M	H	L	L	L	L	H	M	M	M	L	L
C-15ME511.3	H	M	H	H	L	L	L	L	H	M	H	M	M	M
C-15ME511.4	M	M	M	H	L	L	L	L	H	H	H	M	M	M
C-15ME511.5	M	M	M	H	L	L	M	L	H	H	H	M	M	M

TEXT BOOKS:

1. Production and Operations Management, William J Stevenson, Tata McGraw Hill, 8thEdition. 2011
2. Operations Management-Theory and Practice, B Mahadevan, Pearson Education, 2007.

REFERENCE BOOKS:

1. Production and Operations Management, Norman Gaither & Greg Frazier,
2. Operations Management for Competitive Advantage, R.B.Chase, NJ.Aquilino, F. Roberts Jacob; McGrawHill Companies Inc., Ninth Edition.

3. Production & Operations Management, Everett E.Adams, Ronald J.Ebert, Prentice Hall of India Publications, Fourth Edition.
4. Production / Operations Management, Joseph G Monks, McGraw Hill Books, 2001
5. Production / Operations Management, R. Pannerselvam, PHI India, 2011

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MATERIAL SELECTION FOR ENGINEERING DESIGN

Sub Code : 15ME512 **Credits 03**
Hrs/Week : 3+0+0+0 **Total Hours 39**

Course Learning Objectives:

This course will enable students to:

1. Understand basics of design processes and properties of engineering materials.
2. Know the use material property charts and to gain knowledge about material selection under fatigue, corrosion &fracture.
3. Know about wear mechanism and study wear design through case studies. Case studies to understand the design of plastics and ceramics.
4. Understand process selection procedure and to gain the knowledge in process selection through case studies.
5. Understand selection process under multiple constraints and conflicting objectives through case studies and to know the basics of hybrids.

UNIT I

The design process: types of design, design tools, conceptual and configuration design of products**,** analysis of technical systems, case study.

3 Hours

Families of engineering materials and mechanical properties: Ferrous and Non-ferrous metals and Alloys, Ceramics, Polymers, Composites, the causes of failure in service.

4 Hours

UNIT – II

Effects of composition, structure and processing on material properties; Material property charts, Basis of material selection**.** Evolution of microstructure change in steel products.

4 Hours

Design for fracture toughness, fatigue resistance, corrosion resistance, and high temperature applications. Case studies in materials selection **4 Hours**

UNIT – III

Design for Wear resistance, wear mechanism, and wear design; case studies for design with plastics, ceramics and composites. **8 Hours**

UNIT – IV

Manufacturing aspects of design: Processes and process selection, selection charts, taxonomy of the process kingdom; case studies in process selection; case studies: design for casting, effect of casting on properties, design for deformation processes. **9 Hours**

UNIT – V

Designing for machining and joining, design for ceramic and plastic processing; case studies with multiple constraints and conflicting objective; Introduction to hybrids and types.

7 Hours

Course Outcomes:

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

C-15ME512.1. Know about the basics of design processes and mechanical properties of engineering materials.

C-15ME512.2. Select materials using material property charts and thorough understanding of the material selection process.

C-15ME512.3. Understand wear design mechanism and knowledge of design with plastic, composites and ceramics.

C-15ME512.4. Know the selection of process using selection charts and understanding of design of different process.

C- 5ME512.5. Select process under multiple constraints and conflicting objectives and know about hybrids.

Mapping of POs & COs:

COs / POs	PO1	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-15ME512.1	M	-	-	M	L	L	M	L	H	H	L	H	H	-
C-15ME512.2	H	M	M	L	H	M	-	-	H	M	-	M	M	-
C-15ME512.3	H	H	M	M	L	-	-	L	M	H	-	M	H	-
C-15ME512.4	L	L	H	-	H	M	-	-	M	H	H	M	L	M
C-15ME512.5	M	H	H	M	-	-	L	-	M	-	L	L	M	L

L: Low M: Medium H: High

TEXT BOOK

1. *Material selection in Mechanical Design, Michael F. Ashby, Elsevier (3rd edition 2005).*

REFERENCE BOOK

1. *ASM Hand book of Materials Selection and Deign,* 1996.
2.

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TOTAL QUALITY MANAGEMENT

Sub Code : 15ME513	**Credits 03**
Hrs/Week : 3+0+0+0	**Total Hours 39**

Course Learning Objectives:

This Course will enable students to

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

UNIT – I

INTRODUCTION: The Meaning of Quality and Quality Improvement; Statistical Methods for Quality Control and Improvement; **TOTAL Quality Management:** Definition, Principles of TQM, Gurus of TQM, Benefits of TQM. **Principles of TQM:** Leadership - Deming's philosophy, Customers' satisfaction - Customers perception, Feedback, Employee involvement - quality circles, Continuous Improvement- Juran's Trilogy, PDSA cycle, Kaizen, Six sigma, ISO-9000, ISO-14000, ISO-18000 series of standards.

8 Hours

UNIT – II

MODELING PROCESS QUALITY: Mean, Median, Mode, Standard deviation, calculating area, Normal distribution tables, Finding the Z score, Central limit theorem, 7 QC tools.

METHODS AND PHILOSOPHY OF STATISTICAL PROCESS CONTROL: Chance and assignable causes, Statistical Basis of the Control Charts (basic principles, choices of control limits, significance of control limits, sample size and sampling frequency, rational subgroups, analysis of pattern on control charts, warning limits, Average Run Length-ARL).

8 Hours

UNIT – III

CONTROL CHARTS FOR VARIABLES: Control Charts for X-Bar and R- Charts, Type I and Type II errors, the probability of Type II error. Simple Numerical Problems.

6 Hours

PROCESS CAPABILITY: The foundation of process capability, Natural Tolerance limits, c_p – process capability index, c_{pk}, p_p – process performance index, summary of process measures. Numerical problems.

4 Hours

UNIT - IV

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

7 Hours

UNIT – V

LOT-BY-LOT ACCEPTANCE SAMPLING FOR ATTRIBUTES: The acceptance sampling problem, single sampling plan for attributes, Double, Multiple, and Sequential sampling, AOQL, LTPD, OC curves, Numerical problems.

3 Hours

INTRODUCTION TO DESIGN OF EXPERIMENTS: Hypothesis testing, one sample t-test, orthogonal design of experiments, two factor experimental design, numerical problems on the above topics.

3 Hours

Course Outcomes:

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

C-15ME513.1. Interpret quality and evolution of quality concepts over the years
C-15ME513.2. Apply statistical concepts for solving simple quality problems.
C-15ME513.3. Draw and interpret control charts for variables.
C-15ME513.4. Draw and interpret the control chart for attributes.
C-15ME513.5. Illustrate the basic concepts of Acceptance Sampling and design of experiments.

Mapping of POs & COs:

COs	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
C-ME513.1	M	M	H	M	H	L	M	H	H	H	H	H	M	M
C-ME513.2	H	-	H	M	H	L	M	L	H	M	L	M	H	L
C-ME513.3	H	-	H	M	H	L	-	M	H	M	L	H	H	M
C-ME513.4	H	L	H	H	H	L	M	H	H	H	H	H	M	L
C-ME513.5	H	H	H	H	H	L	-	H	H	H	H	H	M	M

L: Low M: Medium H: High

TEXT BOOKS:

1. **Statistical Quality Control:** E.L. Grant and R.S. Leavenworth, 7th edition, McGraw- Hill publisher, 2004.
2. **Statistical Quality Control**: RC Gupta, Khanna Publishers, New Delhi, 3rd edition, 2005.
3. **Total Quality Management**: Dale H. Besterfield, Pearson Education, 3rd edition, 2011.

REFERENCE BOOKS:

1. **Statistical Process Control and Quality Improvement:** Gerald M. Smith, Pearson Prentice Hall. ISBN 0 – 13-049036-9.
2. **Statistical Quality Control for Manufacturing Managers:** W S Messina, Wiley & Sons, Inc. New York, 1987
3. **Statistical Quality Control:** Montgomery, Douglas, 5th Edition, John Wiley & Sons, Inc. 2005, Hoboken, NJ (ISBN 0-471-65631-3).
4. **Principles of Quality Control:** Jerry Banks, Wiley & Sons, Inc. New York.
5. **Design and Analysis of Experiments:** R. Pannerselvam, PHI Learning Private Limited, New Delhi., 2012
6. **NPTEL course material on Design of Experiments.**

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METAL FORMING THEORY & PRACTICE

Sub Code : 15ME514 **Credits 03**
Hrs /Week: 3+0+0+0 **Total Hours 39**

Course Learning Objectives:

This course will enable students to:

1. Know the various characteristics of wrought products and stresses induced in wrought products.
2. Apply forging calculations for various forging products and to know about the concepts of rolling.
3. Understand the concepts of extrusion and drawing.
4. Understand various sheet metal forming and stretch forming processes.
5. Discuss and understand about powder metallurgy.

UNIT - I

INTRODUCTION AND CONCEPTS: Classification of metal working processes, characteristics of wrought products, advantages and limitations of metal working processes. Concepts of true stress, true strain, triaxial & biaxial stresses. Determination of flow stress. Principal stresses, Tresca & Von-Mises yield criteria, concepts of plane stress & plane strain.

6 Hours

EFFECTS OF PARAMETERS: Temperature, strain rate, friction and lubrication, hydrostatic pressure in metalworking, Deformation zone geometry, workability of materials, Residual stresses in wrought products.

6 Hours

UNIT - II

FORGING PROCESS - classification - equipment calculation of forging loads - forging defects - residual stresses. Rolling: classification -rolling mills - rolling of bars & shapes - rolling forces - analysis of rolling - defects in rolling- theories of hot & cold rolling - torque power estimation.

6 Hours

UNIT - III

EXTRUSION: classification-equipment - Analysis of extrusion process- extrusion defects - hydrostatic extrusion - tube extrusion. Drawing: Classification - rod & wilt drawing equipment - analysis. Deep drawing - tube drawing - analysis, residual stresses.

7 Hours

UNIT - IV

SHEET METAL FORMING - methods - shearing and blanking bending - stretch forming - deep drawing - forming limit criteria - defects. Stretch forming - press brake forming - explosive forming - electro hydraulic forming magnetic pulse forming - super plastic forming - electro forming - fine blanking PIM forging-Isothermal forging –HERF

7 Hours

UNIT - V

POWDER METALLURGY: Basic steps in Powder metallurgy brief description of methods of production of metal powders, conditioning and blending powders, compaction and sintering application of powder metallurgy components, advantages and limitations.

7 Hours

Course Outcomes:

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

C15ME514.1. Know the various characteristics of wrought products and stresses induced.
C15ME514.2. Perform calculations for various forging products and to know about the concepts of rolling.
C15ME514.3. Explain the concepts of extrusion and drawing.
C15ME514.4. Distinguish between various sheet metal forming and stretch forming processes.
C15ME514.5. Elaborate about powder metallurgy.

Course articulation matrix

CO	PO 1	PO2	PO 3	PO 4	PO 5	PO 6	PO7	PO8	PO 9	PO 10	PO 11	PO12	PSO 1	PSO 2
C15ME514.1	M	H	L	M	L	L						M	M	M
C15ME514.2	M	L	L	H	L	L			L			M	M	M
C15ME514.3	M	M	L	M	L	L						M	M	M
C15ME514.4	L	L	L	L		L			L			L	M	M
C15ME514.5	L	M	L	M	M	M						M	L	M

L : Low M: Medium H : High

TEXT BOOKS:

1. **Mechanical metallurgy (SI units),** by G.E. Dieter, Mc Graw Hill pub.2001
2. **Manufacturing Engineering and Technology** by Serope Kalpakjian and Stevan R.

REFERENCE BOOKS:

1. **Materials and Processes in Manufacturing** by E.paul, Degramo, J.T. Black, Ronald, A.K. Prentice –Hall of India 2002
2. **Principles of Industrial metal working process** – G.W. Rowe, CBSpub. 2002
3. **Manufacturing Science,** hy Amitabha Ghosh & A.K. Malik – East –Westpress 2001
4. **Theory of plasticity by Dr. Sadhu Sing**

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ADVANCED STRENGTH OF MATERIALS

Sub Code : 15ME515 **Credits 03**
Hrs /Week: 3+0+0+0 **Total Hours 39**

Course Learning Objectives:

This Course will enable students to

1. Understand the application of three dimensional stress for design.
2. Understand the application of three dimensional strain for design.
3. Understand the design of beams under different loadings.
4. Understand the stress and strain concepts for rotating cylinders and discs.
5. Understand the behavior of bars and tubes under torsion.

UNIT – I

Chapter 1 - Stress

Definition notation and sign convention of stress; Equilibrium equations, Stress components on an arbitrary plane; Principle stresses- maximum shear stress, octahedral stresses- boundary conditions.

8 Hours

UNIT – II

Chapter 2 – Strain

Definitions – strain - displacement relations - compatibility equations Principal strains- Generalized Hooke's law.

5 Hours

Chapter 3 – Uniqueness theorem

Saint Venant's Principal- Principal of super position- Reciprocal theorem.

6 Hours

UNIT - III

Chapter 4 - Two dimensional problems in Cartesian co-ordinates

Plane stress and plane strain conditions- Bi-harmonic equation- Investigation of Airy's stress function for simple beam problems- Solution for cantilever beam under end load and simply supported under uniformly distributed load. **8 Hours**

UNIT – IV

Chapter 5 - General equations in polar co-ordinates

Thick cylinder under pressure – Analysis of shrink fit. **3 Hours**

Chapter 6 - Discs

Stresses in rotating hallow and solid discs. **3 Hours**

UNIT – V

Chapter 7 - Torsion

Torsion of solid circular and elliptical bars- torsion in thin tubes, membrane analogy

6 Hours

Course Outcomes:

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

C-15ME515.1. Label the types of stresses like principle stresses, octahedral stresses, applying boundary conditions to practical problems and the sign conventions of stresses.

C-15ME515.2. Explain Hooke's law which gives the general relation between stress and strain and interpret Saint Venant's Principle.

C-15ME515.3. Identify the plain stress and plane strain conditions and apply the Airy's stress function for simple practical problems of beams.

C-15ME515.4. Perform the analysis of thick cylinder under pressure due to shrink fit, stresses in rotating solid and hollow discs.

C-15ME515.5. Apply torsion to solid circular and elliptical bars, thin tubes and recall membrane analogy.

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-15ME515.1	H	H	H	L	H	M	H	L	L	L	H	H	L	L
C-15ME515.2	H	H	H	L	H	M	H	L	L	L	L	H	L	L
C-15ME515.3	H	H	M	L	H	M	H	L	L	L	M	L	M	M
C-15ME515.4	H	H	H	L	H	M	H	L	L	L	H	M	M	M
C-15ME515.5	H	H	H	L	H	M	H	L	L	L	L	M	M	M

L : Low M: Medium H : High

TEXT BOOKS:

1. Boresi A P and Sidebottom O M, "Advanced Mechanics of Materials", John Wiley and Sons, New Delhi, 1985.
2. "Theory of Elasticity"-S. P. Timoshenko and J. N. Goodier - 3rd Edition- McGraw Hill- New York 1970.
3. "Applied Elasticity"– T. G. Sitharam, L. GovindaRaju, Interline Publishing 2008.
4. Advanced Mechanics of solids" - L. S. Srinath" Tata Mcgraw-Hill book Company - 1980.
5. "Applied Elasticity" -C. T. Wang- McGraw –Hill- Book Co.- 1953.

REFERENCES BOOKS:

1. Cook R D, and Young, "Advanced Mechanics of Materials", John Wiley Co., New Delhi, 1987.
2. Den Hartog, "Advanced Strength of Materials", McGraw Hill Inc., New Delhi, 1975.

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COMPUTER AIDED DESIGN (CAD) TOOL: UG NX

Sub Code : 15ME516 **Credits : 03**
Hrs/Week: 1+0+2+0 **Total Hours : 39**

Course Learning Objectives:

This course will enable students to:

1. Learn the various coordinate systems and software interface.
2. Understand the various geometric relationships and feature creations.
3. To be familiar with the various commands of creation and modifying features.
4. Students must be able to load and assemble the various parts and convert them to 2D drawings.
5. Understand basics of GD&T and stack up analysis.

UNIT - I

Introduction to CAD theory: Introduction to NX, file overview, layers.
Activities: Opening and working with parts.
NX CAD tool interface: User Interface Preferences, roles, NX layout configuration between sessions.
Activities: Getting to know the NX interface: Toolbars and roles
Coordinate systems on parts: Coordinate systems on parts, WCS options, WCS dynamics overview, impact of coordinate systems on parts.
Creating parts with sketches: Sketch overview, types of constraints, sketch dimensions, convert to / from reference, CAD environment.
Activities: Create constraints
Projects: Simple sketching. **7 Hours**

UNIT - II

Sweeping geometry to create part features: Types of swept features, internal and external sketches, extrude, combine bodies using Boolean commands, revolve and sweep along guide.
Activities: sweeping geometry to create part features
Projects: Simple sweeps

Creating and editing geometric relationships with formulas: Expressions, parameter entry options, Expression options.
Activity: Creating and editing geometric relationships with formulas
Creating datum geometry to support design intent: Datum plane, create datum planes.
Activities: Creating datum geometry to support design intent, applications for a datum CSYS.
Structure of a model: Part navigator, feature replay, reorder feature, feature dimension measurements, delayed updates.
Activity: Examining the structure of a model. **8 Hours**

UNIT – III

Editing and manipulating sketches: Auto constrain, auto dimension, edit dimension associativity, attach a dimension to different geometry, reattach sketch, mirror curve, sketch evaluation and update techniques.

Activity: Auto dimensioning rules
Trimming a solid body, creating swept features with offset and draft: Extrude with offset, two sided offset examples, single sided offset examples, extrude with draft, design logic parameter entry options.
Project: Advanced sweeps
Creating and editing holes, Creating and manipulating shell features, Copying and Mirroring part segments. 8 Hours

UNIT - IV

Blending and chamfering edges, modifying geometry of imported parts
Loading and working with assemblies: Introduction to NX assemblies, component objects, part files, load states, scope group, assembly navigator display commands.
Activity: Part revisions and saving assemblies.
Projects: Shell, associative copies, blends and chamfers.

Adding and positioning parts in an assembly
Activity: Create an assembly, move component, assembly constraints, show degrees of freedom.

Drafting / Creating simple drawings: Drafting application, model based drafting process, master model concept, the drafting interface, setting and changing the style of your view.
Activity: Create notes and labels
Projects: Create simple drawings **8 Hours**

UNIT - V

Geometric Dimensioning and Tolerancing + Stack up Analysis
Basics of GD&T: Tolerances of form, straightness, flatness, circularity, cylindricity, angularity, perpendicularity, parallelism, tolerances of runout, circular runout, total runout, tolerances of profile, profile of a surface, tolerances of location, true position, concentricity, symmetry, coordinate vs geometric tolerancing methods.
Activity& Project **4 Hours**

Stack up Analysis

Introduction to Stack Up analysis
Activity & Project **4 Hours**
(***Activities and projects are considered for internal assessment only).***

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

C-15ME516.1. Acquire the knowledge about coordinate systems and software interface in UG NX.
C-15ME516.2. Model parts with various feature creations.
C-15ME516.3. Edit and manipulate sketches using advanced tools.
C-15ME516.4. Load and assemble the various parts in assembly environment and convert them to 2D drawings.
C-15ME516.5. Develop GD&T relationships to the models and use stack up analysis.

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-15ME516.1			M	L					L			L	M	M
C-15ME516.2			M		H							L	H	M
C-15ME516.3			M							H			L	M
C-15ME516.4			M	H	H							L	H	H
C-15ME516.5			M	M						L		M	H	H

L: Low M: Medium H: High

TEXT BOOKS:

1. Radhakrishnan P and Subramanyan S, "CAD/CAM/CIM", New Age International (P) Ltd., 2004.
2. P. N. Rao, "CAD/CAM Principles and Applications", 2nd Edition, TMH education, 2007.

REFERENCE BOOKS:

1. Radhakrishnan P and Kothandaraman C P, "Computer Graphics and Design", Dhanpat Rai and Sons, New Delhi, 2002.
2. Vera B Anand, "Computer Graphics and Geometric Modeling for Engineers", John Wiley and Sons Inc., New Delhi, 2000.

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EMPLOYABILITY SKILL DEVELOPMENT

Sub Code : 15IL001 **Credits : Nil (MLC)**
Hrs/Week : 1+0+0+0 **Total Hours : 12**

UNIT – I

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

UNIT – II

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

UNIT - III

Quantitative- Time & work
Analytical/logical- Syllogism
Verbal- Vocabulary (antonyms)

UNIT – IV

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

UNIT - V

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

UNIT - VI

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

UNIT – VII

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

UNIT - VIII

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

REFERENCE BOOKS:

1. Aggarwal R.S "Modern Approach to Logical Reasaning" S. Chanda Publication, 2008.
2. Aggarwal R.S "Quantitative Aptitude" S. Chand Publication ,2014.
3. Aggarwal R.S "Modern Approach to verbal and non verbal reasoning" S. Chanda Publication, 2013.
4. Arun Sharma "Verbal ability and reading comprehension CAT" TMH Publications, 2014.
5. Ethnus Consultancy Pvt. Ltd "APTIMTRA: Your friend for cracking aptitude test", MGH Publications, 2014.
6. Aggarwal R.S "Advanced objective general knowledge" S. Chanda Publication, 2014.

Examination pattern:

This course is a mandatory learning course without credit. Continuous internal examination (CIE) consists of 1 internal exams (40 marks) and tasks (10 marks). There is no semester end examination (SEE). The student will be awarded PP or NP grade as per autonomous regulations.

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OPERATIONS RESEARCH

Sub Code : 15ME601 **Credits 04**
Hrs/Week : 4+0+0+0 **Total Hours 52**

Course Learning Objectives:

This Course will enable students to

1. Understand the use of Operations Research for solving problems by selecting appropriate modeling technique. Use of linear programming for formulating and solving problems.
2. Get the idea of using transportation and assignment techniques in real life problem solving.
3. Make use of sequencing, replacement and simulation techniques for solving real life problems.
4. Tell how queuing theory can be helpful in solving real life problems related to queues in a service facility and game theory for working out strategies in conflict situations.
5. Demonstrate the use of network analysis techniques in planning and scheduling of complex projects

UNIT – I

INTRODUCTION:, Definition, scope of Operations Research (OR) and limitations of OR Models, Characteristics and phases of OR. **Linear programming problems:** Mathematical formulation of L P P. Graphical solution methods. The simplex method - slack, surplus and artificial variables.Concept of duality, two phase method, dual simplex method, Dynamic Programming. **12 Hours**

UNIT - II

TRANSPORTATION PROBLEM: Formulation of transportation Model, Basic feasible solution using different methods, Optimality Method, Unbalanced transportation problem, Degeneracy in transportation problems, Applications of Transportation problems.
ASSIGNMENT PROBLEM: Formulation, unbalanced assignment problem, Traveling salesman problem. **10 Hours**

UNIT – III

SEQUENCING: Johnson's algorithm, n - jobs to 2 machines, n jobs 3 machines, n jobs m machines without passing sequence. 2 jobs n machines with passing. Graphical solutions,
REPLACEMENT THEORY: Replacement policy for equipment which deteriorates gradually. Replacement of items that fail suddenly.
SIMULATION: Introduction, process of simulation, Monte Carlo Simulation, Advantages and disadvantages of Simulation, Problems on Simulation. **10 Hours**

UNIT – IV

QUEUING THEORY: Queuing system and their characteristics. The M/M/1Queuing system, Steady state performance analysing of M/M/1 and M/M/C queuing model.
GAME THEORY: Formulation of games, Two person-Zero sum game, games with and

without saddle point, dominance property, Graphical solution (2x n, m x 2 game) **10 Hours**

UNIT – V

PROJECT MANAGEMENT USING NETWORK ANALYSIS: Network construction, determining critical path, floats, scheduling by network, project duration, PERT- Estimation of project duration, variance under probabilistic models, Crashing of networks. **10 Hours**

Course Outcomes:

Upon completion of this course, graduates will,

C-15ME601.1. Appreciate the use of Operations Research for solving problems in real life by selecting appropriate modeling technique. Use of linear programming for formulating and solving problems.

C-15ME601.2. Use of transportation and assignment technique to find solutions to real life problems.

C-15ME601.3. Use sequencing technique to solve real life problems and simulation for solving a variety of real life problems.

C-15ME601.4. Appreciate the use of queuing theory to solve real life problems and game theory for working out strategies in conflict situations.

C- 5ME601.5. Use of network analysis techniques for planning and scheduling complex projects and to determine critical paths.

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-15ME601.1	H	H	L	L	L	L	L	L	L	M	L	L	L	L
C-15ME601.2	H	H	L	L	L	L	L	L	L	M	L	L	L	L
C-15ME601.3	H	H	L	L	L	L	L	L	L	M	L	L	L	L
C-15ME601.4	H	H	L	L	L	L	L	L	L	M	L	L	L	L
C-15ME601.5	H	H	L	L	L	L	L	L	L	M	L	L	L	L

L: Low M: Medium H: High

TEXT BOOKS:

1. Operations Research an Introduction, Taha H. A. 8th edition – Pearson Education 2007
2. Operations Research, S. D. Sharma -Kedarnath Ramnath & Co 2002.
3. Quantitative Techniques in Management, N D Vohra- Tata McGraw Hill Education Private Limited, New Delhi. 4th edition 2010

REFERENCE BOOKS:

1. "Operation Research" AM Natarajan, P. Balasubramani, A Tamilaravari Pearson

education 2009
2. Introduction to operation research, Hiller and Liberman, Mc Graw Hill. 5th edition 2001.
3. Operations Research: Principles and practice: Ravindran, Phillips & Solberg, John Wiley & Sons, India 2nd edition 2007
4. Operations Research, Prem Kumar Gupta, D S. Hira, S Chand Publications, New Delhi, 2nd edition 2008
5. "PERT & CPM", L. S. Srinath, Affiliated East-West Press, New Delhi 3rd edition 2001
6. Problems in Operations Research (Principles and Solutions), Prem Kumar Gupta, D S Hira- S.Chand & Company LTD, New Delhi 4th edition 2009

MOOC/NPTEL Resources:

1. http://nptel.ac.in/courses/112106134/1

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DESIGN OF MACHINE ELEMENTS – II

Sub Code : 15ME602	**Credits 04**
Hrs/Week : 3+2+0+0	**Total Hours 52**

Course Learning Objectives:

This Course will enable students to

1. Get the idea how Winkler-Bach theory can be used to analyze the distribution of stresses in curved beams.
2. Analyze and quantify the forces, stresses and related parameters which are necessary to design springs.
3. Identify the factors to be considered while designing brakes and clutches.
4. Demonstrate the ability to develop designs for gears.
5. Make use of the theory of thick film lubrication for the selection of suitable oils for journal bearings.

Pre-requisites:

Engineering Mechanics, Elements of Mechanical Engineering, Mechanics of Materials, Design of Machine Elements-1, Dynamics of Machinery, Kinematics of machines.

UNIT – I

Design of simple machines: Crane hook, punching presses and clamps, closed rings and links; design of piston and connecting rod. **10 Hours**

UNIT – II

Design of springs: Types of springs - tension and compression springs, stresses in coil springs of circular and non circular cross sections; springs subjected to fluctuating load, leaf springs - stresses in leaf springs; equalized stresses – energy stored in springs; torsion springs, Belleville springs. **10 Hour**

UNIT – III

Clutches & Brakes: Design & selection - introduction to plate clutches and design of multi plate clutches; design of cone clutch; introduction to shoe brakes and design of double shoe block brakes, band and expansion brakes, principle and condition for self locking of brakes.

8 Hours

UNIT – IV

Design of Gears: Review of gear fundamentals, interference, gear forces, design of a spur gear pair. Helical gears: parallel axis helical gear, normal and transverse planes, helix angles, equivalent number of teeth, design of helical gear pair.

Bevel gears: types & nomenclature only (design problems on bevel gears not included)

Worm gears: nomenclature, thermal capacity, efficiency, design of a pair of worm gears.

14 Hours

UNIT – V

Design of Journal bearings: Introduction to tribological consideration in design: friction, wear, lubrication; lubrication and mountings, oil seal and packing, sliding contact bearings, sintered bearing materials, bearing types and their construction details; hydrodynamic lubrication - basic theory, thick and thin film lubrication, coefficient of friction, Sommerfeld number, design consideration in hydrodynamic bearings, heat balance in journal bearings, temperature rise, introduction to hydrostatic bearings.

Rolling contact bearings: Types, static and dynamic load capacities, equivalent bearing load, load-life relationship, bearing life, load factor, selection of bearing from manufacturer's catalogue; ball and roller bearings, design for variable load and speed, bearings with probability of survival other than 90%, bearing materials and their properties.

10 Hours

Course Outcomes:

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

C-15ME602.1. Acquire the knowledge about analysis of stresses in various curved beams.

C-15ME602.2. Design different types and cross sections of springs and compute the stresses for fluctuating loads.

C-15ME602.3. Design different types of clutches and brakes.

C-15ME602.4. Design spur, helical, worm gears and understand the nomenclature of bevel gears.

C- 5ME602.5. Demonstrate the tribological considerations in design including friction, wear, lubrication and design sliding and rolling contact bearings for different applications.

Course Articulation Matrix:

Course Outcome	Programme Outcomes													
	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
C-15ME602.1	H	H	M	-	L	M	-	-	H	M	M	M	H	H
C-15ME602.2	M	M	M	-	M	M	-	-	M	M	M	M	M	H
C-15ME602.3	L	M	H	-	-	-	L	-	M	L	L	M	L	L
C-15ME602.4	M	M	H	L	M	-	-	L	M	H	M	H	M	H
C-15ME602.5	M	M	H	L	-	-	L	-	L	M	M	M	M	L

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

DESIGN DATA HAND BOOKS:

1. Mahadevan K. and Reddy B., "Design Data Hand Book", CBS Publication, 4th Edition, 2013.
2. Lingaiah K., "Machine Design Databook", McGraw Hill, 2nd edition, 2010.

TEXT BOOKS:

1. Shigley J.E. and Mischke C.R., "Mechanical Engg. Design", McGraw Hill International Edition, 8th Edition, 2010.
2. Bhandari V.B., "Design of Machine Elements", Tata McGraw Hill Publishing Company Ltd., New Delhi, 3rd Edition, 2010.

REFERENCE BOOKS:

1. Norton R.L., "Machine Design" , Pearson Education Asia, 2012.
2. Hall, Holowenko, Laughlin (Schaum's Outlines series) adapted by Somani S.K., "Machine Design" , Tata McGraw Hill Publishing Company Ltd., New Delhi, Special Indian Edition, 1st Edition, 2011.
3. Ugural A.C., "Mechanical Design of Machine Components", 2nd Edition, CRC Press, Taylor and Francis Group, 2015.
4. Rao T.K., "Design of Machine Elements-Volume II", I.K. International Publishing House Pvt. Ltd., 2010.
5. Annaiah M.H., "Design of Machine Elements-II", New Age International Pvt. Ltd., 2nd edition, 2012.

E-books:

1. Spotts M.F., "Design of Machine elements", 8th edition, Pearson Education, 2008.
2. Jadon V.K. and Verma S., "Analysis and Design of machine elements", I.K. International publishing house, 2010.
3. Sharma C.S. and Purohit K., "Design of Machine elements", 9th edition, PHI Learning, 2013.
4. Schmid S.R., "Fundamentals of Machine elements", 3rd edition, CRC Press, 2014.

MOOC/NPTEL Resources:

1. https://www.mooc-list.com/course/machine-design-part-i-coursera
2. http://nptel.ac.in/courses/112105125

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AUTOMOTIVE ENGINEERING

Sub Code : 15ME603 **Credits 04**
Hrs/Week: 3+0+2+0 **Total Hours : 52**

Course Learning Objectives:

This Course will enable students to

1. Get an idea on the different components of an engine and its types with lubrication system.
2. Understand the fuel supply system and ignition systems used in automobiles.
3. Demonstrate the working of transmission system.
4. Explain the importance of suspension system, steering geometry and drives in automobiles
5. Know the concept of braking system, tyres and emission control.

UNIT - I

CHASSIS SYSTEM AND SUB-SYSTEMS:
Classification of vehicles, Types of chassis and Construction

Suspension and springs: Requirements, leaf spring, coil spring, Torsion bar suspension systems, independent suspension for frontwheel, Air suspension system.

Wheels &Tyres: Types of wheels, Desirable tyre properties, Types of tyres.

Steering And Front Axle System: steering geometry, camber, king pin inclination, included angle, castor, toe-in & toe-out, condition for exact steering, steering gears, power steering, general arrangements of links and stub axle, over steer, under steer & neutral steer, numerical problems. **10 Hours**

UNIT - II

DRIVE TRAIN, REAR AXLE AND BRAKING SYSTEM:

DRIVE TRAIN: Clutches- Single plate, multiplate and centrifugal clutches. Gear box: Necessity for gear ratios in transmission, Constant mesh gear box, Synchromesh gear box, over drive, fluid coupling and torque converter, Epicyclic gear box, principle of automatic transmission, calculation of gear ratios, Numerical calculations for torque transmission by clutches.

Propeller shaft, universal joints, Hotchkiss.and torque tube drives, differential, rear axle, different arrangements of fixing the wheels to rear axle,

Types of brakes, mechanical, compressed air, vacuum and hydraulic braking systems, construction and working of master and wheel cylinder, brake shoe arrangements, Disc brakes, Drum brakes, numerical problems related to brake torque, minimum stopping distance with brakes on front, rear and all wheels,
weight transfer and heat dissipation during braking. **10 Hours**

UNIT - III

ENGINE SYSTEMS AND EMISSIONS CONTROL:
SI & CI engines, Cylinder-arrangements and their relative merits, Liners, Piston, connecting rod, crankshaft, valves, valve actuating mechanisms, valve and port timing diagrams, Types of combustion chambers for S. I. Engine and C. I. Engines, Choice of materials for different engine components, engine positioning, cooling requirements, methods of cooling, thermostat valves, different lubrication arrangements.

Engine exhaust emissions, sources and emission control methods. **10 Hours**

UNIT – IV

FUEL SUPPLY, STARTING AND ELECTRICAL SYSTEMS
Fuel supply systems for SI and CI engines: Fuel mixture requirements for SI engines, Principle of carburetion, multi point and single point fuel injection systems, CRDI system, fuel transfer pumps, fuel injection pumps and injectors

Battery Ignition systems, magneto Ignition system, Transistor assisted contacts. Electronic Ignition, Automatic Ignition advance systems, lighting systems, starting device (Bendix drive), alternator. **10 Hours**

UNIT - V

AUTOMOTIVE ELECTRONICS, ONBOARD DIAGNOSTICS & SAFETY LAWS

Automotive Sensors: Basics and overview, automotive applications, features of vehicle sensors, sensor classification, error type and tolerance requirements, physical effects of sensors, selection of sensor technologies (Only functional description)
Sensor measuring principle: sensors for the measurement of position, speed, rpm, acceleration, pressure, force and torque, flow meters, gas sensors and concentration sensors, temperature sensors, imaging sensors(Only functional description)

Sensor types: Engine speed sensors, hall phase sensors for transmission control and wheel speed, yaw-rate sensors, pressure sensors, temperature sensors, accelerator-pedal sensors, steering angle sensors, position sensors, axle sensors, piezoelectric knock sensors, air mass sensors, acceleration sensors, rain/light sensors, oxygen sensors. **12 Hours**

Automobile Safety Laws.

List of proposed Experiments in the Automotive Laboratory:

1. Study of Automotive - Chassis & superstructure/body and its functions. Also involves study of seat, cut section of wheel rims(Drop-center and Flat-base) &tyres(bias and radial types).
2. Study of more commonly used tools and equipment in Automotive shop
3. Study of carburettors and petrol & diesel fuel injection systems (If part is not available, Charts/video to be used at present).
4. Demonstration and study of Front axle and steering system
5. Demonstration and study of various suspension systems
6. Power train - Dismantling and assembly of single/multi cylinder Engine as available
7. Power train - Study of clutch mechanism. Demonstration and study of dry friction clutches and wet clutches - Single plate & multi-plate types
8. Power train - Demonstration and study of transmission system - Gear box
9. Power train - Demonstration and study of Universal joints, propeller shaft, final drives, differential, and rear axles
10. Demonstration and study of brake mechanism (hydraulic type) and study of disc and drum brakes
11. Field visit to Automotive Servicing Station - Study of electrical system, wheel alignment (measuring and adjustment of castor, camber, king-pin inclination, toe-in and toe-out), automotive emission control systems.

(The details of each experiment to be given out as handout to each student or may be uploaded in Intranet)

Course Outcomes:

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

15ME603.1. Draw the layout and understand the functions of each part of an automobile including suspensions, wheels and axle system.

15ME603.2. Explain the construction and working of transmission and its types, along with braking system.

15ME603.3. Describe the types of IC Engines and its parts followed by the control of emission from IC Engines.

15ME603.4. Deduce the latest types of fuel supply systems used in an automobile.

15ME603.5. Know the automotive electronics, sensors and the safety laws.

Mapping of POs & COs:

CO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
15ME603.1	L	M	L	L	H	L	H	M	H	H	L	M	H	H
15ME603.2	L	M	L	L	H	L	H	M	H	H	L	M	H	H

15ME603.3	**H**	**H**	**H**	**H**	**H**	**L**	**H**	**L**	**L**	**L**	**L**	**H**	**M**	**H**
15ME603.4	**H**	**H**	**H**	**H**	**H**	**L**	**H**	**L**	**L**	**L**	**L**	**H**	**M**	**H**
15ME603.5	**M**	**M**	**L**	**L**	**H**	**L**	**H**	**M**	**H**	**H**	**L**	**M**	**H**	**H**

L: Low, M: Medium, H: High

TEXT BOOKS:

1. Automotive Mechanics by S. Srinivasan, Tata McGraw Hill, 2003
2. Automobile Engineering, Kirpal Singh, Vol I and II, 2013.

REFERENCE BOOKS:

1. Automobile Engineering, R. B. Gupta, SatyaPrakashan, 4th Edn. 1984.
2. Automobile Engineering, Narang, Khanna Publishers 2002
3. Automotive Mechanics, Crouse, McGraw Hill 2002
4. Automotive Mechanics, Joseph Heithner 2000
5. Automobile Mechanics by N. K. Giri, Khanna publishers 2002
6. Newton and Steeds Motor Vehicle, Butterworth, 2nd Edn. 1989.
7. Automobile Engineering by K. K. Jain and R. B_ Arshana, Tata McGraw Hill, 2002

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CAD / CAM

Sub Code : 15ME604 **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 CAD/CAM, product cycle, CAD/ CAM process, the software functions, and transformation of geometries.
2. Provide capability to analyze and solve problems associated with curves,
3. Provide capability to analyze and solve problems associated with surfaces and solid modelling techniques
4. To familiarize with fundamentals of NC/CNC, adaptive control system, and understand the basics of programming.
5. Understand basics of robotics, types of configurations, end effectors, sensors and robot applications.

UNIT - I

Introduction to CAD and CAM

Product Cycle, Definition of CAD and CAM, use of computers in product cycle, Conventional design process, computer aided design, benefits of CAD, Advantages and disadvantages of CAD.

Hardware for CAD: Graphic displays – Image generation techniques, Direct beam refresh, Direct view storage, Raster scan, LED, LCD monitors, Display controller & display memory.

Graphics software: Transformations 2-D – Translation, Rotation and Scaling, Reflection
Introduction to Virtual reality. **7 Hours**

UNIT – II

Algorithm for generation and display of simple graphical elements like lines, circle, ellipse.
Types and representation of curves: Synthetic curves – Cubic, Bezier & B-spline curves.
11 Hours

UNIT – III

Types and representation of surfaces: Analytic surfaces – Plane, ruled, revolution and tabulated surfaces. Synthetic surfaces – cubic, Bezier and B-spline surfaces. Types and representation of solids – Solid representation, half spaces, Boundary Representation (B-Rep), Constructive Solid Geometry (CSG). **7 Hours**

UNIT - IV

NC, CNC and Adaptive control system
Basic components of NC, NC procedure, Classifications of NC, Machining centres, advantages and disadvantages of NC, Problems with Conventional NC, Introduction to CNC, Functions of CNC, CNC part programming on turning and milling operations.
Adaptive control optimization, Adaptive control constraint, ACC for turning, Adaptive control of grinding, optimization strategy. **7 Hours**

UNIT – V

Industrial Robotics:
Introduction to Robotics, Robot anatomy, physical configurations, Manipulator Kinematics, Technical features, programming the robot, robot programming language, end effecters, work cell design, work cell control and interlock, robotic sensor, robotic applications. **7 Hours**

Course Outcomes:

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

C-15ME604.1. Acquire basic knowledge of CAD/CAM
C-15ME604.2. Analyze and solve problems associated with curves.
C-15ME604.3. Analyze and solve problems associated with surface and solid modeling techniques
C-15ME604.4. Outline the fundamentals of NC/CNC, adaptive control system, and basics of programming.
C- 5ME604.5. Acquire fundamental knowledge about robotics, types of configurations, end effectors and sensors.

Mapping of POs & COs:

Course outcome	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
C-15ME604.1	L	L	–	–	M	L	L	–	M	L	L	M	L	M

C-15ME604.2	**M**	**H**	**L**	**M**	**H**	**M**	**L**	**–**	**M**	**L**	**L**	**H**	**M**	**H**
C-15ME604.3	**L**	**H**	**M**	**M**	**H**	**M**	**M**	**–**	**M**	**H**	**H**	**H**	**M**	**M**
C-15ME604.4	**M**	**H**	**M**	**M**	**H**	**M**	**M**	**–**	**H**	**M**	**M**	**H**	**L**	**M**
C-15ME604.5	**M**	**M**	**M**	**M**	**H**	**M**	**M**	**–**	**H**	**H**	**M**	**M**	**M**	**M**

L : Low M: Medium H : High

TEXT BOOKS:

1. **GrooverMikell P. and Zimmers Emory W.**(2003) "Computer aided design and manufacturing"*Prentice Hall of India* , New Delhi.
2. **KorenYoram and Ben and Uri Joseph** (2005) "Numerical Control of Machine Tools"*Khanna Publishers*, New Delhi.
3. **Zienkiewicz O.C. (1977) "The Finite Element Method" Tata McGraw Hill New Delhi**
4. **Computer control of Manufacturing System** YoramKoren McGraw Hill Intl.Pub.2002.

REFERENCE BOOKS:

1. **Ibrahim K Zeid** (1998) "CAD/CAM Theory and Practice" *Tata McGraw Hill* New Delhi
2. **Daryl L Logan** (2003) "A First Course in Finite Element Method" *Pearson Education* New Delhi
3. **Newman W. and R. Sproull**(2005) "Interactive Computer graphics" *Tata McGraw Hill* New Delhi
4. **MikellGroover P., Mitchell Weiss, Roger Nagel N. and Nicholas Odrey G.** (1986) "Industrial Robotics Technology, Programming and Applications" *McGraw-Hill Inc*, Singapore.
5. **Mechatronics,** HMT Ltd., Tata MaGraw Hill Pub.200.
6. Vince, John (2004), Introduction to Virtual Reality Authors: Vince, Springer-Verlag London

MOOC/NPTEL Resources:

1. http://nptel.ac.in/courses/112102101/

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COMPUTER AIDED MODELING & ANALYSIS LAB

Sub Code : 15ME605 **Credits 02**
Hrs/Week : 0+0+3+0 **Total Hours 39**

Course Learning Objectives:

This Course will enable students to

1. Learn to use the different modules of ANSYS V17.2, such as pre- processing, processing and post-processing to perform linear static analysis.
2. Apply the concepts of FEM to solve numerical problems related to trusses, 1- D bar, and compare the theoretically obtained results with ANSYS V17.2.
3. Apply the concepts Machine Design to solve numerical problems related to plates and compare the theoretically obtained results with ANSYS V17.2.
4. Apply the concepts FEM/Mechanics of Materials to solve numerical problems related to beams and compare the theoretically obtained results with ANSYS V17.2.
5. Apply the knowledge of tools of Pro E. (Creo V2.0) to create models and assembly of couplings (like, Universal and Flanged) and joints (like Knuckle and Cotter).

PART A – STRUCTURAL ANALYSIS

Study of Finite Element Analysis (ANSYS) Static Finite Element Analysis of Bars, Trusses, Beams, Plates. (8 exercises). **20 Hours**

PART B – PART MODELING & ASSEMBLY

Study of solid modeling packages (PRO-E & CATIA), Modeling and assembly of Flanged coupling (protected & unprotected type), Oldham's coupling, Knuckle joint, Socket and Spigot joint, using above two software packages. **19 Hours**

Course Outcomes:

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

C-15ME605.1. Acquire the knowledge about different modules used in ANSYS.
C-15ME605.2. Determine the unknown variables related to 1-D Bar, and Truss Element using ANSYS software and compare the results with FEM.
C-15ME605.3. Determine the maximum stress induced in a plate subjected to different types of load and varying geometries. Using the concept of machine design and compare the results.
C-15ME605.4. Draw the variation of shear force and bending moment diagrams for different types of beams subjected to different loadings and verify with ANSYS plots.
C- 5ME605.5. Model the parts and assemble different types of joints and couplings using Pro E. (Creo V2).

Mapping of POs & COs:

Course Outcome	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
C-15ME605.1	H	H	H	H			H	M	M			M	H	M
C-15ME605.2	H	H	M	H			H	M	M			M	H	M
C-15ME605.3	H	H	M	H			H	M	M			M	H	M
C-15ME605.4	H	H	M	H			H	M	M			M	H	M
C-15ME605.5	H	H	M	L			H	M	L			H	H	M

L : Low M: Medium H : High

Scheme for Examination:
One Question from Part A - 20 marks
One Question from Part B - 20 marks
Viva - Voce - 10 marks
Total - 50 marks

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CNC & ROBOTICS LABORATORY

Sub Code : 15ME606 **Credits 02**
Hrs/Week : 0+0+3+0 **Total Hours 39**

Course Learning Objectives:

This Course will enable students to

1. Understand the programming part using ISO codes.
2. Analyze and to write manual part programming for simple machine parts of CNC turning and machining.
3. Learn to write the manual part programming of simple components for CNC milling operation.
4. To understand the basics about the robot programming.
5. Learn the robot program for pick and place applications.

PART A – Programming & operation on CNC Lathe

- Writing manual part programming using ISO codes for machining of simple machine parts in CNC turning machine and machining the model. (4 Exercises)
- Writing manual part programming using ISO codes for machining of simple machine parts in CNC milling machine. (6 exercises).

PART B - Programming & operation of 6 axis articulated Robot

- Different methods of Programming of Robot for pick and place application (10 exercises).

Course Outcomes:

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

C-15ME606.1. Acquire the knowledge about part programming using ISO codes.
C-15ME606.2. Write the manual part programming for simple machine parts to be machined using CNC machining.
C-15ME606.3. Write the manual part programming for simple components using CNC milling.
C-15ME606.4. Know about the basics of robot programming.
C-15ME606.5. Write robot programs for pick and place applications.

Mapping of POs & COs:

Course outcome	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
C-15ME606.1		H		L			M			M			H	H
C-15ME606.2	M	H		L			M			M			H	H
C-15ME606.3	M	H		L			M			M			H	H
C-15ME606.4		H		L			M			M			M	M
C-15ME606.5	M	H		H			L			M			M	M

L : Low M: Medium H : High

Scheme for Examination:
One Question from Part A - 20 marks
One Question from Part B - 20 marks
Viva - Voce - 10 marks

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NON-TRADITIONAL MACHINING

Sub Code : 15ME611 **Credits : 03**
Hrs/Week : 3+0+0+0 **Total Hours : 39**

Course Learning Objectives:

This Course will enable students to

1. Know about non-traditional machining process, its need and importance in manufacturing. To machine hard and tough materials by using thermo-electric energy like plasma, laser and electron beam.

2. Machine brittle and soft materials by applying mechanical energy using abrasives in combination of ultrasonic energy or pressurised fluids like gas and liquids.
3. Fabricate tools and dies which are made-up of hard materials using electric discharge energy.
4. Get an idea of how electro-chemical energy is used to machine hard, tough and brittle materials with high metal removal rate.
5. Know how chemicals are used in machining complex part profiles by chemical blanking and chemical milling.

UNIT – I

INTRODUCTION: Introduction, Classification, Comparison with traditional machining, Need of NTM, Process selection and applications.

PLASMA ARC MACHINING (PAM): Introduction, Plasma generation, Machining Principle, Mechanism of Metal Removal Rate, Parameters, Plasma torch- Mode of operation, types and design of torch, Selection of gas, Process Characteristics, Working Environment & Safety precautions, Applications, Advantages & Limitations.

LASER BEAM MACHINING (LBM): Introduction, Laser Generation- Solid state pulse laser and CO_2 gas laser, Equipments, Machining Principle, Process Characteristics, Applications, Advantages & Limitations.

ELECTRON BEAM MACHINING (EBM): Introduction, Machining Principle & Equipments, Process Characteristics, Application, Advantages & Limitations. **10 Hours**

UNIT - II

ULTRASONIC, MACHINING (USM): Introduction, Machining Principle & Equipments used, Tools of USM- Tool material, Tool Size & Design of tool, Abrasives of USM- Purpose of abrasives, Abrasive materials, Selection of abrasives, Transducers, Process Characteristics, Application, Advantages & Limitations.

ABRASIVE JET MACHINING (AJM): Introduction, Machining Principle and equipments used, Elements of the Process, Process Characteristics, Application, Advantages & Limitations.

Water Jet Machining Process (WJM): Introduction, Machining Principle and equipments used, Process Details, Applications, Advantages & Limitations. **8 Hours**

UNIT – III

ELECTRICAL DISCHARGE MACHINING (EDM): Introduction, Machine setup, Dielectric Fluid, Generators, Electrode feed control, Tools used, Flushing, Process Characteristics, Applications, Electric Discharge Grinding, Wire EDM, Advantages & Limitations. **7 Hours**

UNIT - IV

ELECTROCHEMICAL MACHINING (ECM): Introduction, Machine setup, Electrolyte and its system, Process Characteristics, Process Capability, Types of tools, Tool and Insulation materials, Tool size, Handling of Slug, Applications- Cavity Sinking, Drilling & Trepanning, Electro-Chemical turning, Electro-Chemical Sawing & Cutting, Electro-Chemical honing, Electro-Chemical Deburring and Electro-Chemical Grinding, Economics of ECM, Advantages & Limitations. **8 Hours**

UNIT – V

CHEMICAL MACHINING (CHM): Introduction, CHM Technique, Classification, Maskant.

Chemical Blanking: Process steps, Process Characteristics, Applications, Advantages & Limitations.

Chemical Milling: Process steps, Process Characteristics, Applications, Advantages & Limitations. **6 Hours**

Course Outcomes:

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

C-15ME611.1. Outline and classify different Non-Traditional Machining processes and its comparison with traditional machining processes.
C-15ME611.2. Explain and compare different mechanical energy based machining processes.
C-15ME611.3. Demonstrate the use of electrical and chemical energy in machining processes.
C-15ME611.4. Explain the significance, use and application of electrochemical machining process.
C-15ME611.5. Summarize the salient characteristics of chemical machining process.

Mapping of POs & COs:

Course Outcome	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
C-15ME611.1	H	H	-	M	L	-	H	M	L	H	L	H	M	H
C-15ME611.2	H	M	M	H	M	L	M	L	-	L	-	M	M	H
C-15ME611.3	H	M	M	H	M	L	M	L	-	L	-	M	M	H
C-15ME611.4	H	M	M	H	M	L	M	L	-	L	-	M	M	H
C-15ME611.5	H	M	M	H	M	L	M	L	-	L	-	M	M	H

L : Low M: Medium H : High

TEXT BOOKS:

1. Modern machining process, Pandey and Shah, Tata McGraw Hill 2000.
2. Production Technology: HMT Tata McGraw Hill 2001.

REFERENCE BOOKS:

1. Advanced Machining process, V.K Jain,2007.
2. New Technology, Bhattacharya 2000.

3. Modern Machining Process, Aditya 2002.
4. Non-Conventional Machining, P.K. Mishra, The Institution of Engineers (India) Test book series, Narosa Publishing House 2005.
5. Metals Handbook: Machining- Volume 16.
6. Nontraditional Machining Processes, E. Weller, Society of Manufacturing, 2 Sub edition (1984).

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MANAGEMENT INFORMATION SYSTEM

Sub Code : 15ME612 **Credits : 03**
Hrs/Week: 3+0+0+0 **Total Hours : 42**

Course Learning Objectives:

This course will enable students to:

1. Understand the basics of business information systems.
2. Discuss the various available information technologies and know both hardware and software applications.
3. Understand the basics of data resource management and business applications.
4. Understand and apply the concept of e-business.
5. Understand various management challenges and managing global systems.

UNIT – I

FOUNDATION CONCEPTS: Foundations of Information Systems in Business Information System and Technologies, Business applications, developments and management, competing with Information Technology using Information Technology for strategic advantage**.**

7 Hours

UNIT – II

REVIEW OF INFORMATION TECHNOLOGIES: Computer Hardware – computer systems, end user and enterprise computing, computer peripherals, input, output, and storage technologies, Computer Software- application software, end user application, system software, computer system management.

7 Hours

UNIT – III

DATA RESOURCE MANAGEMENT: Managing Data Resources, Technical foundations of Database Management, Telecommunication and Networks – overview of telecommunications and networks, technical telecommunications alternatives.

5 Hours

BUSINESS APPLICATIONS: The Internet worked E. business Enterprise, The Internet, Intranets and Extranets in Business, Enterprises Communication and Collaboration, Electronic Business Systems, Cross Functional E-Business systems, Functional E-Business

systems, Electronic Commerce systems, Electronics commerce fundamentals, commerce applications and Issues. **5 Hours**

UNIT – IV

BUSINESS DECISION: E –Business Decision Supports Systems for decision support, executive support systems, group decision support system, Artificial Intelligence Technologies in Business **5 Hours**

DEVELOPMENT PROCESSES: Developing E-Business strategies, E-Business planning fundamentals, implementing E-Business strategies, Developing E-Business solutions – Developing E-Business systems, Implementing E-Business systems. **5 Hours**

UNIT – V

MANAGEMENT CHALLENGES: Security and Ethical challenges of E-Business – Security, Ethical and Societal challenges of E-Business, security management of E –Business, Enterprise and Global management of E-Business Technology – Managing E-Business Technologies, Global E-Business, Technology Management. **5 Hours**

MANAGING GLOBAL SYSTEMS: Growth of International Information Systems, Organizing International Information Systems, Managing Global systems, Off/Outsourcing, Global Value chain, Case Studies. **3 Hours**

Course Outcomes:

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

C-15ME612.1. Recall the basics of business information systems.
C-15ME612.2. Discuss the various available information technologies and hardware & software applications.
C-15ME612.3. Apply data resource management and explain various business applications.
C-15ME612.4. Illustrate the concept of e-business.
C- 5ME612.5. Discuss the various management challenges and management of global systems.

Course Articulation Matrix:

CO	PO 1	PO2	PO 3	PO 4	PO 5	PO 6	PO7	PO8	PO 9	PO 10	PO 11	PO12	PSO 1	PSO 2
C15ME612.1	H	H	L	M	L	L					H	M	M	M
C15ME612.2	M	H	L	H	L	L					M	M	M	M
C15ME612.3	H	M	L	M	L	L					H	M	M	M
C15ME612.4	M	H	L	L		L					H	L	M	M
C15ME612.5	H	H	L	M	M	M					M	M	L	M

L : Low M: Medium H : High

TEXT BOOKS:

1. Management Information Systems, managing information Technology in the Internet Worked Enterprise, Jams, A O'Braien - McGraw Hill publishing company Ltd., 2002. 5th edition ISBN 0-07048637-9
2. Managing information systems, W.S. Jawadekar, Tata McGraw Hill publishing Co. Ltd., New Delhi 1998. ISBN 0-07-463197-9

REFERENCE BOOKS:

1. Management Information Systems, Laudon & Laudon, PHI 1998 Ed. ISBN 81-203-1282-1
2. Management Information systems, S. Sadagopan, Prentice Hall of India, 1998 Ed. ISBN 81-203-1180-9
3. Information systems for Modern Management G.R.Murdick, PHI 2002.

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DESIGN FOR MANUFACTURING AND ASSEMBLY

Sub Code : 15ME613	**Credits : 03**
Hrs/Week : 3+0+0+0	**Total Hours : 42**

Course Learning Objectives:

This Course will enable students to

1. Know the basics of material selection and material selection by DFM approach.
2. Apply statistical method to determine process capability.
3. Understand the basics of tolerances.
4. Redesign cast members using weldments.
5. Understand the use of tolerance worksheets and centrality analysis.

UNIT – I

Selection of materials and processes: Phases of design - General requirements, material and process selection, effect of material properties and manufacturing process on design-- The material selection process- DFM approach, DFM guidelines. **8 Hours**

UNIT – II

Product design for manual assembly, automatic assembly and robotic assembly, Computer aided DFMA. Process capability, mean, variance, skewness, kurtosis, process capability metrics, Cp, Cpk, Cost aspects, feature, tolerances. **8 Hours**

UNIT – III

Geometric tolerances, surface finish, review of relationship between attainable tolerance grades and different machining process, cumulative effect of tolerances, sure fit law, normal law and truncated normal law, Selective assembly. Datum Systems-Feature location, Comparison between co-ordinate and convention method of feature location, tolerancing and true position tolerancing, virtual size concept, floating and fixed fasteners, projected tolerance zone, assembly with gasket, zero true position tolerance, functional gauges, paper layout gauging, compound assembly, examples **10 Hours**

UNIT – IV

Redesign of castings based on parting line considerations, minimizing core requirements, redesigning cast members using weldments, use of welding symbols. Operation sequence for typical shaft type of components, preparation of process drawings for different operations. **8 Hours**

UNIT – V

Tolerance worksheets and centrality analysis, examples. Design features to facilitate machining, datum features - functional and manufacturing, component design machining considerations, redesign for manufacture, examples. **8 Hours**

Course Outcomes:

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

C15ME613.1. Know the basics of material selection and using DFM approach.

C15ME613.2. Apply statistical methods to determine process capability.

C15ME613.3. Know the basics of tolerances and its application.

C15ME613.4. Discuss redesign of cast members using weldments.

C15ME613.5. Analyse tolerance worksheets and apply centrality analysis.

Mapping of POs & COs:

CO	PO 1	PO2	PO 3	PO 4	PO 5	PO 6	PO7	PO8	PO 9	PO 10	PO 11	PO12	PSO1	PS 2
C15ME613.1	H	L	L	L	L				L		L	M	M	M
C15ME613.2	M	M	L	H	L						L	M	M	M
C15ME613.3	M	M	L	M							L	M	M	M
C15ME613.4	H	H	M	L	M				M	M	L	L	M	M
C15ME613.5	H	H	M	M	M				M		L	M	M	M

L : Low M: Medium H : High

TEXT BOOK:

1. *Harry Peck, 'Designing for Manufacture', Pitman Publications,* 1983.

REFERENCE BOOKS:

1. *Creveling,* CM., *'Tolerance Design* - A *Hand Book for Developing Optimal Specifications', Addison Wesley Longman, Inc,* 1997.
2. *James* G. *Bralla, 'Design for Manufacturability Handbook', McGraw-Hill Publications,* 1999.

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RAPID PROTOTYPING TECHNOLOGY

Sub Code : 15ME614	**Credits : 03**
Hrs/Week : 3+0+0+0	**Total Hours: 42**

Course Learning Objectives:

This course will enable students to:

1. Understand the history and needs of rapid prototyping with basic concepts of data preparation.
2. Understanding the process of laser sintering and fusion deposition modeling.
3. Know about 3-D printing methods.
4. Understand various methods of rapid tooling.
5. To understand and apply various softwares for rapid prototyping.

UNIT – I

INTRODUCTION: Need for the compression in product development, history of RP systems, Survey of applications, Growth of RP industry, and classification of RP systems. **STEREO LITHOGRAPHY SYSTEMS**: Principle, Process parameter, Process details, Data preparation, data files and machine details, Application. **10 Hours**

UNIT – II

SELECTIVE LASER SINTERING: Type of machine, Principle of operation, process parameters, Data preparation for SLS, Applications. **FUSION DEPOSITION MODELLING**: Principle, Process parameter, Path generation, Applications.

8 Hours

UNIT – III

SOLID GROUND CURING: Principle of operation, Machine details, Applications. Laminated Object Manufacturing: Principle of operation, LOM materials. Process details, application.

CONCEPTS MODELERS: Principle, Thermal jet printer, Sander's model market, 3-D printer. Genisys Xs printer HP system 5, object Quadra systems. **8 Hours**

UNIT – IV

RAPID TOOLING: Indirect Rapid tooling, Silicone rubber tooling, Aluminum filled epoxy tooling, Spray metal tooling, Cast kirksite, 3Q keltool, etc. Direct Rapid Tooling Direct. AIM. **RAPID TOOLING:** Quick cast process, Copper polyamide, Rapid Tool, DMILS, Prometal, Sand casting tooling, Laminate tooling soft Tooling vs. hard tooling.

8 Hours

UNIT - V

SOFTWARE FOR RP: STL files, Overview of Solid view, magics, mimics, magic communicator, etc. Internet based software, Collaboration tools.

RAPID MANUFACTURING PROCESS OPTIMIZATION: factors influencing accuracy. Data preparation errors, Part building errors, Error in finishing, influence of build orientation.

8 Hours

Course Outcomes:

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

C-15ME614.1. Demonstrate the need for rapid prototyping systems.
C-15ME614.2. Explain the process of laser sintering and fusion deposition modeling.
C-15ME614.3. Know about 3-D printing methods.
C-15ME614.4. Make use of various methods of rapid tooling.
C-15ME614.5. Apply various software for rapid prototyping.

Course articulation matrix

CO	PO 1	PO2	PO 3	PO 4	PO 5	PO 6	PO7	PO8	PO 9	PO 10	PO 11	PO12	PSO 1	PSO 2
C15ME614.1	H	H	L	M	L	L					H	M	M	M
C15ME614.2	M	H	L	H	L	L					M	M	M	M
C15ME614.3	H	M	L	M	L	L					H	M	M	M
C15ME614.4	M	H	L	L		L					H	L	M	M
C15ME614.5	H	H	L	M	M	M					M	M	L	M

L : Low M: Medium H : High

TEXT BOOKS:

1. **Stereo Lithography and other RP & M Technologies,** Paul F. Jacobs: SME, NY 1996.
2. **Rapid Manufacturing,** Flham D.T & Dinjoy S.S Verlog London 2001.

REFERENCE BOOKS:

1. **Rapid Prototyping,** Terry Wohlers Wohler's Report 2000" Wohler's Association 2000.
2. **Rapid Prototyping Materials,** Gurumurthi, IISc Bangalore.
3. **Rapid Automated,** Lament wood. Indus press New York

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DESIGN PRACTICES OF JIGS & FIXTURE

Sub Code : 15ME615 **Credits : 03**
Hrs/Week : 3+0+0+0 **Total Hours : 39**

Course Learning Objectives:

This course will enable students to:

1. Understand the various pneumatic and hydraulic actuation systems.
2. Understand the various types of jigs.
3. To know the functions of various fixtures and press tools.
4. Students must be able to apply some design concepts in various kinds of dies.
5. The project work will enhance the knowledge to design jigs and fixtures.

UNIT – I

Locating and clamping devices-Design Principles of Jigs and Fixtures-Locating principles-Locating elements-Standard parts-Clamping devices- Mechanical actuation, Pneumatic & hydraulic actuation, Analysis of clamping forces. **7 Hours**

UNIT – II

Jigs-Drill bushes, Different types of Jigs-Plate latch, channel, box, post, angle plate, angular post, turnover, pot jigs. Automatic drill jigs, Rack & Pinion Operated jigs, Air operated Jigs and Components. Design and development of Jigs for given components. **8 Hours**

UNIT – III

Fixtures: General principles of boring, lathe, milling, broaching, Grinding, and shaping fixtures. Assembly, Inspection and welding fixtures. Modular fixtures. Design and development of Fixtures for given components, Press tools: Press working terminology Presses and Press accessories, Computation of capacities and tonnage requirements.

8 Hours

UNIT – IV

Design concepts of the following elements of progressive and combination dies, Selection of standard die sets. Strip layout and development. Design and development of Compound, Progressive and Combination dies. **8 Hours**

UNIT - V

Term project: Submission of an Industrial report on observation/ training in Jigs, Fixture and Press Tools.
(Not for end-semester examination; to be considered for internal assessment only). **8 Hours**

Course outcomes:

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

C15ME615.1. Recall the fundamental principles of location and clamping.
C15ME615.2. Contrast between the various types of jigs.
C15ME615.3. Compare the functions of various fixtures and press tools.
C15ME615.4. Design various kinds of dies.
C15ME615.5. Develop a jig or a fixture applying the fundamental principles.

Course articulation matrix

CO	PO 1	PO2	PO 3	PO 4	PO 5	PO 6	PO7	PO8	PO 9	PO 10	PO 11	PO12	PSO 1	PSO 2
C15ME615.1	L	L	L	M							L	M	M	M
C15ME615.2	M	M	L	H							L	M	M	M
C15ME615.3	M	M	L	M							L	M	M	M
C15ME615.4	H	H	M	L							L	L	M	M
C15ME615.5	H	H	M	M							L	M	M	M

L : Low M: Medium H : High

TEXTBOOKS:

1. *Kempster* M H, *'An Introduction to Jigs and tool design', ELBS,* 1976.
2. *Palquin and Crowley, 'Die design fundamentals', Industrial Press, New York,* 1979.

REFERENCE BOOKS:

1. *ASTME, 'Fundamentals of Tool Design', Prentice Hall,* 1983.
2. *Donaldson,* G H *Lecain, Goold V V. Tool design', Tata McGraw-Hili Publishing Company Limited,* 1976.
3. *'Design Data Book', PSG College of Technology.*
4. *A K. Goroshkin, 'Jigs and Fixtures Handbook', Mir, Moscow,* 1983.
5. *'Die Design Handbook', McGraw-Hili,* 1965.
6. *P Eugene Ostergaard, 'Basic Die Making',* Mc *Graw-Hill,* 1963.
7. *Kurt Lunge, 'Handbook of Metal forming', McGraw-Hill* 1985.

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DESIGN OF THERMAL SYSTEMS

Sub Code : 15ME616 **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 thermal systems.
2. To apply the approach of system simulation for thermal systems.
3. To know the various optimization and search methods for thermal systems.
4. Understand dynamic and geometric programming.
5. To apply techniques of mathematical modeling and steady state simulation for large systems.

UNIT - I

Designing a Workable System: Workable and optimum systems, Steps in arriving at a workable system, Creativity in concept selection, Workable Vs Optimum system, designing of a food freezing plant

Modeling of thermal systems: Importance of Modeling in Design, Basic Features of Modeling. Types of Models, Modeling of counter flow heat exchanger, Evaporators and Condensers, Heat exchanger effectiveness.

Equation Fitting: Mathematical modeling, Polynomial representation, Functions of two variables, Exponential forms, Best fit Method of least squares **8 Hours**

UNIT - II

System Simulation: Importance of Simulation, Different Classes, Flow of Information, Information flow diagrams. Methods for Numerical Simulation, Distributed Systems, Sequential and simultaneous calculations, Successive substitution, Newton-Raphson method, sizing of systems like fan-duct. **8 Hours**

UNIT - III

Optimization, Calculus Methods, Search Methods, Linear Programming, Types of Thermal Systems, Examples Practical Aspects in Optimal Design Choice of Variables for Optimization.

Lagrange Multipliers: Introduction to Calculus Methods, The Lagrange Multiplier Method Basic Approach, Physical Interpretation, Significance of the Multipliers. Optimization of Constrained Problems, Applicability to Thermal Systems, Use of Curve Fitting Examples, Inequality Constraints, Some Practical Considerations, Computational Approach. **8 Hours**

UNIT - IV

Dynamic Programming: Characteristic of the Dynamic programming solution, apparently constrained problem, Geometric Programming, degree of difficulty, mechanics of solution for one independent variable, un constrained. Theory behuing geometric programming, unconstrained multivariable solution's. **7 Hours**

UNIT - V

Mathematical Modeling: Thermodynamic Properties-Need for mathematical modeling, Criteria for fidelity of representation, Linear regression analysis, Internal energy and enthalpy, Pressure temperature relationship at saturated `conditions, Specific heat, P- V-T Equations Overview of various technologies and conventional methods of energy conversion, Power cycles. **8 Hours**

Course Outcomes:

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

C15ME616.1. Explain the basics of thermal systems.
C15ME616.2. Simulate thermal systems.
C15ME616.3. Evaluate various optimization and search methods for thermal systems.
C15ME616.4. Illustrate dynamic and geometric programming.
C15ME616.5. Apply techniques of mathematical modeling and steady state simulation for large systems.

Course articulation matrix

CO	PO 1	PO2	PO 3	PO 4	PO 5	PO 6	PO7	PO8	PO 9	PO 10	PO 11	PO12	PSO 1	PSO 2
C15ME616.1	M	M	M	L	M	L	L	L	L	L	L	M	M	M
C15ME616.2	L	M	L	L	H	L	L	L	L	L	L	M	H	M
C15ME616.3	H	H	M	M	L	L	L	L	L	L	L	M	M	H
C15ME616.4	M	M	M	L	H	L	L	L	L	L	L	L	H	M
C15ME616.5	L	L	M	L	M	L	L	L	L	L	L	M	M	M

L: Low M: Medium H: High

TEXT BOOK:

1. W F Stoecker, Design of Thermal Systems, 3rd Edition, Mc Grow Hill, Malaysia, 1989.
2. Design and optimization of thermal systems, Y.Jaluria, McGraw Hill, 1998.
3. Thermal Design and Optimization, Adrian Bejan, George Tsatsaronis, Michael Moran, John
4. Wiley and Sons, 1995.
5. Elements of thermal fluid system design, L.C. Burmeister, Prentice Hall, 1998.

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RENEWABLE SOURCES OF ENERGY

Sub Code : 15ME617 **Credits 03**
Hrs/Week : 3+0+0+0 **Total Hours 39**

Course Learning Objectives:

This Course will enable students to

1. Identify different sources of Renewable energies and their possible use for the welfare of the Mankind.
2. Study the Conversion technologies, pros and cons, and application of
   i) solar energy
   ii) biomass energy
   iii) wind energy
   iv) geothermal energy
   v) ocean energy
   vi) tidal energy
   vii) wave energy
   viii) energy from fuel cells.

UNIT - I

Energy sources- Introduction, Classification of Energy Resources; Conventional Energy Resources - Availability and their limitations; Non-Conventional Energy Resources – Classification, Advantages, Limitations; Comparison of Conventional and Non-Conventional Energy Resources;

Solar energy: Introduction, Solar Constant, Basic Sun-Earth Angles – definitions and their representation, Solar Radiation Geometry (numerical problems), Estimation of Solar Radiation of Horizontal and Tilted Surfaces (numerical problems); Measurement of Solar Radiation Data – Pyranometer and Pyrheliometer.

Principle of Conversion of Solar Radiation into Heat through

- Flat Plate Collectors (Liquid flat plate collector), Effect of various parameters on the performance, testing procedure.
- Concentrating collectors – Introduction, cylindrical, parabolic collector, Compound parabolic collector, Central receiver collector.

8 Hours

UNIT - II

Solar thermal applications - Solar pond, Solar Air heater, Solar Water heater, solar power generation, solar space cooling and refrigerator, solar distillation, solar drying, solar cooking, solar pumping, solar furnace. Solar photo Volatics.
Solar thermal energy storage – Introduction, Sensible, Latent and thermo Chemical storage, numerical problems. **8 Hours**

UNIT – III

Biomass Energy- Introduction, Photosynthesis process, Biomass fuels, Biomass conversion technologies, Biomass Gasification, Biomass to Ethanol Production, Biogas production, factors affecting biogas generation, types of biogas plants. **4 Hours**

Wind Energy: Introduction, Power of wind energy, conversion systems, and types of wind machines, performance of wind machines with numerical problems, applications and prospects in India. **4 Hours**

UNIT – IV

Tidal Power- Introduction, causes for tide formation, power of tide, numerical problems tidal power plants, advantages and limitations.

3 Hours

Ocean Thermal Energy – Introduction to O.T.E.C., open and closed cycle OTEC systems, prospects in India.

2 Hours

Wave Energy– Introduction, power of wave energy, numerical problems, conversion devices.

3 Hours

UNIT – V

Geothermal Energy- Introduction, types of geothermal resources, methods of harnessing, geothermal energy applications, environmental problems and prospects in India. **3 Hours**

Fuel Cells- Introduction, Principle and operation of fuel cells, classification and types of fuel. Fuel for fuel cells, performance characteristics of fuel cells, application of fuel cells Energy

4 Hours

Course Outcomes:

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

C15ME617.1. Recognize the need of renewable energy technologies and their role in the world energy demand.
C15ME617.2. Describe the principles of renewable energy production from various sources
C15ME617.3. Explain the technological basis for harnessing renewable energy sources
C15ME617.4. Describe the main components of different renewable energy systems
C15ME617.5. Compare the pros and cons of various renewable energy technologies and propose the best possible energy conversion system for a particular location

Course articulation matrix

CO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
C15ME617.1	H	H	H	M	L	L	M	L	L	L	L	H	H	H
C15ME617.2	M	M	H	M	L	M	H	L	L	L	L	H	M	M
C15ME617.3	H	H	H	M	L	M	H	L	L	H	L	H	H	H

C15ME617.4	H	H	H	M	L	M	M	L	L	M	L	H	M	L
C15ME617.5	H	H	H	M	L	H	H	L	L	H	L	H	M	M

L : Low M: Medium H : High

TEXT BOOKS:

1. Renewable Energy Sources by Twidal& Weirs. Taylor & Francis, 2006
2. Boyle, G. 2004. Renewable energy: Power for a sustainable future. Oxford University press, Oxford, UK

REFERENCE BOOKS:

1. Solar Energy by Dr. S.P.Sukhatme Tata McGraw Hill. 2008
2. Solar Energy utilization by G.D. Rai Khanna Publishers. 2004
3. Non Conventional Energy Sources by G.D.Rai.- Khanna Publishers. 2011
4. Power Plant Engineering by Arora, Domkundwar. Dhanpat Rai & Sons. 1999
5. Energy Technology (Non Conventional& Conventional) by S. Rao, Dr. B.B.Parulekar Khanna Publishers, third edition 2013

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INTRODUCTION TO AIRCRAFT DESIGN

Sub Code : 15ME618 **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 Aerospace Industry. and understand the Basics of Aircraft and Aircraft Structures.
2. Understand basic principles of flight.
3. Appreciate the basic mechanics of flight.
4. Classify and appreciate the different aircraft design configurations, and aircraft systems
5. Appreciate the importance of different aircraft systems and subsystems

UNIT - I

Chapter-1- Aircraft industry overview

Evolution and History of Flight, Types Of Aerospace Industry, Key Players in Aerospace Industry, Aerospace Manufacturing, , Prime contractors, Tier 1 Suppliers, Aerospace industry trends, Global and Indian Aircraft Scenario.

3 Hours

Chapter-2 - Aircrafts Classification and Structure

Basic components of an Aircraft, Structural members, Aircraft Axis System, Aircraft Motions, Forces on the airplane, Control surfaces, Types of Aircrafts - Lighter than Air/Heavier than Air Aircrafts **3 Hours**

UNIT - II

Chapter 3- Basic Principles of Flight

Properties of Atmosphere, Air speed and Ground Speed, Bernoulli's Equation, Measurement of air speed, Types of air speeds, Airflow over wing section, Pressure Distribution over a wing section, Center of Pressure and its effects, Definitions of lift, drag and angle of attack, Generation of Lift, Factors affecting lift, Lift curve, Drag, Types of Drag, Drag Curve, Lift/Drag Ratio Curve, Pitching moment, stalling.

Aerofoil Nomenclature, Types of Aerofoil, Wing Section- Aerodynamic Center, Aspect Ratio, High lift devices(flaps and slats), Effect of flaps and slats on lift, drag and angle of attack.

Significance of speed of Sound, Mach Numbers, Mach Waves, Mach Angles, Shock Waves, Sonic and Supersonic Flight and its effects.

10 Hours

UNIT – III

Chapter 4- Basics of Flight Mechanics

Stability and Control: Meaning of stability, Definitions of static and dynamic stability, Types of static stability- Lateral, Longitudinal and Directional Stability, Maneuverability , Control Tabs, Landing, Gliding, Turning- Forces acting on a Aeroplane during a Turn, Loads during a Turn, Correct and incorrect Angles of Bank.

Aircraft Performance : Power Curves, Maximum and minimum speeds of horizontal flight, Effects of Changes of Engine Power, Effects of Altitude on Power Curves.

Maneuvers : Aerobatics – Loop, spin, Inverted Maneuvers – inverted loop.

8 Hours

UNIT – IV

Chapter 5- Aircraft Design configurations

Conventional Design Configurations based on Power Plant Location, Wing vertical location, intake location, Tail Unit Arrangements, Landing Gear Arrangements. Unconventional Configurations-Biplane, Variable Sweep, Canard Layout, Twin Boom Layouts, Span loaders, Blended Body Wing Layout, STOL and STOVL Aircraft, Stealth Aircraft. Advantages and disadvantages of these Configurations. **3 hours.**

Chapter – 6 Aircraft Systems Types of Aircraft Systems, Classification, Engine Control Systems, Types of engines- Turbo jet, Turbo fan and Turbo prop, Fuel systems, Hydraulic systems – open and closed loop hydraulic system.

4 Hours

UNIT - V

Chapter 7- Aircraft Systems - Continued

Landing gear systems, Ice and rain protection systems, Cabin Pressurization and Air-Conditioning Systems, Steering and Brakes Systems Auxiliary Power Unit, Environmental control systems (ECS), Brief overview of Electrical and Electronic Systems and Avionics.

7 Hours

Course Outcomes:

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

C- 5ME618.1. Get an exposure to the Aerospace Industry. and understand the Basics of Aircraft and Aircraft Structures.

C-15ME618.2. Understand basic principles of flight.
C-15ME618.3. Appreciate the basic mechanics of flight.
C-15ME618.4. Classify and appreciate the different aircraft design configurations, and aircraft systems
C- 5ME618.5. Appreciate the importance of different aircraft systems and subsystems

Mapping of POs & COs:

Course outcome	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO 1	PSO 2
C-15ME618.1	L	L	L	L	L	M	M	H	M	H	M	M	M	L
C-15ME618.2	H	M	M	L	M	M	M	M	L	M	M	M	L	H
C-15ME618.3	H	M	M	L	M	M	H	H	L	M	M	M	L	H
C-15ME618.4	H	H	M	H	M	M	M	H	H	M	H	M	H	L
C-15ME618.5	M	M	M	H	M	M	M	H	H	H	H	M	L	L

L : Low M: Medium H : High

TEXT BOOKS:

1. Flight without Formulae by A.C Kermode, Pearson Education,10th Edition.
2. Mechanics of Flight by A.C Kermode, Pearson Education, 5thEdition.

REFERENCE BOOKS:

1. Introduction to Flight by Dave Anderson
2. Aircraft Systems: Mechanical, Electrical and Avionics Subsystems Integration by Ian Moir, Allan Sea Bridge.
3. Fundamentals of Flight, Shevell, Pearson Education, 2nd Edition.

Web resources

1. http://www.aero.org/
2. http://www.rl.af.mil/rrs/resources/griffiss_aeroclub/aircraft.html
3. http://ameslib.arc.nasa.gov/randt/1999/aero/aero.html
4. http://www.ctas.arc.nasa.gov/project_description/pas.html
5. http://www.moog.com/noq/_acoverview c463/
6. http://www.dcmt.cranfield.ac.uk/aeroxtra/e339.htm
7. http://www.aeromech.usyd.edu.au/structures/as/acs1-p4.htm
8. http://www.av8n.com/how/htm/xref.html

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PRODUCT DESIGN & DEVELOPMENT

Sub Code :15ME619 **Credits : 03**
Hrs/Week : 1+0+2+0 **Total Hours : 39**

Course Learning Objectives:

This course will enable students to:

1. Understand the various types and processes of product development and opportunity identification.
2. Understand the product development planning and specifications.
3. Acquire skill in concept generation, selection and testing.
4. To know product architecture, need for industrial design and life cycle of a product.
5. To design the prototype and overview of patents and intellectual property right.

UNIT – I

Introduction: Introduction to product development, importance, types of product development, advantages of structured methods.
Development Processes and organizations: Product development process, product development organizations.
Discussion: How offshore team supporting product development.
Opportunity Identification: Process of opportunity identification in various industries.
Activity: Implementation of bug list. **7 Hours**

UNIT – II

Product planning: Product development opportunities, market competition, technology portfolio planning, mission statement.
Activity and discussion.

Product specifications: Introduction, importance of specification, establishing target specifications, setting final specifications.

Activity / Project: Students to establish specification for 2 wheeler bike for 18 – 24 years
8 Hours

UNIT – III

Concept generation: Introduction, Process and Practice
Activity / Project: Vegetable peeler
Concept selection: Introduction, concept screening, concept scoring
Activity / Project:
Concept testing: Overview, purpose, process of survey
Activity / Project: **8 Hours**

UNIT – IV

Product Architecture: Overview of product architecture, establishing architecture, factors affecting product architecture, planning and design issues
Activity / Project:

Industrial Design: Overview, need for industrial design, industrial design process, discussion with guest lecture
Design for Environment: Introduction, life cycle of a product, life cycle assessment
Activity / Project: LCA of shoes and packaging to minimize the damage
Design for Manufacturing: Overview / introduction, DFM principles
Activity: DFM Exercise **8 Hours**

UNIT - V

Prototyping: Overview / introduction, prototyping methods, finishing of prototypes, discussion
Robust design: Overview / introduction, identify control factors, noise factors and performance metrics, developing and running experimental plan, conduct the analysis.
Activity:
Patents and Intellectual Property: Overview / Introduction, patents & IP
Discussion: Indian process of filing a IP / Design patent **8 Hours**

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

C15ME619.1. Acquire the basic knowledge of product development.
C15ME619.2. Contrast between development and planning.
C15ME619.3. Outline the fundamentals of concept generation, selection and testing.
C15ME619.4. Demonstrate product architecture, industrial design and life cycle of a product.
C15ME619.5. Develop a prototype and acquire basic knowledge about patents and intellectual property.

Course articulation matrix

CO	PO 1	PO2	PO 3	PO 4	PO 5	PO 6	PO7	PO8	PO 9	PO 10	PO 11	PO12	PSO 1	PSO 2
C15ME619.1				M				H	H	H	M	L	M	M
C15ME619.2				M				H	H	H	M	L	H	M
C15ME619.3			M	H				M	M	H	M	L	M	H
C15ME619.4			M	M				M	H	H	M	L	H	M
C15ME619.5		H	M	M			M	M		M	M	L	M	M

L: Low M: Medium H: High

TEXTBOOKS:

1. Karl T Ulrich, Steven D Eppinger, Anita Goyal, "Product Design and Development", Tata McGraw-Hill, 2009.
2. Kevin Otto and Kristin Wood, "Product design"- Pearson, 2004

3. Mike Ashby, Kara Johnson, "Materials and Design: The Art and Science of Material Selection in Product Design", Butterworth Heinemann, 2009.
4. Edward Magrab, "Integrated product and process design and Development", CRC Press, 2009.

REFERENCE BOOKS:

1. Chitale A.K, Gupta R.C, "Product Design and Manufacturing", Prentice Hall Of India, 2009.
2. Lal G.K, Vijay Gupta, Venkata Reddy.N, "Fundamentals of Design and Manufacturing", Narosa Book Distributors Private Limited, 2010.

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GAS DYNAMICS JET PROPULSION

Sub Code : 15ME621	**Credits : 03**
Hrs/Week: 3+0+0+0	**Total Hours: 39**

Course Learning Objectives:

This course will enable students to:

1. Calculate the mach numbers for compressible flows and understand isentropic flows in nozzles and diffusers.
2. Know the use of gas tables and charts in flow through ducts.
3. Derive the Prandtl and Meyer relations in normal and oblique shocks.
4. Understand the various propulsion engines and derive the thrust equations.
5. Students will be able to know the various space propulsion engines and various propellants.

UNIT – I

BASIC CONCEPTS AND ISENTROPIC FLOWS : Energy and momentum equations of compressible fluid flows - Stagnation states, Mach waves and Mach cone –Effect of Mach number on compressibility - Isentropic flow through variable area ducts - Nozzle and Diffusers –Use of Gas tables. **7 Hours**

UNIT – II

FLOW THROUGH DUCTS: Flow through constant area ducts with heat transfer (Rayleigh flow) and Friction (Fanno flow) - Variation of flow properties - Use of tables and charts - Generalised gas dynamics. **8 Hours**

UNIT – III

NORMAL AND OBLIQUE SHOCKS: Governing equations - Variation of flow parameters across the normal and oblique shocks - Prandtl – Meyer relations - Use of table and charts - Applications. **8 Hours**

UNIT - IV

JET PROPULSION: Theory of jet propulsion - Thrust equation - Thrust power and propulsive efficiency - Operation principle, cycle analysis and use of stagnation state performance of ram jet, turbojet, turbofan and turbo prop engines – Aircraft combustors.

8 Hours

UNIT - V

SPACE PROPULSION: Types of rocket engines - Propellants - Ignition and combustion - Theory of rocket propulsion – Performance study - Staging - Terminal and characteristic velocity - Applications - Space flights. **8 Hours**

Course Outcomes:

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

C-15ME621.1. Calculate the mach numbers for compressible flows and infer isentropic flows in nozzles and diffusers.
C-15ME621.2. Know the use of gas tables and charts in flow through ducts.
C-15ME621.3. Derive the Prandtl and Meyer relations in normal and oblique shocks.
C-15ME621.4. Evaluate the various propulsion engines and derive the thrust equations.
C-15ME621.5. Know the various space propulsion engines and propellants.

Course articulation matrix

CO	PO 1	PO2	PO 3	PO 4	PO 5	PO 6	PO7	PO8	PO 9	PO 10	PO 11	PO12	PSO 1	PSO 2
C15ME621.1	M	M	M	L	M	L	L	L	L	L	L	M	M	M
C15ME621.2	L	M	L	L	H	L	L	L	L	L	L	M	H	M
C15ME621.3	H	H	M	M	L	L	L	L	L	L	L	M	M	H
C15ME621.4	M	M	M	L	H	L	L	L	L	L	L	L	H	M
C15ME621.5	L	L	M	L	M	L	L	L	L	L	L	M	M	M

L : Low M: Medium H : High

TEXT BOOK:

1. Yahya S M " Fundamentals of Compressible Flow ", New Age International (P) Limited, New Delhi, 1996.

REFERENCE BOOKS:

1. Hill P and Peterson C, " Mechanics and Thermodynamics of Propulsion ", Addison Wesley Publishing Company, 1992.
2. Zucrow N J " Aircraft and Missile Propulsion, Vol. I and II ", John Wiley , 1975.

3. Zucrow N J " Principles of Jet Propulsion and Gas Turbines ", John Wiley, New York, 1970.
4. Cohen H , Rogers G E C and Saravanamuttoo, " Gas Turbine Theory ", Longman Group Ltd., 1980.
5. Sutton G P, "Rocket Propulsion Elements ", John Wiley, 1986, New York.
6. Shapiro A H, " Dynamics and Thermodynamics of Compressible Fluid Flow Vol.kl ",John Wiley , 1953, New York.
7. Ganesan V, " Gas Turbines ", Tata McGraw Hill Publishing Co., New Delhi, 1999.
8. Thomas E Vollman, Clay Whybark D, “Manufacturing Planning And Control For Supply Chain Management”, Tata Mcgraw-Hill, Fifth Edtition, 2005.
9. Edward B Magrab, Balakumar Balachandran,“Vibrations”, Thomson Learning, 2005.
10. Shridhara Bhat K, “World Class Manufacturing”, Himalaya Bublishing House, 2007
11. Hans Vanohain and Jack D Mattingly, ”Elements of Gas Turbine Propulsion”, TMH.

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PROJECT MANAGEMENT

Sub Code : 15ME622 **Credits : 03**
Hrs/Week : 3+0+0+0 **Total Hours: 39**

Course Learning Objectives:

This course will enable students to

1. Understand the basic concepts of project management.
2. Understand and apply the concept of network scheduling.
3. To know linear programming and network flow formulations.
4. Software for project scheduling is being understood and applied.
5. Understand the building and application of precedence diagram.

UNIT – I

Foundations of Project Management: Project Life Cycle-Project Environment-Project Selection-Project Proposal-Project Scope-Work Breakdown Structure. 7 **Hours**

UNIT – II

Network Scheduling: Critical Path Method, Program Evaluation & Review Technique-Planning and Scheduling of Activity Networks-Assumptions in PERT Modelling-Tir;ne-cost Trade-offs. **8 Hours**

UNIT – III

Linear Programming and Network Flow Formulations-PERT/COST Accounting. Scheduling with limited resources: **8 Hours**

UNIT – IV

Resource Planning-Resource Allocation-Project Schedule Compression-Project Scheduling Software. **8 Hours**

UNIT – V

Precedence Diagrams-Decision CPM-Generalized Activity Networks-GERT. Estimation of Project Costs-Earned Value Analysis. Monitoring Project Progress. Project Appraisal and Selection-Recent Trends in Project Management **8 Hours**

Course Outcomes:

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

C15ME622.1. Define the basic concepts of project management.
C15ME622.2. Apply the concept of network scheduling.
C15ME622.3. Know linear programming and network flow formulations.
C15ME622.4. Examine the role of project scheduling.
C15ME622.5. Formulate projects and calculate project completion time and cost using different tools / techniques.

Course articulation matrix

CO	PO 1	PO2	PO 3	PO 4	PO 5	PO 6	PO7	PO8	PO 9	PO 10	PO 11	PO12	PSO 1	PSO 2
C15ME622.1	L	L	M	M		M	M				H	M	M	M
C15ME622.2	M	M	M	L		M	L				M	M	H	M
C15ME622.3	H	H	H	M	L	L	M				H	M	H	H
C15ME622.4	M	M	M	L	L	H	L				H	L	M	M
C15ME622.5	H	H	H	H	H	H	L				H	M	M	M

L : Low M: Medium H : High

REFERENCE BOOKS:

1. *Meredith, Jack R and Samuel* J, *Mantel Jr., 'Project Management-* A *Managerial Approach', John Wiley,* 1995.
2. *KIastorin Ted, 'Project Management, Tools, and Trade-offs', John Wiley, 2004.* 3. *Mantel Samuel* J, *Jack R Meredith et aI,* 'Core *Concepts of Project Management', John Wiley, 2001.*

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MACHINE TOOL DESIGN

Sub Code : 15ME623 **Credits : 03**
Hrs/Week : 3+0+0+0 **Total Hours: 39**

Course Learning Objectives:

This course will enable students to:

1. Understand the basic concepts of machine tool and layouts of machine tools.
2. Know the various driving mechanisms and calculate speed ratio for various drives.
3. Design the various parts of machine tools.
4. Understand the function of guide ways and power screws and know the selection process of power screws.
5. Understand the design of bearings and know the basics of CNC machines.

UNIT – I

PRINCIPLES OF MACHINE TOOL DESIGN: General requirements of Machine Tool design, Engineering design process applied to Machine Tool, Classification of Machine Tools, Working and Auxiliary motions, Layout of Machine Tool **8 Hours**

UNIT - II

MACHINE TOOL DRIVES AND MECHANISMS: Drives – Electric drives: Induction motor, Servo motor, Selection of AC and DC servo motors, Hydraulic transmission, Regulations of speed and feeds, Stepped regulations, Standardization of speed and feed, Stepless regulation of speed and feeds, Servo drives. **8 Hours**

UNIT – III

DESIGN OF MACHINE TOOL STRUCTURES: Functions, Requirements, Design criteria Material used – Static and Dynamic Stiffness – Profile and Basic Design procedure for Machine Tool Structures, Design of Beds, Columns, Housing, Bases, Tables, Cross–rails, Arms Saddle, Carriages. **8 Hours**

UNIT – IV

DESIGN OF GUIDE WAYS AND POWER SCREWS: Functions and Classification of guide ways (V-guide, Flat guide ways), Design of slideways, Antifriction guide ways, Combination guide ways, Protecting devices for slideways, Selection of Power Screws and Recirculating Ball Screws. **8 Hours**

UNIT – V

DESIGN OF SPINDLE AND SPINDLE BEARINGS: Function – Requirements and Materials for Spindle Compliance and Machining Accuracy, Design of Spindles – Antifriction Bearing, Hydrodynamic and Hydrostatic bearing, Air lubricated bearings. **INTRODUCTION TO CNC MACHINES AND SPECIAL PURPOSE MACHINE**

(SPMS): Difference between Conventional and CNC Machine Tools. Features of CNC machines and its advantages, Purpose of SPMs with typical examples of automobile components **7 Hours**

Course Outcomes:

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

C-15ME623.1. Explain the basic concepts of machine tool and layouts of machine tools.
C-15ME623.2. Know the various driving mechanisms and calculate speed ratio for various drives.
C-15ME623.3. Design the various parts of machine tools.
C-15ME623.4. Identify the functions of guide ways and power screws and know the selection process of power screws.
C-15ME623.5. Explain the design of bearings and know the basics of CNC machines.

Course articulation matrix

CO	PO 1	PO2	PO 3	PO 4	PO 5	PO 6	PO7	PO8	PO 9	PO 10	PO 11	PO12	PSO 1	PSO 2
C15ME623.1	L	L	L	M	L	L	L	L	L	L	L	M	M	M
C15ME623.2	M	M	L	H	L	L	L	L	L	L	L	M	M	M
C15ME623.3	M	M	L	M	L	L	L	L	L	L	L	M	M	M
C15ME623.4	H	H	M	L	L	L	L	L	L	L	L	L	M	M
C15ME623.5	H	H	M	M	L	L	L	L	L	L	L	M	M	M

L : Low M: Medium H : High

TEXT BOOK:

1. **Machine Tool Design & Numerical Control, 2nd edition** N.K. Mehta, TATA Mc Graw – Hill 2005.

REFERENCE BOOKS:

1. **Machine Tool Design - Volume II and III,** N. Acharkan, MIR Publications 2000.
2. **Design and Machine Tools,** S.K. Basu and D.K.Pal 2000.
3. **Principles of Machine Tool Design,** Koenisberger, 1993.
4. **"CMTI Machine Tool Design Hand Book",** Published by Tata McGraw-Hill 1998
5. **Numerical Control of Machine Tools**, S.J. Martin.
6. **"Computer numerical controls", Yorem Koren,** McGraw-Hill-Kogakush 1998

Scheme Examination:
TWO questions to be set from each UNIT and Students shall answer **FIVE** full questions choosing at least **ONE** question from each UNIT.

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FINITE ELEMENT METHOD

Sub Code : 15ME624	**Credits : 03**
Hrs/Week : 3+0+0+0	**Total Hours : 39**

Course Learning Objectives:

This Course will enable students to

1. Define FEM, classify various elements used in FEM and study node numbering and stress strain relationships.
2. Determine the deflection and stress at various points on cantilever, simply supported and fixed beams using Rayleigh-Ritz and Galerkin's method.
3. Understand various displacement polynomials using Pascal's triangle and obtain shape functions for different elements.
4. Implement the steps required for FEM to obtain appropriate solution to a variety of physical systems (Bar and truss) and obtain engineering design parameters.
5. Make use of direct method of analysis for analyze deflection and slope in beams and stress strain relationships in plates.

UNIT – I

Introduction: Definition of FEM, General Description of FEM, Engineering applications of FEM, Discretization process, Types of Elements – 1D, 2D, 3D and Axisymmetric elements, location of nodes, node numbering scheme, boundary conditions, half band width, stiffness matrix of bar elements by direct method, properties of stiffness matrix, preprocessing, post processing. Displacement of 3D Elastic body, Differential equations of equilibrium of stresses at a point, strain displacement relations, stress – strain relations for plane stress and plane strain. **8 Hours**

UNIT – II

Principle of minimum potential energy, Rayleigh – Ritz method, Galerkins Method, Numerical Integration**.** **7 Hours**

UNIT – III

Displacement models, Pascal Triangle - displacement functions for higher order quadrilateral & triangular elements, Shape functions, Derivation of Shape function for 1D linear element, quadratic element, CST element, Convergence & its types **8 Hours**

UNIT – IV

Finite element formulation of 1D linear element, Numerical problems on bars, stepped bars - solution of displacements, reactions and stresses by using elimination approach, penalty approach. Stress and strain in plane truss by direct stiffness method, Numerical problems.

8 Hours

UNIT –V

Beams, Hermite Cubic polynomial function, Finite element formulation of beam element, Numerical problems on beams. Stress-strain analysis of 2D structural problems, Modeling of the plate continuum using triangular elements, Isoparametric formulation of CST elements. Derivation of Stress – Displacement Matrix, Derivation of Element matrices, Numerical problems. **8 Hours**

Course Outcomes:

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

C-15ME624.1. Define the concept of FEM along with its applications.

C-15ME624.2. Apply the principle of minimum potential energy for various structural problems and implement weighted residual methods for determining deformation and deflection of structural systems and also solve problems using numerical integration methods.

C-15ME624.3. Express displacement functions of various basic and higher order 1D,2D and 3D elements along with shape functions for those particular elements

C-15ME624.4. Implement the steps required for FEM to obtain appropriate solution to a variety of physical systems (Bars, truss) and obtain engineering design parameters using different boundary condition handling methods.

C- 5ME624.5. Determine the deflection and stress at various points on different types of beams and formulate 2D structural problems.

Course Articulation Matrix

CO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	P010	PO11	PO12	PSO1	PSO2
C-15ME624.1	H	H	H	M	H	-	H	M	M	-	-	-	M	H
C-15ME624.2	H	H	H	M	L	-	M	M	M	-	-	-	M	M
C-15ME624.3	H	H	H	M	L	-	H	L	M	-	-	-	H	H
C-15ME624.4	H	H	H	H	H	-	H	L	H	-	-	-	H	H
C-15ME624.5	H	H	H	H	H	-	H	L	H	-	-	-	H	H

L : Low M: Medium H : High

TEXT BOOKS:

1. Finite Element Methods, Daryl L. Logon, Thomson Learning 6th edition, 2015.
2. Introduction to Finite Elements in Engineering, Chandrupatla T. R., 4th Pearson edition, 2014.

REFERENCE BOOKS:

1. The finite element method in Engineering, S S Rao, 5th edition, 2013
2. Introduction to the Finite Element Method, C. S. Desai and J.F. Abel
3. Finite Element Analysis – Theory & Programming, Krishnamoorthy C.S
4. Numerical Methods in Finite Element Analysis, Bathe K. J & E. L Wilson

5. Higher Engineering Mathematics, B. S. Grewal
6. An Introduction to the Finite Element Method J. N. Reddy

MOOC/NPTEL Resources:

1. http://nptel.ac.in/courses/112104115/

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COMPUTATIONAL FLUID DYNAMICS

Sub Code : 15ME625	**Credits : 03**
Hrs/Week : 3+0+0+0	**Total Hours : 39**

Course Learning Objectives:

This course will enable students to:

1. Understand the basic concepts of computational dynamics and a brief solution procedure.
2. Derive the equations related to turbulent flows and understand various discretization methods.
3. Understand the solution obtained by CFD.
4. Know the areas where CFD is applicable.
5. Know the application of CFD to multiphase systems and fluid structure interaction.

UNIT – I

INTRODUCTION: Computational Fluid Dynamics, Advantages, Applications, Future of CFD.
CFD SOLUTION PROCEDURE: Problem set up-pre-process, Numerical solution – CFD solver, Result report and visualization-post-process. **8 Hours**

UNIT – II

GOVERNING EQUATIONS FOR CFD: Introduction, the continuity equation, the momentum equation, the energy equation, the additional equations for turbulent flows, generic form of the governing equations for CFD, boundary conditions. **CFD TECHNIQUES:** Introduction, Discretization of governing equations, Finite difference method, Finite volume method, converting governing equations to algebraic equation system, Numerical solutions. **9 Hours**

UNIT - III

CFD SOLUTION ANALYSIS: Introduction, consistency, stability, convergence, accuracy, efficiency, case studies. **PRACTICAL GUIDELINES FOR CFD:** Introduction, grid generation, boundary conditions, turbulent modeling. **8 Hours**

UNIT - IV

APPLICATIONS OF CFD: Introduction, CFD as a design tool, indoor air flow distribution, CFD as a research tool, CFD applied to heat transfer coupled with fluid flow, buoyant free standing fire, flow over vehicle platoon, air/particle flow in human nasal cavity, high speed flows. **8 Hours**

UNIT - V

ADVANCED TOPICS IN CFD: Introduction, advances in numerical methods and techniques – incompressible flows, compressible flows, moving grids, multigrid methods, parallel computing, immersed boundary methods. Advances in computational methods – DNS, LES, RANS-LES coupling for turbulent flows, multiphase flows, combustion, fluid-structure interaction, physiological fluid dynamics and other numerical approaches.

6 Hours

Course Outcomes:

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

C-15ME625.1. Apply the basic concepts of computational dynamics.
C-15ME625.2. Derive the equations related to turbulent flows and understand various discretization methods.
C-15ME625.3. Estimate the solution s for problems using CFD.
C-15ME625.4. Outline the areas where CFD is applicable.
C-15ME625.5. Examine the application of CFD to multiphase systems and fluid structure interaction.

Course articulation matrix

CO	PO 1	PO2	PO 3	PO 4	PO 5	PO 6	PO7	PO8	PO 9	PO 10	PO 11	PO12	PSO 1	PSO 2
C15ME625.1	M	M	M	L	M	-	-	-	-	-	L	M	M	M
C15ME625.2	L	M	L	L	H	-	-	-	-	-	L	M	H	M
C15ME625.3	H	H	M	M	L	-	-	-	-	-	L	M	M	H
C15ME625.4	M	M	M	L	H	-	-	-	-	-	L	L	H	M
C15ME625.5	L	L	M	L	M	-	-	-	-	-	L	M	M	M

L : Low M: Medium H : High

TEXT BOOKS:

1. **Computational Fluid Dynamic – a practical approach,** Jiyuan Tu, Guan Heng Yeoh and Chaoqun Liu, Butterworth-Heinemann (ELSEVIER), 2008.
2. **Introduction to Computational Fluid Dynamics**, Pradip Niyogi, S.K. Chakrabarthy and M.K. Laha, Pearson Education, 2006.

REFERENCE BOOKS:

1. **An introduction to CFD,** H. Versteeg and W. Malalasekra, Pearson, Education, 2nd Edition, 2008.
2. **Introduction to Computational Fluid Dynamics,** Anil W. Date, Cambridge University press, 2007.
3. **Computational Fluid Dynamics – The basics and applications**, Anderson J.D. Jr, (1995), Mcgraw-Hill, New York.

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ORGANIZATIONAL BEHAVIOR & PROFESSIONAL ETHICS

Sub Code : 15ME626	**Credits : 03**
Hrs/Week : 3+0+0+0	**Total Hours : 39**

Course Learning Objectives:

This course will enable students to:

1. Know the basics of organizational behavior.
2. Understand various learning theories and perception.
3. Understand the theories of motivation and know about groups.
4. Students must be able to apply the concepts of stress management which includes job rotation and reengineering work process.
5. Students will know the importance of communication and rules of effective communication.

UNIT - I

INTRODUCTION: Definition of Organization Behaviour and Historical development, Environmental context (Information Technology and Globalization, Diversity and Ethics, Design and Cultural, Reward Systems). THE INDIVIDUAL: Foundations of individual behaviour, individual differences. Ability. Attitude, Aptitude, interests. Values. **8 Hours**

UNIT - II

LEARNING: Definition, Theories of Learning, Individual Decision Making, classical conditioning, operant conditioning, social learning theory, continuous and intermittent reinforcement. PERCEPTION: Definition, Factors influencing perception, attribution theory, selective perception, projection, stereotyping, Halo effect. **8 Hours**

UNIT - III

MOTIVATION: Maslow's Hierarchy of Needs theory, Mc-Gregor's theory X and Y, Hertzberg's motivation Hygiene theory, David Mc-Clelland's three needs theory, Victor Vroom's expectancy theory of motivation. THE GROUPS: Definition and classification of groups, Factors affecting group formation, stages of group development, Norms, Hawthorne studies, group processes, group tasks, group decision making. **8 Hours**

UNIT – IV

CONFLICT & STRESS MANAGEMENT: Definition of conflict, functional and dysfunctional conflict, stages of conflict process. Sources of stress, fatigue and its impact on productivity. Job satisfaction, job rotation, enrichment, job enlargement and reengineering work process. **8 Hours**

UNIT –V

PRINCIPLES OF COMMUNICATION: Useful definitions, communication principles, communication system, role of communication in management, barriers in communication, how to overcome the barriers, rule of effective communication. **7 Hours**

Course Outcomes:

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

C15ME626.1. Know the basics of organizational behavior.
C15ME626.2. Compare various learning theories and perception.
C15ME626.3. Examine the theories of motivation and know about groups.
C15ME626.4. Apply the concepts of stress management which includes job rotation reengineering work process.
C15ME626.5. Know the importance of communication and rules of effective communication.

Course articulation matrix

CO	PO 1	PO2	PO 3	PO 4	PO 5	PO 6	PO7	PO8	PO 9	PO 10	PO 11	PO12	PSO 1	PSO 2
C15ME626.1	-	-	L	L	-	-	-	H	M	H	L	M	M	M
C15ME626.2	-	-	L	M	-	-	-	M	M	H	L	M	H	H
C15ME626.3	-	-	M	M	-	-	-	H	M	M	L	M	M	M
C15ME626.4	-	-	L	L	-	-	-	H	M	H	L	L	H	M
C15ME626.5	-	-	M	L	-	-	-	M	L	H	L	M	M	M

L : Low M: Medium H : High

TEXT BOOKS:

1. **Organizational Behaviour,** Stephen P Robbins, 9th Edition, Pearson Education Publications, ISBN-81-7808-561-5 2002
2. **Organizational Behaviour,** Fred Luthans, 9th Edition, Mc Graw Hill International Edition, ISBN-0-07-120412-12002

REFERENCE BOOKS:

1. **Organizational Behaviour,** Hellriegel, Srocum and Woodman, Thompson Learning, 9th Edition, Prentice Hall India, 2001

2. **Organizational Behaviour,** Aswathappa - Himalaya Publishers. 2001
3. **Organizational Behaviour,** VSP Rao and others, Konark Publishers.2002
4. **Organizational Behaviour,** (Human behaviour at work) 9th Edition, John Newstron/ Keith Davis. 2002

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INTRODUCTION TO PIPING ENGINEERING

Sub Code : 15ME627 **Credits 03**
Hrs/Week : 3+0+0+0 **Total Hours 39**

Course Learning Objectives:

This course will enable students to:

1. To know basics of piping and pipe materials.
2. To get an understanding of cylinders and pipe thickness calculation.
3. To know the different piping components.
4. To get the thorough understanding of drawing associated with piping.
5. To identify loads acting on pipe and perform stress analysis.

UNIT – I

Scope of piping engineering, major phases in life cycle of a chemical process, Introduction to Piping, Fundamentals of piping, Classification of pipe, Pipe Manufacturing Methods, Pipe Sizes, Pipe Schedule & Pipe Representation. Codes and standards. Types of pipes. Material selection for pipe, pipe size, wall thickness. **8 Hours**

UNIT – II

Thick and thin cylinders. Hoop stress, pipe thickness calculations. **7 Hours**

UNIT – III

Piping Components, Piping Fittings, Types of Flanges, Types of Valves, Speciality Items. Functions of valves. **7 Hours**

UNIT – IV

Basics of piping and equipment layout, piping symbols, plans and isometrics. Piping arrangements, valve location. GAD,P&ID. **9 Hours**

UNIT – V

Pipe under stress, classification of loads and failures. Theories of failure. Stress analysis. **8 Hours**

Course Outcomes:

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

C-15ME627.1. Know about the basics of design piping industry and different codes used.
C-15ME627.2. Perform pipe thickness calculations.
C-15ME627.3. Understand different pipe fittings and valves.
C-15ME627.4. Know and draw piping drawing.
C-15ME627.5. Perform stress analysis.

Mapping of POs & COs:

COs	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO1 0	PO1 1	PO1 2	PSO 1	PSO 2
1	-	L	H	M	L	M	L	M	M	L	L	H	L	H
2	H	H	-	-	-	-	-	L	L	H	-	H	M	H
3	-	H	-	-	-	-	-	-	-	-	H	H	-	M
4	M	M	-	-	-	-	-	-	-	H	-	H	-	H
5	H	H	M	M	M	L	-	-	-	H	-	H	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.*

3. A course on Piping Engineering, IIT

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WELDING TECHNOLOGY
(Industry offered Elective Course with IWS support)

Sub Code : 15ME628 **Credits : 03**
Hrs/Week: 3+0+0+0** **Total Hours : 39**

Course Learning Objectives:

This Course will enable students to

1. Explain the working principles and process parameters of welding technology and explain the parts, mechanisms and working of conventional various welding processes.

2. Suggest suitable solutions to metallurgical issues and Weldability of various metals.
3. Suggest suitable testing aspects of welding in both destructive testing, non- destructive testing.
4. Select suitable welding and expert systems in welding. and select suitable welding codes to the welding code.
5. Suggest suitable precautions for electrical safety, fire hazards.

UNIT – I

Introduction to Welding processes: Conventional welding and advanced welding processes, Shielded metal arc welding, gas welding and cutting, submerged arc welding, tungsten arc welding, gas metal arc welding, resistance welding process
Advanced welding process: Plasma welding, cutting, cladding, electron beam welding, laser beam welding, **9 Hours**

UNIT - II

Welding Metallurgy
Weldability of carbon steel, weldability of Stainless steel, weldability of non-ferrous materials like titanium and aluminum. **8 Hours**

UNIT - III

Testing and quality control: destructive testing, non-destructive testing such as liquid penetrant inspection, magnetic particle inspection, ultrasonic testing, radiographic testing, **8 Hours**

UNIT – IV

Welding Design:
Welding symbols, weld joint design, static and fatigue design, distortion and residual stresses. Welding productivity and economics. Expert systems in welding. **6 Hours**

UNIT – V

Developments and applications in welding Technology
Welding application to pressure vessel, structures, ship building, automobile. Welding robots and automation. Introduction to welding codes, ASME code. Precautions for electrical safety, fire hazards, fumes and use of different personal protective equipment for different processes. **9 Hours**

**** Industry visits can be covered/arranged after completion of entire syllabus at BHEL/WRI/Ship building manufacturer or SKF Moodbidri**

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

1. Understand the principles of various welding processes
2. Understand metallurgical issues and quality of welds

3. Industrial application of welding
4. Understanding the codes, healthy & safety issues
5. And overall enhancing their welding skill levels for better employability in fabrication

Course Articulation Matrix:

CO	PO1	PO2	PO3	PO4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 10	PO 11	PO 12	PSO1	PSO2
C-15ME628.1	H	L	-	-	-	L	L	-	-	-	-	H	H	L
C-15ME628.2	H	H	H	L		-	L					H	H	H
C-15ME628.3	H	M	H	H								M	H	H
C-15ME628.4	H	H	H	M			M			H		M	H	H
C-15ME628.5	H	H	L	L		M	H					M	M	L

L: Low M: Medium H: High

TEXT BOOKS:

1. Welding Engineering and Technology by Dr. R.S. Parmar, Khanna Publishers, ISBN-13: 978-81-7409-028-2, 1374 pages, 2016.
2. A Text-Book of Welding Technology, by O.P. Khanna, Dhanpat Rai Publications; 2013 edition (2011)

REFERENCE BOOKS:

3. Welding handbook by American Welding Society, 9th edition, Volumes 1 to 5.
4. Welding Handbook, American Welding Society, Section-II: Gas Arc and Resistance
5. The Science and Practice of Welding, Vol-2: The Practice of Welding: A. C. Davies, Cambridge University Press (Website: www.cambridge.org).

MOOC/NPTEL Resources:

1. http://nptel.ac.in/courses/112107090/

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EMPLOYABILITY SKILL DEVELOPMENT - II

Sub Code : 15IL002 **Credits : Nil (MLC)**
Hrs/Week : 1+0+0+0 **Total Hours : 12**

UNIT - I

Quantitative- Permutations & Combinations
Analytical/logical- Cause & Effect statements
Verbal- Sentence corrections (Pronoun errors & misplaced modifiers)

UNIT - II

Quantitative- Area, volume & surface areas
Analytical/logical- Scenario based questions
Verbal- Sentence correction (Parallel construction & Parallel Comparison)

UNIT - III

Quantitative- Profit & loss
Analytical / logical- Figure series & mathematical puzzles
Verbal- Sentence correction (Tense usage)

UNIT - IV

Quantitative- Simple and compound interest
Analytical/logical- Statement & assumption
Verbal- Sentence correction (Subject-verb agreement)

UNIT - V

Quantitative- Logarithms
Analytical/logical- Reasoning analogies
Verbal- Verbal analogies

UNIT - VI

Quantitative- Stocks & Shares
Data interpretation- Tables, bar charts
Verbal- Reading comprehension (simple passage)

UNIT - VII

Quantitative- Discounts (True discounts, bankers' discount)
Data interpretation- Line graphs & Pie charts
Verbal- Reading comprehension (Difficult passage)

UNIT - VIII

Quantitative- Clocks & Calendars
Data sufficiency
Verbal- Inferences from passages

REFERENCE BOOKS:

1. Aggarwal R.S "Modern Approach to Logical Reasaning" S. Chanda Publication, 2008.
2. Aggarwal R.S "Quantitative Aptitude" S. Chand Publication, 2014.
3. Aggarwal R.S "Modern Approach to verbal and non verbal reasoning" S. Chanda Publication, 2013
4. Arun Sharma "Verbal ability and reading comprehension CAT" TMH Publications, 2014

5. Ethnus Consultancy Pvt. Ltd "APTIMTRA: Your friend for cracking aptitude test", MGH Publications, 2014.
6. Aggarwal R.S "Advanced objective general knowledge" S. Chanda Publication, 2014.

Examination pattern:

This course is a mandatory learning course without credit. Continuous internal examination (CIE) consists of 1 internal exam (40 marks) and tasks (10 marks). There is no semester end examination (SEE). The student will be awarded PP or NP grade as per autonomous regulations.

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