Vel Tech
Rangarajan Dr. Sagunthala
R&D Institute of Science and Technology
(Deemed to be University Estd. u/s 3 of UGC Act, 1956)

Curriculum & Syllabus

for

B. Tech. – Mechanical Engineering

(as per regulations R15)

Revised in 30th Board of Studies Meeting
on 11th December 2018
&
Approved by 30th Academic Council Meeting
on 27th January 2019

DEPARTMENT OF MECHANICAL ENGINEERING

SCHOOL OF MECHANICAL & CONSTRUCTION

VISION AND MISSION OF THE INSTITUTION

Vision

To create, translate and disseminate frontiers of knowledge embedded with creativity and innovation for a positive transformation of emerging society.

Mission

To nurture excellence in teaching, learning, creativity and research; translate knowledge into practice; foster multidisciplinary research across science, medicine, engineering, technology and humanities; incubate entrepreneurship; instill integrity and honour; inculcate scholarly leadership towards global competence and growth beyond self in a serene, inclusive and free academic environment

VISION AND MISSION OF THE DEPARTMENT

Vision

To be a centre of excellence for education and research in the field of Mechanical Engineering to meet the national as well as global challenges.

Mission

- To educate and enrich effective and responsible engineers for national as well as global requirements by providing quality education.
- To maintain vital state of the art research facilities to provide its students and faculty with opportunities to create, interpret, apply and disseminate knowledge.
- To develop linkages with the world class organizations and educational institutions in India and abroad for excellence in teaching, industry and research.
- To cultivate and promote entrepreneurship using industry and R&D facilities of the university.

DEPARTMENT OF MECHANICAL ENGINEERING

B. TECH-MECHANICAL ENGINEERING

Programme Educational Objectives

The Programme Educational Objectives are to prepare students to:

1 Apply modern analytical, computational, simulation tools and techniques on engineering materials, thermal sciences, applied mechanics and manufacturing methods to address the global challenges faced in mechanical and allied engineering streams.

2 Enable the students in using the techniques of engineering science and their applications to conceive, organize and develop the design of engineering systems.

3 Work as an individual and in teams on multi-disciplinary assignments in industries, research organizations and academic institutions both in national and global level through collaboration.

4 Acquire techno-commercial skills such as research interest and entrepreneurial ability in students to cater the societal problems.

DEPARTMENT OF MECHANICAL ENGINEERING
POs & PSOs of B. TECH - MECHANICAL ENGINEERING

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, research literature, and analyze complex engineering problems reaching substantiated conclusions using first principles of mathematics, natural sciences, and engineering sciences.
PO3	**Design/development of solutions**: Design solutions for complex engineering problems and design system components or processes that meet the specified needs with appropriate consideration for the public health and safety, and the cultural, societal, and environmental considerations.
PO4	**Conduct investigations of complex problems**: Use research-based knowledge and research methods including design of experiments, analysis and interpretation of data, and synthesis of the information to provide valid conclusions.
PO5	**Modern tool usage**: Create, select, and apply appropriate techniques, resources, and modern engineering and IT tools including prediction and modeling to complex engineering activities with an understanding of the limitations.
PO6	**The engineer and society**: Apply reasoning informed by the contextual knowledge to assess societal, health, safety, legal and cultural issues and the consequent responsibilities relevant to the professional engineering practice.
PO7	**Environment and sustainability**: Understand the impact of the professional engineering solutions in societal and environmental contexts, and demonstrate the knowledge of, and need for sustainable development.
PO8	**Ethics**: Apply ethical principles and commit to professional ethics and responsibilities and norms of the engineering practice.
PO9	**Individual and team work**: Function effectively as an individual, and as a member or leader in diverse teams, and in multidisciplinary settings.
PO10	**Communication**: Communicate effectively on complex engineering activities with the engineering community and with society at large, such as, being able to comprehend and write effective reports and design documentation, make effective presentations, and give and receive clear instructions.
PO11	**Project management and finance**: Demonstrate knowledge and understanding of the engineering and management principles and apply these to one's own work, as a member and leader in a team, to manage projects and in multidisciplinary environments.
PO12	**Life-long learning**: Recognize the need for and have the preparation and ability to engage in independent and life-long learning in the broadest context of technological change.
PSO1	Apply their knowledge in the domains of design, manufacturing and thermal sciences to solve engineering problems using advanced technology.
PSO2	Engage professionally in industries or as entrepreneurs by applying innovative ideas in design and manufacturing using modern CAD/CAE/CAM tools.

Minimum credits required in course categories

Sl.No.	Course Category	Minimum Credits Required	
		For Regular Students	For Lateral Entry Students
1.	Foundation courses	60	25
2.	**Programme core**	60	50
3.	**Programme elective**	18	18
4.	Allied elective	6	6
5.	University elective	10	10
6.	Value education elective	4	4
7.	Independent learning	20	20
8.	Industry/Higher Institute Learning Interaction	2	2
	Total	**180**	**135**

Courses exempted for lateral entry students (approved in 26th BoS meeting on 14th May 2017)

Sl. No.	Code	Course	L	T	P	C
1	1151ME106	Strength of Materials	2	2	0	3
2	1151ME303	Strength of Materials Laboratory	0	0	2	1
3	1151ME104	Manufacturing Technology	3	0	0	3
4	1151ME107	Machining and Machine Tool Technology	3	0	0	3
					Total	**10**

Programme Core

Programme Core - Domain Wise						
Sl. No.	**Code**	**Course**	**L**	**T**	**P**	**C**
Design Domain						
1	1151ME101	Engineering Mechanics	2	2	0	3
2	1151ME105	Kinematics of Machinery	2	2	0	3
3	1151ME106	Strength of Materials	2	2	0	3
4	1151ME110	Dynamics of Machinery	2	2	0	3
5	1151ME111	Design of Machine Elements	2	2	0	3
6	1151ME114	Design of Transmission Systems	2	2	0	3
Manufacturing Domain						
7	1151ME104	Manufacturing Technology	3	0	0	3
8	1151ME107	Machining and Machine Tools Technology	3	0	0	3
9	1151ME117	Engineering Materials and Metallurgy	3	0	0	3
10	1151ME109	Mechatronics Systems	3	0	0	3
Thermal Domain						
11	1151ME102	Engineering Thermodynamics	2	2	0	3
12	1151ME103	Fluid Mechanics and Machinery	2	2	0	3
13	1151ME108	Applied Engineering Thermodynamics	2	2	0	3
14	1151ME112	Thermal Engineering	2	2	0	3
15	1151ME115	Heat and Mass Transfer	2	2	0	3
Laboratory Courses						
16	1151ME303	Strength of Materials Laboratory	0	0	2	1
17	1151ME306	Dynamics of Machinery Laboratory	0	0	2	1
18	1151ME302	Manufacturing Technology Laboratory	0	0	2	1
19	1151ME304	Machining and Machine Tools Laboratory	0	0	2	1
20	1151ME305	Mechatronics Laboratory	0	0	2	1
21	1151ME301	Fluid Mechanics and Machinery Laboratory	0	0	2	1
22	1151ME307	Thermal Engineering Laboratory	0	0	2	1
23	1151ME309	Heat and Mass Transfer Laboratory	0	0	2	1
Integrated Core						
24	1151ME201	Engineering Metrology and Measurements	2	0	2	3
25	1151ME202	Finite Element Analysis (Theory Dominated)	2	0	2	3
26	1151ME203	Computer Aided Design and Drafting (Laboratory Dominated)	1	0	2	2
Total						**61**

Programme Electives - Domain Wise						
Sl. No.	**Code**	**Course**	**L**	**T**	**P**	**C**
Design Domain						
1	1152ME104	Composite Materials	3	0	0	3
2	1152ME109	Industrial Tribology	3	0	0	3
Manufacturing Domain						
3	1152ME102	Applied Hydraulics and Pneumatics	3	0	0	3
4	1152ME106	Computer Integrated Manufacturing	3	0	0	3
5	1152ME111	Jigs and Fixture	3	0	0	3
6	1152ME115	Non Destructive Testing	3	0	0	3
7	1152ME118	Tool Design Engineering	3	0	0	3
8	1152ME124	Non Traditional Machining Processes	3	0	0	3
Thermal Domain						
9	1152ME105	Computational Fluid Dynamics	3	0	0	3
10	1152ME107	Fuels and Combustion	3	0	0	3
11	1152ME110	Internal Combustion Engines	3	0	0	3
12	1152ME116	Power Plant Engineering	3	0	0	3
13	1152ME117	Renewable Sources of Energy	3	0	0	3
14	1152ME120	Refrigeration and Air Conditioning	3	0	0	3
General						
15	1152ME108	Industrial Engineering and Management	3	0	0	3
16	1152ME122	Total Quality Management	3	0	0	3
17	1152ME119	Operations Research	3	0	0	3
18	1152ME112	Logistics and Supply Chain Management	3	0	0	3
19	1152ME113	Maintenance Engineering	3	0	0	3
Advanced Technology						
20	1152ME101	Additive Manufacturing Technology	3	0	0	3
21	1152ME103	Automobile Engineering	3	0	0	3
22	1152ME114	Nano Materials and Applications	3	0	0	3
23	1152ME123	Solar Energy Engineering	3	0	0	3
24	1152ME125	Advanced Welding Technology	3	0	0	3
25	1152ME126	Advanced Metal Casting Technology	3	0	0	3
26	1152ME127	Gas Dynamics and Jet Propulsion	3	0	0	3
27	1152ME128	Micromachining & Manufacturing	3	0	0	3
28	1152ME129	Advanced 3D Modelling using Unigraphics NX	2	0	2	3
29	1152ME138	Process Planning and Cost Estimation	3	0	0	3

Programme Electives - Domain Wise						
Sl. No.	**Code**	**Course**	**L**	**T**	**P**	**C**
Advanced Technology						
30	1152ME139	Design of Rotodynamic Pumps	3	0	0	3
31	1152ME140	Welding Metallurgy and Weldability of Stainless Steels	3	0	0	3
32	1152ME141	Finite Element Modelling of Composite Structures	3	0	0	3
33	1152ME142	Integrated Product Design and Process Development	3	0	0	3
34	1152ME143	System Modelling and Control Engineering	3	0	0	3
35	1152ME144	Advanced Metal Forming Processes	3	0	0	3
36	1152ME145	Material Characterization and Testing Methods	3	0	0	3
37	1152ME146	Artificial Intelligence System in Manufacturing	3	0	0	3
38	1152ME147	Laser Processing of Materials	3	0	0	3
39	1152ME150	Advanced Metal Joining	3	0	0	3
40	1152ME151	Engineering Applications of Pump	3	0	0	3
Integrated Courses Under Program Elective						
1	1152ME201	Surface Modelling and Assembly (Lab Dominated)	1	0	4	3
2	1152ME202	Analysis of Mechanical Systems (Lab Dominated)	1	0	4	3
Laboratory Courses Under Program Elective						
1	1152ME301	Computer Aided Drawing Laboratory	0	0	2	1

COURSE CODE	ENGINEERING MECHANICS	L	T	P	C
1151ME101		2	2	0	3

1. **Preamble**
This course provides an introduction to the basic concepts of forces, inertias, centroids, and moments of area and techniques of finding their effects on motion. It introduces the phenomenon of friction and its effects. It introduces students to cognitive learning in applied mechanics and develops problem-solving skills in both theoretical and engineering-oriented problems.

2. **Pre-Requisite**
Engineering Physics 1150PH101

3. **Links to other courses**
1 Kinematics of Machinery 1151ME105
2 Strength of Materials 1151ME106

4. **Course Educational Objectives**
Students, after undergoing this course would
   - Possess the basic knowledge in mechanics in the areas of applied engineering.
   - Develop the skills in the areas of forces and their effects and in the concept of free body diagram.

5. **Course Outcomes**
Upon the successful completion of the course, learners will be able to

CO Nos.	Course Outcomes	Level of learning domain (Based on revised Bloom's)
CO1	Solve elementary Engineering problems related to the principles of Statics.	K2
CO2	Estimate the magnitude of forces and moments acting on rigid bodies.	K2
CO3	Determine the properties related to surfaces and solids	K3
CO4	Solve the problems related to dynamics of particles in engineering.	K3
CO5	Describe the principles of various types of friction	K2

(K3 - Apply)

6. **Correlation of COs with Programme Outcomes**

COs	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
CO1	H	M										L	M	L
CO2	H	M										L	M	L
CO3	H	M										L	M	L
CO4	H	M										L	M	L
CO5	H	M										L	M	L

H- High; M-Medium; L-Low

7. Course Content

UNIT I BASICS & STATICS OF PARTICLES **L-6 T-6**
Introduction – Units and Dimensions – Laws of Mechanics – Lami's theorem, Parallelogram and Triangular Law of forces – Vectors – Vectorial representation of forces and couples – Vector operations: additions, subtraction, dot product, cross product – Coplanar Forces – Resolution and Composition of forces – Equilibrium of a particle – Forces in space – Equilibrium of a particle in space – Equivalent systems of forces – Principle of transmissibility – Single equivalent force.

UNIT II EQUILIBRIUM OF RIGID BODIES **L-6 T-6**
Free body diagram – Types of supports and their reactions – requirements of stable equilibrium – Moments and Couples – Moment of a force about a point and about an axis –Scalar components of a moment – Varignon's theorem – Equilibrium of Rigid bodies in two dimensions – Equilibrium of Rigid bodies in three dimensions – Examples

UNIT III PROPERTIES OF SURFACES AND SOLIDS **L-6 T-6**
Determination of Areas and Volumes – First moment of area and the Centroid of sections –Second and product moments of plane area – Parallel axis theorem and perpendicular axis theorem – Polar moment of inertia – Principal moments of inertia of plane areas – Principal axes of inertia – Mass moment of inertia

UNIT IV DYNAMICS OF PARTICLES **L-6 T-6**
Displacement, Velocity and Acceleration, their relationship – Relative motion – Curvilinear motion – Newton's laws – Work-Energy Equation of particles – Impulse and Momentum – Impact of elastic bodies.

UNIT V FRICTION **L-6 T-6**
Frictional force – Laws of Coulomb friction – simple contact friction – Belt friction – Roller friction. Translation and Rotation of Rigid Bodies – General Plane motion.

TOTAL: 30 + 30 = 60 Periods

8. Text Books

1. Hibbeller, R.C., Engineering Mechanics, Vol. 1 Statics, Vol. 2 Dynamics, Pearson Education Asia Pvt. Ltd., 2015.
2.S.Timoshenko, D.H.Young, J.V.Rao, Sukumar Pati, Engineering Mechanics, McGraw Hill Education (India) Private Limited., 2013.

9. References

1. Palanichamy, M. S., and Nagan, S., Engineering Mechanics (Statics and Dynamics),Tata McGraw Hill, New Delhi 2012.
2. Kumar, K. L., Engineering Mechanics, Tata McGraw- Hill, New Delhi, 2011.
3. Shames, I. H., and Krishna Mohana Rao, G., Engineering Mechanics (Statics and Dynamics), Dorling Kindersley India) Pvt. Ltd. (Pearson Education), 2011.
4.Beer, F. P., and Johnston, E. R., Vector Mechanics for Engineers – Dynamics and Statics, Tata McGraw-Hill, New Delhi, 2011.
5. Natarajan, K.V., Engineering Mechanics, Dhanalakshmi Publishers, 2011.
6. Rajasekaran,S. and Sankarasubramanian,G., Engineering Mechanics, Vikas Publishing House Pvt Ltd, 2011.

10. Revised Bloom's based Assessment Pattern

Revised Bloom's Category	Internal				University Examination (%)
	Unit Test 1 (%)	Mid Term Test 1 (%)	Unit Test 2 (%)	Mid Term Test 2 (%)	
Remember	20	20	10	10	15
Understand	30	30	20	20	25
Apply	50	50	70	70	60
Analyse					
Evaluate					
Create					

Revised Bloom's Category	Assignment	
	I (CO1 & CO2 addressed) (Max marks in %)	II (CO3 & CO4 addressed) (Max marks in %)
Remember		
Understand		
Apply	50	50
Analyse	50	50
Evaluate		
Create		

COURSE CODE	KINEMATICS OF MACHINERY	L	T	P	C
1151ME105		2	2	0	3

1. Preamble

This course provides adequate knowledge on the basic components and layout of linkages with respect to the displacement, velocity, and acceleration at any point in a link of a mechanism. It enables design of cam mechanisms for specified output motions and solving of problems in toothed gear trains and the effects of friction in machine components.

2. Pre requisite

Engineering Mechanics 1151ME101

3. Links to other courses

1 Dynamics of Machinery 1151ME110
2 Design Of Machine Elements 1151ME111

4. Course Educational Objectives

Students undergoing this course are expected to:

- Gain knowledge on the basic concepts of mechanisms, cam, gear train and their kinematics.
- Understand the effects of friction in machine components

5. Course Outcomes

Upon the successful completion of the course, learners will be able to

CO Nos.	Course Outcomes	Level of learning domain (Based on revised Bloom's)
CO1	Discuss the fundamentals of various mechanisms.	K2
CO2	Construct the velocity and acceleration diagrams for a given mechanism.	K3
CO3	Construct the cam profile for a given follower motion.	K3
CO4	Analyze various types of gear and gear trains.	K3
CO5	Apply the effect of friction in clutches, brakes, and belt and rope drives.	K3

(K3-Apply)

6. Correlation of COs with Programme Outcomes:

Cos	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
CO1	H	M										L	M	L
CO2	H	M										L	M	L
CO3	H	M										L	M	L
CO4	H	M										L	M	L
CO5	H	M										L	M	L

H- High; M-Medium; L-Low

7. Course Content

UNIT I BASICS OF MECHANISMS **L-6 T-6**
Definitions-Degree of Freedom, Mobility-Kutzbach criterion-Grashoff's law-Kinematic Inversions of 4-bar chain, single and double slider crank chains-Mechanical Advantage-Transmission angle. Description of common Mechanisms: Single, double and offset slider mechanisms - Quick return mechanisms - Ratchets and escapements - Indexing Mechanisms.

UNIT II KINEMATICS OF MECHANISMS **L-6 T-6**
Displacement, velocity and acceleration - analysis in simple mechanisms - Graphical Method: velocity and acceleration polygons - Vector Approach - Coincident points- Coriolis Acceleration.

UNIT III KINEMATICS OF CAM **L-6 T-6**
Classifications - Derivatives of Follower motions, Displacement diagram and cam profile: Uniform velocity, Simple harmonic, uniform acceleration and retardation and Cycloid motions. Pressure angle and undercutting.

UNIT IV GEARS **L-6 T-6**
Spur gear Terminology and definitions - Fundamental Law of toothed gearing and involute gearing - Interference and undercutting - Helical, Bevel, Worm, Rack and Pinion gears (Basics only) - Gear-Motion Analysis - Parallel axis gear trains - Epicyclic gear trains

UNIT V FRICTION **L-6 T-6**
Surface contacts-Sliding friction - Friction in screw threads - Friction clutches - Belt and rope drives, Friction aspects in Brakes –Band Brake - Block Brake - Friction in vehicle propulsion and braking - Elementary treatment

Total: 30 + 30 = 60 Periods

8. Text Books

1. Shigley J.E and Uicker J.J “Theory of Machines and Mechanisms,” McGraw Hill ISE, 2011
2. Rattan. S.S, “Theory of Machines”, Tata McGraw Hill, 2014

9. References

1. Thomas Bevan, “Theory of Machines”, Pearson education, Noida, 5 th Edition, 2013.
2. Khurmi R.S. “Theory of Machines” S.Chand & Co.,. Delhi, 2013
3. B.L. Balleney, “Theory of Machines”, Khanna Pub. Delhi, 2012
4. Rao J.S and Dukkipati R.V, “Mechanism and Machine Theory”, New Age Intl., New Delhi, 2nd Edition, 2012.

10. Revised Bloom's based Assessment Pattern

Revised Bloom's Category	Internal				University Examination (%)
	Unit Test 1 (%)	Mid Term Test 1 (%)	Unit Test 2 (%)	Mid Term Test 2 (%)	
Remember	20	20	20	20	20
Understand	30	30	20	30	30
Apply	50	50	60	50	50
Analyse					
Evaluate					
Create					

Revised Bloom's Category	Assignments	
	I (CO1 & CO2 addressed) (Max marks in %)	II (CO3 & CO4 addressed) (Max marks in %)
Remember		
Understand		
Apply	**30**	**20**
Analyze	**70**	**80**
Evaluate		
Create		

COURSE CODE	STRENGTH OF MATERIALS	L	T	P	C
1151ME106		2	2	0	3

1. Preamble

This course provides knowledge of stresses, strains and deformations in components due to various loads. It helps in assessing the stresses and deformations through mathematical models of beams, twisting bars or combinations of both.

2. Prerequisite

Engineering Mechanics 1151ME101

3. Links to other Courses

1 Design of Machine Elements 1151ME111
2 CAD and Applied Finite Element Analysis 1151ME116

4. Course Educational Objectives

After successful completion of this course, students will be able to

- Understand the basic concepts related tensile, compressive and shear stresses in engineering components.
- Understand the basic principles of torsion in shafts, shear force and bending moment in beams, deflection in springs and beams.

5. Course Outcomes

Upon the successful completion of the course, learners will be able to

CO Nos.	Course Outcomes	Level of learning domain (Based on revised Bloom's)
CO1	Explain the fundamental concepts of rigid and deformable solids in the perspective of stress, strain and energy.	K2
CO2	Illustrate the strength and stiffness of shafts and springs.	K3
CO3	Calculate the forces and moments associated with beams using different methods.	K3
CO4	Solve for the deflections of the various beams using different methods.	K3
CO5	Determine the various stresses and strains in a bi-axial stress system and in thin cylindrical and spherical shells.	K3

(K3-Apply)

6. Correlation of Cos with Programme Outcomes

COs	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
CO1	H	M										L	M	L
CO2	H	M										L	M	L
CO3	H	M										L	M	L
CO4	H	M										L	M	L
CO5	H	M										L	M	L

H- High; M-Medium; L-Low

7. Course Content

UNIT I DEFORMATION OF SOLIDS **L- 6 T-6**

Introduction to Rigid and Deformable bodies – Types of Load, Stress, Strain, Tensile- Stress and Strain, Compressive Stress and Strain - normal stress – Hook law, Shear Stress and Strain ,Shear Modulus, Bearing Stress, Stress-strain Diagram, Factor of Safety, Selection of Factor of Safety, Poisson's Ratio, Volumetric Strain-Relation Between Bulk Modulus and Young's Modulus, Relation Between Young's Modulus and Modulus of Rigidity, Impact Stress, stress in simple and composite bars under axial load – Thermal stress – Strain energy.

UNIT II TORSION **L- 6 T-6**

Theory of torsion equation-Torsion of Solid and hollow circular bars – Shear stress distribution – Stepped shaft – Twist and torsion stiffness – Compound shafts – springs – types - helical springs – shear stress and deflection in springs.

UNIT III BEAMS **L- 6 T-6**

Types : Beams , Supports and Loads – Shear force and Bending Moment diagram – Cantilever, Simply supported ,Overhanging beam, fixed beam, continuous beam –Theory of simple bending – Stress, Shear stress in beams – Evaluation of 'I' , 'L' & 'T' sections.

UNIT IV DEFLECTION OF BEAMS **L- 6 T-6**

Introduction - Evaluation of beam deflection and slope: Cantilever, Simply supported beams- Macaulay Method and Moment-area Method.

UNIT V ANALYSIS OF STRESSES IN TWO DIMENSIONS **L- 6 T-6**

Biaxial state of stresses – Principal planes and stresses – Mohr's circle for biaxial stresses – Maximum shear stress. Introduction to theories of failure-Stresses in thin cylindrical and spherical shells.

TOTAL: 30+30 = 60 periods

8. Text Books

1. Nash W.A, "Theory and problems in Strength of Materials", Schaum Outline Series, McGraw-Hill Book Co, New York, 2014.
2. Timoshenko S.P, "Elements of Strength of Materials", Tata McGraw-Hill, New Delhi 2013.

9. References

1. Popov E.P, "Engineering Mechanics of Solids", Prentice-Hall of India, New Delhi, 2010.
2. Ramamurtham, S, Narayan .R, "Strength of materials", 16th Edition, Dhanpat Rai Publishing Co, 2008.
3. Jindal U.C. "Strength of Materials" Asian Books Pvt Ltd, New Delhi 2007.
4. Bansal, R.K., A Text Book of Strength of Materials, Lakshmi Publications Pvt. Limited,New Delhi, 2012
5. Rajput.R.K. "Strength of Materials" , S.Chand & co Ltd. New Delhi 2012.
6. Khurmi R.S, A Text book of strength of materials, S.Chand & co Ltd. New Delhi 2012
7. http://nptel.ac.in/courses/112101095/

10. Revised Bloom's based Assessment Pattern

Revised Bloom's Category	Internal				University Examination %
	Unit Test-I %	Mid Term Test I%	Unit Test-II%	Mid Term Test II %	
Remember	40	40	40	40	20
Understand	60	40	60	40	60
Apply		20		20	20
Analyse					
Evaluate					
Create					

Revised Bloom's Category	Assignments	
	1 (CO1 &CO2) (max marks in %)	2 (CO3&CO4) (max marks in %)
Remember		
Understand		
Apply	**30**	**20**
Analyze	**70**	**80**
Evaluate		
Create		

COURSE CODE	DYNAMICS OF MACHINERY	L	T	P	C
1151ME110		2	2	0	3

1. Preamble

This course provides the concepts and techniques of force analysis and balancing. It introduces the concepts of vibrations, governors, gyroscopes and develops problem solving skills in engineering problems.

2. Pre-Requisite

Kinematics of Machinery 1151ME105

3. Links to Other Courses

Design of Transmission Systems 1151ME114

4. Course Educational Objectives

Students undergoing this course are expected to:

- Develop the knowledge of complex algebra, vector method, graphical methods and computational skills of the students in the areas of dynamics.
- Gain knowledge in areas of vibration analyses, balancing unbalanced machines, stabilization of ships, aero planes, bomb sights and guided missiles.

5. Course Outcomes

Upon the successful completion of the course, learners will be able to

CO Nos.	Course Outcomes	Level of learning domain (Based on revised Bloom's)
CO1	Understand the mathematical principles to perform dynamic force analysis on machine components.	K3
CO2	Describe the various methods for balancing of rotating and reciprocating masses.	K3
CO3	Analyze free vibration of various systems	K3
CO4	Solve problems related to forced vibration systems.	K3
CO5	Illustrate the functioning of various types of governors & gyroscope and their applications.	K3

(K3-Apply)

6. Correlation of COs with Programme Outcomes:

Cos	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
CO1	H	M										L	M	L
CO2	H	M										L	M	L
CO3	H	M	L									L	M	L
CO4	H	M	L									L	M	L
CO5	H	M	L									L	M	L

H- High; M-Medium; L-Low

7. Course Contents

UNIT I FORCE ANALYSIS **L- 6 T-6**
Rigid Body dynamics in general plane motion – Equations of motion - Dynamic force analysis - Inertia force and Inertia torque – D'Alembert's principle - The principle of superposition - Dynamic Analysis in Reciprocating Engines – Gas Forces - Equivalent masses - Bearing loads - Crank shaft Torque - Turning moment diagrams - Fly wheels.

UNIT II BALANCING **L- 6 T-6**
Static and dynamic balancing - Balancing of rotating masses - Balancing a single cylinder Engine - Balancing Multi-cylinder Engines - Partial balancing in locomotive Engines - Balancing linkages - balancing machines

UNIT III FREE VIBRATION **L- 6 T-6**
Basic features of vibratory systems - idealized models - Basic elements and lumping of parameters - Degrees of freedom - Free vibration - Equations of motion - natural frequency - Types of Damping - Damped vibration critical speeds of simple shaft - Torsional systems; Natural frequency of two and three rotor systems

UNIT IV FORCED VIBRATION **L- 6 T-6**
Harmonic Forcing - Forcing caused by unbalance -Support motion – Force transmissibility and amplitude transmissibility - Vibration isolation. Flow induced vibration

UNIT V MECHANISMS FOR CONTROL **L- 6 T-6**
Governors - Types - Centrifugal governors - Gravity controlled and spring controlled centrifugal governors – Characteristics - Effect of friction - Controlling Force. Gyroscopes - Gyroscopic forces and Torques - Gyroscopic stabilization - Gyroscopic effects in Automobiles, ships and airplanes

Total: 30+30 = 60 Periods

8. Text Books

1. Thomas Bevan, "Theory of Machines", Pearson education, Noida, 5th Edition, 2013.
2. Ratan, S.S., "Theory of Machines", Tata McGraw Hill publishing company Ltd., 3rd Edition, 2011.
3. Balaguru S, "Dynamics of Machines", Cengage Learning, New Delhi, 6th Edition, 2018.

9. References

1. Khurmi R.S. "Theory of Machines" S.Chand & Co.,. Delhi, 2013
2. B.L. Balleney, "Theory of Machines", Khanna Pub. Delhi, 2012
3. Shigley J.E and Uicker J.J "Theory of Machines and Mechanisms," McGraw Hill ISE,2011.
4. Rao J.S and Dukkipati R.V, "Mechanism and Machine Theory", New Age Intl., New Delhi, 2nd Edition, 2012.

10. Revised Bloom's based Assessment Pattern

Revised Bloom's Category	**Internal**				**University Examination %**
	Unit Test-I %	**Mid Term Test I%**	**Unit Test-II%**	**Mid Term Test II %**	
Remember	40	40	40	40	20
Understand	60	40	60	40	60
Apply		20		20	20
Analyse					
Evaluate					
Create					

Revised Bloom's Category	**Assignments**	
	1 (CO1 &CO2) (max marks in %)	**2 (CO3&CO4) (max marks in %)**
Remember		
Understand		
Apply	**30**	**20**
Analyze	**70**	**80**
Evaluate		
Create		

COURSE CODE	DESIGN OF MACHINE ELEMENTS	L	T	P	C
1151ME111		2	2	0	3

1. Preamble

This course provides an introduction to the design procedure for various mechanical components. It introduces the concepts associated with stress and torque calculations of various machine elements such as fasteners, welded joints, shafts and couplings. Apart from this it also gives a detailed view of design of springs, design of flywheel and design of bearings.

2. Prerequisite

Strength of Materials 1151ME106

3. Links to other courses

1 Design of Transmission Systems 1151ME105
2 Industrial Tribology 1152ME109

4. Course Educational Objectives

Students undergoing this course will be able to

- Understand the various steps involved in designing machine components using standard data and practice.
- Create confidence to solve complex problems in the design for various types of fasteners, joints, shafts-keys, couplings, springs flywheels and bearings.

5. Course Outcomes

The students would be benefitted with the following outcomes:

CO Nos.	Course Outcomes	Level of learning domain (Based on revised Bloom's)
CO1	Describe the fundamentals of design for static and variable loading.	K2
CO2	Solve the numerical problems in threaded fasteners and welded joints.	K3
CO3	Apply the design procedure for shafts and couplings.	K3
CO4	Solve the numerical problems associated with design of springs and flywheel.	K3
CO5	Apply the design procedure for solving the numerical problems in bearings.	K3

(K3 – Apply)

6. Correlation of COs with Programme Outcomes

COs	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
CO1	H	M	L									L	M	L
CO2	H	M	L									L	M	L
CO3	H	M	L									L	M	L
CO4	H	M	L									L	M	L
CO5	H	M	L									L	M	L

H- High; M-Medium; L-Low

7. COURSE CONTENT

Required PSG design data book

UNIT I FUNDAMENTALS OF DESIGN **L-6 T-6**

Introduction to the design process - Phases of Design - Factors influencing machine design - Selection of materials based on mechanical properties. Direct, Bending and shear stresses – Impact and shock loading - theories of failure – Stress concentration - Calculation of principle stresses for various load combinations, eccentric loading –Design for variable loading – understanding manual drawings – fits and tolerances

UNIT II FASTENERS AND JOINTS **L-6 T-6**

Design of Threaded fasteners - Design of bolted joints - Design of welded joints - theory of bonded joints.

UNIT III SHAFTS AND COUPLINGS **L-6 T-6**

Design of solid and hollow shafts based on strength, rigidity and critical speed-Design of keys and key ways - Design of rigid and flexible couplings

UNIT IV SPRINGS AND FLYWHEELS **L-6 T-6**

Design of helical, leaf, springs under constant loads and varying loads – Concentric torsion springs. Design of flywheel involving stresses in rim and arm.

UNIT V DESIGN OF BEARINGS **L-6 T-6**

Types of bearing- sliding and rolling. Roller and ball bearing – Basic dynamic load rating - Cubic mean load-life in million hours. Design of journal bearings – Mc Kees equation – Lubrication in journal bearings – calculation of bearing dimensions.

TOTAL: 30+30 = 60 periods

8. Text Books

1. Shigley J., “Mechanical Engineering Design”, Mc Graw Hill, 2010.
2. Bhandari V.B, “Design of Machine Elements”, Tata McGraw-Hill Book Co, 2010

9. References

1. Juvinall R.C,Marshek K.M, “Fundamentals of Machine Component Design”, JohnWiley&Sons, 5th Edn, 2011.
2. Orthwein W, “Machine Component Design”, Jaico Publishing Co, 2006.
3. Ugural A.C, “Mechanical Design – An Integral Approach, McGraw-Hill Book Co, 2004.
4. Khurmi R.S, “Machine Design”, Norton R.L, “Design of Machinery”, Tata McGraw-Hill Book Co, 2014
5. Spotts M.F., Shoup T.E “Design and Machine Elements” Pearson Education, 2004.

10. Revised Bloom's based Assessment Pattern

Revised Bloom's Category	Internal				University Examination %
	Unit Test-I %	Mid Term Test I %	Unit Test-II %	Mid Term Test II %	
Remember	20	20	20	20	20
Understand	20	20	20	20	20
Apply	60	60	60	60	60
Analyse					
Evaluate					
Create					

Revised Bloom's Category	Assignments	
	1 (CO1 &CO2) (max marks in %)	2 (CO3&CO4) (max marks in %)
Remember		
Understand		
Apply	**30**	**20**
Analyze	**70**	**80**
Evaluate		
Create		

COURSE CODE	DESIGN OF TRANSMISSION SYSTEMS	L	T	P	C
1151ME114		2	2	0	3

1. **Preamble**

This course Design of Transmission Systems provide design of various transmission devices which aid in effective working of mechanical systems. It introduces concepts associated with devices such as design of belt drives, chain drives, gear drives and gearboxes. Apart from these, this course give detailed view about design of cams, clutches and brakes

2. Pre-requisite

Design of machine elements 1151ME113

3. Links to other Courses

CAD and Applied FEA 1151ME116

4. Course Educational Objectives

Students undergoing this course are expected to gain knowledge in

- Design of various flexible elements, Gear drives, gear boxes, cams, clutches & brakes
- Solve numerical problems in design of various mechanical drives

5. Course Outcomes

Upon the successful completion of the course, learners will be able to

CO Nos.	Course Outcomes	Level of learning domain (Based on revised Bloom's)
CO1	Describe the given design parameters of various flexible drives.	K2
CO2	Solve the numerical problems in design of gear drives.	K3
CO3	Apply the design procedure for various types of gear box.	K3
CO4	Solve the numerical problems in the design of multi speed gear box.	K3
CO5	Apply the given design procedure for solving numerical problems in the design of clutches, brakes and cams.	K3

(K3- Apply)

6. Correlation of Course Outcomes with Programme Outcomes:

COs	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
CO1	H	M	M									L	H	L
CO2	H	M	M									L	H	L
CO3	H	M	M									L	H	L
CO4	H	M	M									L	H	L
CO5	H	M	M									L	H	L

H- High; M-Medium; L-Low

7. Course Content
Required PSG design data book

UNIT I DESIGN OF MECHNAICAL DRIVES FOR FLEXIBLE ELEMENTS L-6 T-6
Selection of V belts and pulleys– Selection of Flat belts and pulleys - Wire ropes and pulleys – Selection of Transmission chains and Sprockets.

UNIT II SPUR GEARS AND PARALLEL AXIS HELICAL GEARS L-6 T-6
Gear Terminology-Speed ratios and number of teeth-Force analysis -Tooth stresses - Dynamic effects - Fatigue strength - Factor of safety - Gear materials – Module and Face width-power rating calculations based on strength and wear considerations - Parallel axis Helical Gears – Pressure angle in the normal and transverse plane- Equivalent number of teeth-forces and stresses. Estimating the size of the helical gears.

UNIT III BEVEL, WORM AND CROSS HELICAL GEARS L-6 T-6
Straight bevel gear: Tooth terminology, tooth forces and stresses, equivalent number of teeth. Estimating the dimensions of pair of straight bevel gears. Worm Gear: Merits and demerits- terminology. Thermal capacity materials-forces and stresses, efficiency, estimating the size of the worm gear pair. Cross helical: Terminology-helix angles-Estimating the size of the pair of cross helical gears.

UNIT IV DESIGN OF GEAR BOXES L-6 T-6
Geometric progression - Standard step ratio - Ray diagram, kinematics layout -Design of sliding mesh gear box and Constant mesh gear box - Design of synchromesh gear box – Design of multi speed gear box.

UNIT V DESIGN OF CAM, CLUTCHES AND BRAKES L-6 T-6
Cam Design: Types-pressure angle and under cutting base circle determination-forces and surface stresses. Design of plate clutches –axial clutches-cone clutches-internal expanding rim clutches-internal and external shoe brakes.

Total: 30 + 30 = 60 periods

8. Text Books

1. Shigley J., Mechanical Engineering Design, Tata McGraw-Hill Publishing Company Ltd, 2014.
2. Bhandari, V.B., “Design of Machine Elements”, Tata McGraw-Hill Publishing Company Ltd., 2014.

9. References

1. Juvinall R. C., Marshek K.M., “Fundamentals of Machine component Design”, – John Wiley & Sons Third Edition, 2002.
2. Maitra G.M., Prasad L.V., “Hand book of Mechanical Design”, II Edition, Tata McGraw-Hill, 2001.
3. U.C.Jindal : Machine Design, "Design of Transmission System", Dorling Kindersley, 2010.
4. Bernard Hamrock, Steven Schmid, Bo Jacobson, “Fundamentals of Machine Elements”,2nd Edition, Tata McGraw-Hill Book Co., 2006.
5. Robert Norton, “*Design of Machinery”*, McGraw Hill, Fifth Edition, 2011

10. Revised Bloom's based Assessment Pattern

Revised Bloom's Category	Internal				University Examination %
	Unit Test-I %	Mid Term Test I %	Unit Test-II %	Mid Term Test II %	
Remember	20	20	20	20	20
Understand	20	20	20	20	20
Apply	60	60	60	60	60
Analyse					
Evaluate					
Create					

Revised Bloom's Category	Assignments	
	1 (CO1 &CO2) (max marks in %)	2 (CO3&CO4) (max marks in %)
Remember		
Understand		
Apply	**30**	**20**
Analyze	**70**	**80**
Evaluate		
Create		

COURSE CODE	MANUFACTURING TECHNOLOGY	L	T	P	C
1151ME104		3	0	0	3

1. Preamble

This course provides an introduction to the basic concepts and techniques of metal casting processes, joining & deformation processes, special welding processes and various types of component manufacturing techniques.

2. Pre-Requisite

Basic Mechanical Engineering	1150ME101

3. Links to Other Courses

1	Engineering Metrology and Measurements	1151ME113
2	Machining and Machine Tools Technology	1151ME107
3	Tool Design Engineering	1152ME118
4	Computer Integrated Manufacturing	1152ME106

4. Course Educational Objectives

- To understand the various manufacturing processes related to casting, forming, joining of metals, molding and extrusion processes of various components.

5. Course Outcomes

The students would be benefitted with the following outcomes:

CO Nos.	Course Outcomes	Level of learning domain (Based on revised Bloom's)
CO1	Describe preparation of moulds for casting applications.	K2
CO2	Explain arc welding and gas welding operations.	K2
CO3	Describe different deformation processes in manufacturing.	K2
CO4	Explain various special welding processes	K2
CO5	Describe various manufacturing technologies for plastic components	K2

(K3 - Apply)

6. Correlation of COs with Programme Outcomes

CO s	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
CO1	H	L										L	M	L
CO2	H	L										L	M	L
CO3	H	L										L	M	L
CO4	H	L										L	M	L
CO5	H	L										L	M	L

H- High; M-Medium; L-Low

7. Course Content

UNIT I METAL CASTING PROCESSES **L-9**

Sand casting – Sand moulds - Type of patterns – Pattern materials – Pattern allowances – Types of Moulding sand – Properties – Core making – Methods of Sand testing – Working principle of Special casting processes – Shell– Pressure die casting – Centrifugal casting – CO_2 process – Sand Casting defects – Inspection methods, advanced metal casting process.

UNIT II JOINING PROCESSES **L-9**

Fusion welding processes – Types of Gas welding – Equipments used – Flame characteristics – Filler and Flux materials - Arc welding equipments - Gas metal arc welding – Flux cored – Submerged arc welding – Electro slag welding – TIG and MIG welding process. Principles of Resistance welding – Spot/butt, seam welding – Percussion welding- Weld defects

UNIT III DEFORMATION PROCESSES **L- 9**

Hot working and cold working of metals – Forging processes – Open, and closed die forging process – Typical forging operations – Rolling of metals – Types of Rolling mills - Defects in rolled parts - Principle of rod and wire drawing - Tube drawing .

Principles of Extrusion – Types of Extrusion – Hot and Cold extrusion. Sheet metal characteristics - Typical shearing operations, bending and drawing operations – Stretch forming operations - Metal spinning

UNIT IV SPECIAL WELDING PROCESS **L- 9**

Principle and application of special welding processes - Plasma arc welding – Thermit welding – Electron beam welding – Friction welding -laser beam welding.–Ultra sonic welding

UNIT V MANUFACTURING OF PLASTIC COMPONENTS **L-9**

Types of plastics - Characteristics of the forming and shaping processes – Moulding of Thermoplastics – Working principles and typical applications - Injection moulding – Blow moulding – Rotational moulding – Film blowing – Extrusion – Thermoforming. Moulding of thermosets- Working principles and typical applications -Compression moulding, Transfer moulding - Bonding of Thermoplastics.

Total: 45 periods

8. Text Books

1. Dr. P. N Rao,"Manufacturing Technology: Foundry, Forming and Welding, 4e (Volume 1)2013
2. Hajra Choudhury, "Elements of Workshop Technology, Vol. I and II", Media Promoters Pvt Ltd., Mumbai, 2011.

9. References

1. "H.M.T. Production Technology – Handbook", Tata McGraw-Hill, 2000.
2. Begman, 'Manufacturing Process", John Wilely & Sons, VIII Edition, 2010.
3. Fundamentals of Modern Manufacturing: Materials, Processes, and Systems
4. By Mikell P. Groover,2010
5. B.S. Magendran Parashar & R.K. Mittal, "Elements of Manufacturing Processes", Prentice Hall of India, 2012.
6. Serope Kalpajian, Steven R.Schmid, "Manufacturing Processes for Engineering
7. Materials", 4/e, Pearson Education, Inc. 2007.
8. R.K.Jain and S.C. Gupta, "Production Technology", Khanna Publishers. 16th Edition, 2001.
9. Roy. A. Linberg, "Process and Materials of Manufacture", PHI, 2000.

10. Revised Bloom's based Assessment Pattern

Revised Bloom's Category	Internal				University Examination %
	Unit Test-I %	Mid Term Test I%	Unit Test-II%	Mid Term Test II %	
Remember	40	40	40	40	20
Understand	60	40	60	40	60
Apply		20		20	20
Analyse					
Evaluate					
Create					

Revised Bloom's Category	Assignments	
	I (CO1 & CO2 addressed) (Max marks in %)	II (CO3 & CO4 addressed) (Max marks in %)
Remember		
Understand		
Apply	**50**	**50**
Analyse	**50**	**50**
Evaluate		
Create		

COURSE CODE	MACHINING AND MACHINE TOOLS TECHNOLOGY	L	T	P	C
1151ME107		3	0	0	3

1. Preamble

To impart knowledge on mechanics of metal cutting in conventional, special machines tools, NC, CNC Machines.

2. Pre requisite

Manufacturing Technology 1151ME104

3. Links to other Courses

1	Computer Integrated Manufacturing	1152ME106
2	Tool Design Engineering	1152ME118
3	Industrial Engineering and Management	1152ME108

4. Course Educational Objectives

Students undergoing this course will be able to:

- Understand the concepts and basic mechanics of metal cutting in standard machine tools such as lathe, shaping and allied machines, milling, drilling and allied machines, grinding, gear cutting machines, broaching and allied machines.
- Understand the working principles of NC and CNC machine tools and CNC Programming

5. Course Outcomes

Upon the successful completion of the course, learners will be able to

COs	Course Outcomes	Level of learning domain (Based on revised Bloom's)
CO1	Explain the concepts related to metal cutting, tool geometry and tool materials.	K2
CO2	Understand the working principles of centre lathe and special purpose lathes.	K2
CO3	Explain the working principles of reciprocating machine, milling, drilling and gear cutting processes.	K2
CO4	Explain the surface grinding and cylindrical grinding operations.	K2
CO5	To gain the knowledge to program CNC machines for specific operations such as turning, drilling and milling.	K2

(K3-Apply)

6. Correlation of Course Outcomes with Programme Outcomes

Cos	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
CO1	H	L										L	M	L
CO2	H	L										L	M	L
CO3	H	L										L	M	L
CO4	H	L										L	M	L
CO5	H	L										L	M	M

H- High; M-Medium; L-Low

7. Course Contents

UNIT I MECHANICS OF METAL CUTTING L- 9

Introduction: material removal processes, types of machine tools – theory of metal cutting, cutting tool geometry, chip formation, orthogonal cutting, oblique cutting, cutting tool materials, tool wear, tool life, surface finish, cutting fluids.

UNITII CENTRE LATHE AND SPECIAL PURPOSE LATHES L- 9

Centre lathe, constructional features, various operations, taper turning methods, thread cutting methods, machining time and power estimation. Capstan and turret lathes – Turret Indexing mechanism, bar feed mechanism.

UNIT III RECIPROCATING MACHINES, MILLING, DRILLING & GEARCUTTING L-9

Reciprocating machine tools: Shaper, Slotter: Milling: types, milling cutter attachments, operations, Up & down milling, Types of milling cutters –-Gear cutting: Gear forming, Gear Hobbing- Drills, Reamer nomenclature- Hole making: drilling, reaming, boring, tapping, Broaching machines: Introduction to jigs & fixtures.

UNIT IV ABRASIVE PROCESSES L- 9

Abrasive processes: grinding wheel – specifications and selection, types of grinding process – cylindrical grinding, surface grinding, centreless grinding, internal grinding- honing, lapping, super finishing, polishing and buffing, abrasive jet grinding.

UNIT V CNC MACHINE TOOLS AND COMPUTER AIDED PROCESS PLANNING L-9

Numerical control (NC) machine tools – CNC: types, constructional details, special features. -Part programming fundamentals – manual programming – computer assisted part programming – Turning, Drilling and Milling**.** Introduction to Distributed Numerical control (DNC) Machines.
Introduction to computer aided process planning.

Total: 45 Periods

8. Text Books

1. Mikell P. Groover "Fundamentals of Modern Manufacturing: Materials, Processes, and Systems",2012.
2. Rao. P.N "Manufacturing Technology - Metal Cutting and Machine Tools", Tata McGraw-Hill, New Delhi, 2013.
3. Kalpakjian ,"Manufacturing Processes for Engineering Materials", Pearson education India,1992

9. References

1. HMT – "Production Technology", Tata McGraw-Hill, 2010.
2. Philip F.Ostwald and Jairo Munoz, 'Manufacturing Processes and systems', John Wiley and Sons, 10th Edition,2012.
3. M.P.Groover and Zimers Jr., 'CAD/CAM' Prentice Hall of India Ltd., 2011.
4. Milton C.Shaw ,"Metal Cutting Principles", Oxford University Press, Third Edition, 2012.

10. Revised Bloom's based Assessment Pattern

Revised Bloom's Category	Internal				University Examination %
	Unit Test-I %	Mid Term Test I%	Unit Test-II%	Mid Term Test II %	
Remember	40	40	40	40	20
Understand	60	40	60	40	60
Apply		20		20	20
Analyse					
Evaluate					
Create					

Revised Bloom's Category	Assignments	
	1 (CO1 &CO2) (max marks in %)	2 (CO3&CO4) (max marks in %)
Remember		
Understand		
Apply	**30**	**20**
Analyze	**70**	**80**
Evaluate		
Create		

COURSE CODE	ENGINEERING MATERIALS AND METALLURGY	L	T	P	C
1151ME117		3	0	0	3

1. Preamble

This course imparts the knowledge on the structure, properties, heat treatment and mechanical property evaluation of ferrous and nonferrous metals so as to select the appropriate material for suitable applications.

2. Prerequisite

Engineering Physics	1150PH101

3. Links to other courses:

1	Strength of Materials	1151ME106
2	Corrosion and Surface Engineering	1152ME103

4. Course Educational Objectives

Students undergoing this course are expected to:

- Gain knowledge in properties of solids.
- Acquire the knowledge about various phase diagrams of ferrous and non-ferrous metals.
- Attain knowledge in heat treatment of steels, properties of non-ferrous alloys and evaluate the mechanical properties of different metals.
- Impart the knowledge about the failure mechanism of ductile and brittle materials.

5. Course Outcomes

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

CO Nos.	Course Outcomes	Level of learning domain (Based on revised Bloom's)
CO1	Explain the different crystallographic structures and crystal imperfection in solids	K2
CO2	Explain the different types of phase diagrams and properties of ferrous and non-ferrous metals.	K2
CO3	Describe different heat treatment process for various materials.	K2
CO4	Distinguish different strengthening mechanisms and fractures.	K2
CO5	Explain various tests to find mechanical properties of the given material.	K2

(K3-Apply)

6. Correlation of COs with Programme Outcomes

COs	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
CO1	H											L	L	
CO2	H											L	L	
CO3	H											L	L	
CO4	H											L	L	
CO5	H											L	L	

H- High; M-Medium; L-Low

7. Course Content

UNIT- I: CRYSTALLOGRAPHY **L-9**

Classification of Materials, Engineering properties of materials, Structure of Solid materials- BCC- FCC & HCP Structures- Atomic Packing factor- Miller Indices, crystallographic direction, crystallographic Plane, Solid Solution, Types of Solid Solution, Crystal imperfection - point defects, line defects – Edge dislocation, Screw dislocation, surface defects and volume defects.

UNIT- II: FERROUS AND NON FERROUS METALS AND PHASE DIAGRAM **L-9**

Introduction to Phase Diagram, Gibbs phase Rule, Binary Equilibrium diagram, Isomorphus system - Tie Line Rule and Lever Rule, Iron-Iron carbide Diagram, Effect of alloying additions on steel (Mn, Si, Cr, Mo, V Ti & W) , Types of steel - HSLA - Maraging steels – TRIP Steels, Tool Steels, Types Stainless Steels – –Types of Cast Irons -Copper and its alloys – Aluminum and its alloys.

UNIT-III: HEAT TREATMENT **L-9**

Importance of Heat Treatment – TTT- Time Temperature Transformation Diagram (Isothermal Transformation diagram), CCT diagram – cooling curves superimposed on I.T. diagram, Types of Heat treatment Processes – different types of Annealing process, Normalising, Quenching and Tempering of steel. – Hardenability- Grossman's critical diameter, Jominy end quench test – Austempering, Martempering Case hardening, Carburising, Nitriding, Cyaniding, Carbonitriding – Flame and Induction hardening.

UNIT –IV: MECHANICAL PROPERTIES OF MATERIALS & FRACTURE **L-9**

Mechanisms of Plastic and Elastic deformations, Slip and Twinning, Recover Recrystallization and Grain growth- Strengthening Mechanism- Strain hardening, Precipitation hardening, Refinement of Grain, solid solution strengthening, Types of Fracture-, Ductile and Brittle fracture- Griffith's theory, Creep - Mechanisms of Creep- Creep resistant materials, Fatigue Failure- SN curve- Factors affecting fatigue life, prevention of fatigue failure.

UNIT- V: MECHANICAL TESTING **L-9**

Tensile test- Stress Strain curves for Ductile and Brittle materials- Mild steel, Copper, Concrete, and Cast iron, Proof Stress, Yield point phenomenon - compression and shear loads, Hardness tests (Brinnel, Vicker's and Rockwell) - Impact test- Izod and Chorpy, Fatigue and creep test, Fracture toughness tests.

TOTAL: 45 periods

8. Text Books

1. Sidney H. Avner, Introduction to Physical Metallurgy, Tata Mcgraw Hill, 2010.
2. Raghavan V. Physical Metallurgy, Prentice – Hall of India Private Limited, 2nd Edition 2006.

9. References

1. Dieter, G. E., Mechanical Metallurgy, McGraw Hill, Singapore, 2012.
2. Thomas H. Courtney, Mechanical Behaviour of Engineering Materials, McGraw Hill, Singapore, 2011.
3. William D Callister "Material Science and Engineering", John Wiley and Sons, 2010.

10. Revised Bloom's based Assessment Pattern

Revised Bloom's Category	Internal				University Examination %
	Unit Test-I %	Mid Term Test I%	Unit Test-II%	Mid Term Test II %	
Remember	40	40	40	40	20
Understand	60	40	60	40	60
Apply		20		20	20
Analyse					
Evaluate					
Create					

Revised Bloom's Category	Assignments	
	1 (CO1 &CO2) (max marks in %)	2 (CO3&CO4) (max marks in %)
Remember		
Understand		
Apply	**80**	**70**
Analyse	**20**	**30**
Evaluate		
Create		

COURSE CODE	MECHATRONICS SYSTEMS	L	T	P	C
1151ME109		3	0	0	3

1. Preamble

This course provides an introduction to the multidisciplinary field of engineering, modeling of Mechatronics systems; microprocessor programming and interfacing; architecture of PLC; selection and implementation of sensors and actuators; and case studies in Mechatronics systems

2. Pre requisite

Basic Electronics Engineering 1150EC101

3. Links to other courses

Project Work

4. Course Educational Objectives

Students undergoing this course are expected to gain

- Knowledge in mechanical, electronics and computing Engineering.
- The terminologies of microprocessor programming, understand the principles of Sensors, Actuators and Control systems.
- The knowledge to design solutions for the Mechatronics systems.

5. Course Outcomes

The students would be benefitted with the following outcomes:

CO Nos.	Course Outcomes	Level of learning domain (Based on revised Bloom's)
CO1	Understand the concepts of various mechatronics and its applications	K2
CO2	Describe the working principles of microprocessors used in mechatronics.	K3
CO3	Describe about various electrical drives and PLC	K3
CO4	Understand various sensors with its application in Mechatronics	K3
CO5	Apply the knowledge of mechatronics system design in real time requirements	K3

(K3-Apply)

6. Correlation of Cos with Programme Outcomes

Cos	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
CO1	H											L	L	
CO2	H		L									L	L	
CO3	H		L		L							L	L	
CO4	H		L		L		L					L	L	
CO5	H		L				L				L	L	L	

H- High; M-Medium; L-Low

7. Course Content

UNIT I INTRODUCTION **L- 9**

Introduction to Mechatronics systems, Mechatronics system components - Measurement Systems, Control Systems - Open and Closed Loops Systems, Sequential Controllers with examples – Water level controller, Shaft speed control, Washing machine control, Automatic camera and Engine management systems

UNIT II MICROPROCESSOR IN MECHATRONICS **L-9**

Development of microprocessor systems, 8085 – Architecture, Pin diagram, Input and Output peripheral circuits, communications – Input, Output and Memory with timing diagrams, A/D and D/A converters. Introduction to embedded systems.

UNIT III ELECTRICAL DRIVES AND PLC **L-9**

Electrical drives - stepper motors and servo motors and Linear motors. Programmable logic controller - Programming units - Memory - Input - Output Modules - Mnemonics - Timers- Internal relays - Counters - Shift Registers - Programming the PLC using Ladder diagram - Simple example of PLC application.

UNIT IV SENSORS INTERFACING AND MONITORING **L-9**

Resistive, capacitive and inductive transducers, Position Sensors, Limit Switches, Optical encoders – Absolute and Incremental, Proximity Sensors, Solid State Sensors and Transducers, Temperature and Pressure sensors, Introduction to Lab View software-analysis of hydraulic and pneumatic systems.

UNIT V MECHATRONICS SYSTEM DESIGN AND APPLICATION **L-9**

Stages in designing Mechatronics Systems – Traditional and Mechatronics Design - Case Studies of Mechatronics Systems –Pick and place robot – Automatic car park systems –Wind screen wiper motion –Skip control of CD player – Time delay of blower- Position control of permanent magnet DC motor.

Total: 45 periods

8. Text Books

1. W.Bolton, Electronic Control Systems in Mechanical and Electrical Engineering, Prentice Hall, New Delhi,2003.
2. James Harter, Electromechanics, Principles and Concepts and Devices, Prentice Hall, New Delhi,2003.

9. References

1. David W. Pessen, Industrial Automation Circuit Design and Components, John Wiley, New York, 1990.
2. Rohner, P., Automation with Programmable Logic Controllers, Macmillan / McGraw Hill, New York, 1996.
3. Brian Morris, Automatic Manufacturing Systems Actuators, Controls and Sensors, McGraw Hill, New York, 1994.
4. Goankar, R. S., Microprocessor Architecture Programming and Applications, Wiley Eastern, New Delhi, 1997.

10. Revised Bloom's based Assessment Pattern

Revised Bloom's Category	Internal				University Examination %
	Unit Test-I %	Mid Term Test I%	Unit Test-II%	Mid Term Test II %	
Remember	40	40	40	40	20
Understand	60	40	60	40	60
Apply		20		20	20
Analyse					
Evaluate					
Create					

Revised Bloom's Category	Assignments	
	1 (CO1 &CO2) (max marks in %)	2 (CO3&CO4) (max marks in %)
Remember		
Understand		
Apply	**80**	**70**
Analyse	**20**	**30**
Evaluate		
Create		

COURSE CODE	ENGINEERING THERMODYNAMICS	L	T	P	C
1151ME102		2	2	0	3

1. **Preamble**
This course provides an introduction to the basic concepts in thermodynamics, first law of thermodynamics and energy, second law, entropy, enthalpy and internal energy, ideal and real gases and non-reactive ideal gas mixtures and general thermodynamic property relations. It develops the problem solving skills in engineering problems in basic thermodynamics.

2. **Pre-Requisite**
NIL

3. **Links to other courses**
Applied Engineering Thermodynamics 1151ME108

4. **Course Educational Objectives**
Students undergoing this course are expected to
- Understand the basic laws of thermodynamics and their application to the non-flow and flow processes.
- Understand the thermodynamic properties of ideal and real gases, gaseous mixtures.

5. **Course Outcomes**
The students would be benefitted with the following outcomes:

CO Nos.	Course Outcomes	Level of learning domain (Based on revised Bloom's)
CO1	Understand the fundamental concepts and solve the basic thermodynamic problems.	K3
CO2	Apply the concepts of first law of thermodynamics to solve related problems.	K3
CO3	Apply the concepts of second law of thermodynamics and solve problems related to it.	K3
CO4	Understand the concepts of ideal and real gases to solve the problems.	K3
CO5	Understand and derive the general thermodynamic equations.	K3

(K3 - Apply)

6. **Correlation of COs with Programme Outcomes**

COs	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
CO1	H	L										L	H	
CO2	H	L										L	H	
CO3	H	L										L	H	
CO4	H	L										L	H	
CO5	H	L										L	H	

H- High; M-Medium; L-Low

7. Course Content
Steam tables, Mollier charts and psychometric charts are required.

UNIT-I BASIC CONCEPTS L-6 T-6
Basic concepts, Concept of continuum, Microscopic and Macroscopic approach, Thermodynamic systems, control volume, property, point and path functions, Thermodynamic equilibrium, State and process, Reversible and Quasi-static process, Work, Zeroth law, Concept of temperature and heat.

UNIT- II FIRST LAW AND ENERGY L-6 T-6
First law, Application to closed and open systems, Internal energy, Enthalpy, Steady flow process with reference to various engineering devices.

UNIT- III SECOND LAW, ENTROPY AND EXERGY L-6 T-6
Second law – Kelvin Planck and Clausius statements, Heat engine, Refrigerator and Heat pump, Efficiency and COP, Thermodynamic temperature scale, Reversibility and Irreversibility, Carnot theorem, Clausius Inequality, Concept of entropy, Entropy of ideal gases, Principle of increase of entropy, Quality of energy, Energy (Availability), Reversible work, Energy and Irreversibility for closed system and control volume, Second law efficiency.

UNIT –IV IDEAL & REAL GASES AND NON-REACTIVE IDEAL GAS MIXTURES L-6 T-6
Properties of ideal and real gases, Avagadros hypothesis and gas laws, Vander Walls and other equations of state, Principle of corresponding states, Compressibility factor, and generalized compressibility charts. Non-reactive ideal gas mixtures, Mass and Mole fractions, Dalton's law of additive pressures, Amagat's law of additive volumes, Properties of ideal gas mixtures.

UNIT- V GENERAL THERMODYNAMIC PROPERTY RELATIONS L-6 T-6
Partial derivatives and associated relations, Differential relations for U, H, G and A, Maxwell's relations, Clausius Clapeyron equation, Joule Thomson coefficient, Air and Gas tables.

TOTAL = 30 + 30 = 60 periods

8. Text Books

1. Yunus A Cengel / Michael A Boles, "Thermodynamics - An Engineering Approach", (SI Units), Tata Mc Graw Hill India, 8e, Special Indian Edition 2016.
2. P K Nag, "Engineering Thermodynamics", Tata McGraw Hill, New Delhi, 6th Edition, 2013.

9. References

1. Yadav R, "Fundamentals of Engineering Thermodynamics", 7e, Vol 1, Central Publishing House, 2011.
2. Jones J.B and Dugan R.E., "Engineering Thermodynamics", Prentice Hall of India, 2011
3. Roy Choudry T., "Basic Engineering Thermodynamics", Second Edition, Tata McGraw Hill, 2012.

10. Revised Bloom's based Assessment Pattern

Revised Bloom's Category	Internal				University Examination %
	Unit Test 1 %	Mid Term Test 1 %	Unit Test 2 %	Mid Term Test 2 %	
Remember	20	20	10	10	15
Understand	30	30	20	20	25
Apply	50	50	70	70	60
Analyse					
Evaluate					
Create					

Revised Bloom's Category	Assignments	
	I (CO1 & CO2 addressed) (Max marks in %)	II (CO3 & CO4 addressed) (Max marks in %)
Remember		
Understand		
Apply	**50**	**50**
Analyse	**50**	**50**
Evaluate		
Create		

COURSE CODE	FLUID MECHANICS AND MACHINERY	L	T	P	C
1151ME103		2	2	0	3

1. Preamble

This course provides an introduction to the properties and behaviour of fluids. It introduces dimensional analysis and enables to apply the concepts in civil engineering, pipe networks and channel.

2. Pre-requisite

Engineering Mathematics-I	1150MA202

3. Links to other courses

1	Heat and Mass Transfer	1151ME115
2	Applied Hydraulics & Pneumatics	1152ME102
3	Computational Fluid Dynamics	1152ME105

4. Course Educational Objectives

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

- Apply fundamental knowledge of mathematics to modeling and analysis of fluid flow problems in civil and environmental engineering.
- Illustrate the experiments in pipe flows and open-channel flows and interpreting data from model studies to prototype cases, as well as documenting them in engineering reports.
- Recognise the awareness of disasters caused by an incorrect analysis in hydraulic engineering system.

5. Course Outcomes

Upon the successful completion of the course, learners will be able to

CO Nos.	Course Outcomes	Level of learning domain (Based on revised Bloom's)
CO1	Comprehend the different concepts and properties associated with fluid and solving simple problems	K3
CO2	Understand the concepts of fluid dynamics, flow measuring devices, concepts of boundary layer and solve the problems.	K3
CO3	Analyze the dimensional analysis concepts to derive fluid flow equation and derive the equation for flow through pipes.	K4
CO4	Explain the working principle of various hydraulic turbines and its performance.	K3
CO5	Explain the working principle of various hydraulic pumps and its performance.	K3

(K3-Apply)

6. Correlation of COs with Programme Outcomes

COs	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
CO1	H	L										L	L	
CO2	H	L	L									L	L	
CO3	H	L	L									L	L	
CO4	H	L	L									L	L	
CO5	H	L	L									L	L	

H- High; M-Medium; L-Low

7. Course Content

UNIT I BASIC CONCEPTS AND PROPERTIES **L-6 T-6**
Fluid – definition, distinction between solid and fluid - Units and dimensions - Properties of fluids - density, specific weight, specific volume, specific gravity, temperature, viscosity, compressibility, vapour pressure, capillary and surface tension - Fluid statics: concept of fluid static pressure, absolute and gauge pressures - pressure measurements by manometers and pressure gauges.

UNIT II FLUID KINEMATICS AND BOUNDARY LAYER CONCEPTS **L-6 T-6**
Fluid Kinematics - Flow visualization - lines of flow - types of flow (uniform flow and non-uniform flow)- continuity equation (one dimensional differential forms) - fluid dynamics - equations of motion - Navier - Stokes's equation (Statement only) Euler's equation along a streamline - Bernoulli's equation – applications - Venturi meter, Orifice meter, Pitot tube - Boundary layer flows, boundary layer thickness, boundary layer separation - drag and lift coefficients.

UNIT III FLOW THROUGH PIPES AND DIMENSIONAL ANALYSIS **L-6 T-6**
Viscous flow - Shear stress, pressure gradient relationship - laminar flow between parallel plates - Laminar flow through circular tubes (Hagen poiseulle's) - Hydraulic and energy gradient - flow through pipes - Darcy -weisback's equation - pipe roughness -friction factor-minor losses - flow through pipes in series and in parallel - power transmission - Dimensional analysis - Buckingham's π theorem- applications - similarity laws and models**.**

UNIT IV HYDRAULIC TURBINES **L-6 T-6**
Hydro turbines: definition and classifications - Pelton turbine - Francis turbine - Kaplan turbine - working principles - velocity triangles - work done - specific speed - efficiencies -performance curve for turbines.

UNIT V HYDRAULIC PUMPS **L-6 T-6**
Pumps- classifications - Centrifugal pump- classifications, working principles, priming, velocity triangles, specific speed, efficiency and performance curves - Reciprocating pump- classification, working principles, slip, performance curves and work saved by air vessels - cavitations in pumps – working principles of gear pump and submersible pump.

TOTAL: 30 + 30 = 60 periods

8. Text Books

1. Modi P.N. and Seth, S.M. "Hydraulics and Fluid Mechanics", Standard Book House, New Delhi 2013.
2. Streeter, V. L. and Wylie E. B., "Fluid Mechanics", McGraw Hill Publishing Co. 2010.

9. References

1. Kumar K. L., "Engineering Fluid Mechanics", S.Chand & Company Pvt. Ltd, 2014.
2. Robert W.Fox, Alan T. McDonald, Philip J.Pritchard, "Fluid Mechanics and Machinery", 2011.
3. Graebel. W.P, "Engineering Fluid Mechanics", Taylor & Francis, Indian Reprint, 2011
4. Bansal, R.K., "Fluid Mechanics and Hydraulics Machines", (7th edition), Laxmi publications (P) Ltd., New Delhi, 2011.

10. Revised Bloom's based Assessment Pattern

Revised Bloom's Category	Internal				University Examination %
	Unit Test-I %	Mid Term Test I%	Unit Test-II%	Mid Term Test II %	
Remember	40	40	40	40	20
Understand	60	40	60	40	60
Apply		20		20	20
Analyse					
Evaluate					
Create					

Revised Bloom's Category	Assignments	
	I (CO1 & CO2 addressed) (Max marks in %)	II (CO3 & CO4 addressed) (Max marks in %)
Remember		
Understand		
Apply	**50**	**50**
Analyse	**50**	**50**
Evaluate		
Create		

COURSE CODE	APPLIED ENGINEERING THERMODYNAMICS	L	T	P	C
1151ME108		2	2	0	3

1. Preamble

This course provides an update to the knowledge base of the students in Thermodynamics. Students gain knowledge on different working substances such as steam, refrigerants and its respective application. The concepts related to various working systems such as heat engines, refrigerator and air conditioner are explained with illustrations

2. Prerequisite

Engineering Thermodynamics 1151ME102

3. Links to other courses

1	Heat and Mass Transfer	1151ME115
2	IC Engines	1152ME110
3	Refrigeration and Air-Conditioning	1152ME120
4	Fuels and Combustion	1152ME107

4. Course Educational Objectives

Students undergoing this course are expected to:

- Understand the operating principles of gas and vapour cycles involved in power producing devices.
- Understand the working principles and performance characteristics of refrigerators and air conditioners.

5. Course Outcomes

Upon the successful completion of the course, learners will be able to

CO Nos.	Course Outcomes	Level of learning domain (Based on revised Bloom's)
CO1	Understand the properties of pure substance and solve the problems using steam table.	K3
CO2	Understand the working principle of simple and modified vapour power cycles and solve the related problems.	K3
CO3	Understand the working principle of gas power cycles and solve the related problems.	K3
CO4	Explain the working principle of refrigeration system and solve the problems.	K3
CO5	Calculate the COP of air conditioner working with various Psychrometric processes.	K3

(K3-Apply)

6. Correlation of CO's with Programme Outcomes:

Cos	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
CO1	H	L										L	H	
CO2	H	L										L	H	
CO3	H	L										L	H	
CO4	H	L	L				L					L	H	
CO5	H	L	L				L					L	H	

H- High; M-Medium; L-Low

7. Course Content
Use of steam tables permitted.

UNIT I PROPERTIES OF PURE SUBSTANCES **L-6 T-6**
Thermodynamic properties of pure substances in solid, liquid and vapour phases, P-V, P-T, T-V, T-S and H-S diagrams, PVT surfaces, Thermodynamic properties of steam, Use of steam tables and Mollier chart, Calculation of work done and heat transfer in non-flow and flow processes.

UNIT II VAPOUR POWER CYCLES **L-6 T-6**
Rankine cycle modified Rankine cycle, Reheating and Regeneration cycles, Binary vapour cycle, combined gas-vapour power cycles, and cogeneration.

UNIT III GAS POWER CYCLES **L-6 T-6**
Otto cycle, Diesel cycle and Dual cycles, Air standard efficiency, Mean effective pressure, Comparison of Otto, Diesel and Dual cycles, Ideal and Actual Brayton cycle, Stirling cycle, Ericsson cycle, Atkinson cycle.

UNIT IV – REFRIGERATION **L-6 T-6**
Refrigerants – types, Desirable properties and environmental effects, Air refrigeration cycle, Vapour Compression Refrigeration cycle, Sub cooling and Super heating, Performance calculations, Vapour Absorption Refrigeration – Ammonia water, Lithium Bromide water systems (Description only), Comparison between Vapour Compression and Vapour Absorption Refrigeration systems.

UNIT V – PSYCHROMETRY AND AIR – CONDITIONING **L-6 T-6**
Psychrometric properties, Use of psychrometric chart, Psychrometric processes – Sensible heat exchange process, Latent heat exchange process, Adiabatic mixing, Evaporative cooling, Property calculations of air-vapour mixtures.
Principles of air-conditioning, Types of air conditioning systems – summer, winter, year round air conditioners.

TOTAL= 30 + 30 = 60 periods

8. Text Books

1. Yunus A Cengel / Michael A Boles, “Thermodynamics - An Engineering Approach”, (SI Units), McGraw-Hill Higher Education, Eighth Edition, 1 February 2016.
2. P K Nag, “Basic And Applied Thermodynamics”, Tata Mc Graw Hill, New Delhi, 2014.
3. C. P. Arora and Domkudwar, “A Course in Refrigeration and Air- Conditioning”, Dhanpat Rai & Sons, 2014.

9. References

1. Onkar Singh, “Applied Thermodynamics”, New Age International (Pvt) Limited Publishers, Third Edition,2014.
2. Dr.R.Yadav, Applied Thermodynamics, (SI Units), Central Publishing House, 6th Revised Edition 2013.
3. Jones J.B and Dugan R.E., “Engineering Thermodynamics”, Prentice Hall of India, 2014.
4. TD Eastop,A Mc Conkey, “Applied Thermodynamics For Engineering Technologists”, Pearson Education Ltd., 2014.
5. R.K.Rajput, “Engineering Thermodynamics”, Laxmi Publications (P) ltd., 2014
6. freevideolectures.com › Mechanical › IIT Kharagpur

10. Revised Bloom's based Assessment Pattern

Revised Bloom's Category	Internal				University Examination %
	Unit Test 1 %	Mid Term Test 1 %	Unit Test 2 %	Mid Term Test 2 %	
Remember	10	10	10	10	10
Understand	20	20	20	20	20
Apply	40	40	70	70	40
Analyse	30	30			30
Evaluate					
Create					

Revised Bloom's Category	Assignments	
	I (CO1 & CO2 addressed) (Max marks in %)	II (CO3 & CO4 addressed) (Max marks in %)
Remember		
Understand		
Apply	**50**	**50**
Analyse	**50**	**50**
Evaluate		
Create		

COURSE CODE	THERMAL ENGINEERING	L	T	P	C
1151ME112		2	2	0	3

1. Preamble

This course imparts understanding about the power generation using heat energy conversion and makes an attempt to be conversant with the equipment's used in the process. It helps in understanding the thermodynamic concepts, the construction and the working principles of various engineering devices such as steam generators, steam nozzles, steam turbine, internal combustion engines and gas turbines.

2. Pre-Requisite

Heat and Mass Transfer — 1151ME115

3. Links to Other Courses

1. Power Plant Engineering — 1151ME116
2. Automobile Engineering — 1152ME103

4. Course Educational Objectives

- To understand the concepts associated with the construction and the working principles of various thermal devices such as steam generators, steam nozzles, steam turbines, I.C. engines and gas turbines.

5. Course Outcomes

Upon the successful completion of the course, learners will be able to

CO No.	Course Outcome	Level of learning domain (Based on revised Bloom's)
CO1	Explain the working principle of various types of steam generator, components and its performance.	K3
CO2	Explain the working principle of steam ejector and solve the steam nozzle problems.	K3
CO3	Explain the working principles of steam turbines and its performance.	K3
CO4	Describe the function of components and performance of IC engines.	K3
CO5	Explain the working principle of gas turbines and its performance.	K3

(K3-Apply)

6. Correlation of COs with Programme Outcomes

Cos	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
CO1	H	L	L			L						L	M	
CO2	H	L	L									L	M	
CO3	H	L	L									L	M	
CO4	H	L	L			L	L					L	M	
CO5	H	L	L									L	M	

H- High; M-Medium; L-Low

7. COURSE CONTENTS
Steam tables, Mollier charts and psychometric charts are required.

UNIT I STEAM GENERATORS L-6 T-6
Types and classification- low pressure fire & water tube boilers-mountings & accessories-performance testing of boilers-equivalent evaporation-boiler efficiency-boiler trial & Heat balance sheet – criteria for selection of a boiler. High pressure boilers introduction.

UNIT II STEAM NOZZLES L-6 T-6
Expansion of steam through nozzle-types of nozzles-condition for maximum discharge- critical pressure ratio- effect of friction – super saturated flow – steam jet pump

UNIT III STEAM TURBINES L-6 T-6
Principles of impulse, reaction and impulse-reaction turbines-compounding-velocity diagrams for simple & multistage turbines-work done on turbine blades & efficiencies-losses in steam turbines-governing of steam turbines.

UNIT IV INTERNAL COMBUSTION ENGINES L-6 T-6
Engine types & applications-actual cycles-valve and port timing diagrams-fuel supply-ignition-cooling& lubrication systems for SI engines &CI engines. Cetane & octane numbers of fuels- combustion – knocking & detonation – scavenging, turbocharging and supercharging- performance of IC engine-frictional power & various efficiencies & energy calculations.

UNIT V GAS TURBINES L-6 T-6
Open & closed gas turbines- ideal & actual cycles- compressor & turbine efficiency-effect of operating variables on thermal efficiency & work out put-work ratio-types of combustion of chambers-combustion efficiency –methods to improve performance-inter cooling reheating & regeneration.

Total: 30 + 30 = 60 Periods

8. Text Books

1. Nag. P.K., "Thermal Engineering", Tata McGraw Hill, Fourth Edition, 2012
2. Domkundwar, A., "A Course in Thermal Engineering", Dhanpat Rai & Co., New Delhi, 2011
3. V. Ganesan," International Combustion Engines", Tata McGraw Hill, Fourth Edition , 2012

9. References

1. Rajput, R. K., "Thermal Engineering", Laxmi Publications, 9th Edition, New Delhi, 2013
2. J.B Heywood, "I.C engines fundamentals", McGraw Hill International Edition .2011.
3. P.W Gill. J.H Smith & E.J Ziurgs," Fundamentals Of I.C Engines", Oxford & I B H Publication, 2007, New Delhi.
4. R. YADAV, "Steam & Gas Turbines", Central Publishing House, 2000.
5. P.L Ballaney, "Thermal Engineering", Khanna Publication, 5thEdition, 2005.

10. Revised Bloom's based Assessment Pattern

Revised Bloom's Category	Internal				University Examination %
	Unit Test-I %	Mid Term Test I%	Unit Test-II%	Mid Term Test II %	
Remember	40	40	40	40	20
Understand	60	40	60	40	60
Apply		20		20	20
Analyse					
Evaluate					
Create					

Revised Bloom's Category	Assignments	
	1 (CO1 &CO2) (max marks in %)	2 (CO3&CO4) (max marks in %)
Remember		
Understand		
Apply	**30**	**20**
Analyze	**70**	**80**
Evaluate		
Create		

COURSE CODE	HEAT AND MASS TRANSFER	L	T	P	C
1151ME115		2	2	0	3

1. Preamble
This course deals with the different modes of heat transfer from one medium to another. It enables an understanding of the laws governing the heat transfer and mass transfer processes and helps in designing various thermal equipment's.

2. Prerequisite

Applied Engineering Thermodynamics 1151ME108

3. Links to other courses

1 Power Plant Engineering 1152ME116
2 Automobile Engineering 1152ME103
3 Computational Fluid Dynamics 1152ME105

4. Course Educational Objectives
Students undergoing this course are expected:

- To understand the modes of heat transfer and their applications
- To apply the various methods on heat and mass transfer & their applications.
- To find the behaviour of fluids in various modes of heat and mass transfer
- To design and identify various types of heat exchangers for different thermal applications.

5. Course Outcomes
Upon the successful completion of the course, learners will be able to

CO Nos.	Course Outcomes	Level of learning domain (Based on revised Bloom's)
CO1	Understand the basic concepts of heat transfer and solve the conduction heat transfer problems.	K3
CO2	Understand to solve convective heat transfer problems.	K3
CO3	Understand the concepts of heat exchanger and solve the problems using LMTD and NTU methods.	K3
CO4	Understand the concepts of solar radiation and solve the radiation problems.	K3
CO5	Understand the basic concepts of mass transfer and solve the mass transfer and convective mass transfer problems.	K3

(K3-Apply)

6. Correlation of COs with Programme Outcomes

COs	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
CO1	H	L	L									L	M	
CO2	H	L	L				L					L	M	
CO3	H	L	L									L	M	
CO4	H	L	L				L					L	M	
CO5	H	L	L				L					L	M	

H- High; M-Medium; L-Low

7. Course Content

(HMT data book is permitted)

UNIT I CONDUCTION **L - 6 T - 6**

Basic Concepts – Mechanism of Heat Transfer – Conduction, Convection and Radiation – General Differential equation of Heat Conduction – Fourier Law of Conduction – Cartesian and Cylindrical Coordinates – One Dimensional Steady State Heat Conduction – Conduction through Plane Wall, Cylinders and Spherical systems – Composite Systems – Conduction with Internal Heat Generation – Extended Surfaces – Unsteady Heat Conduction – Lumped Analysis – Infinite and Semi Infinite Solids - Analysis using Heisler chart – Introduction to 2-D heat transfer

UNIT II CONVECTION **L - 6 T - 6**

Basic Concepts – Convective Heat Transfer Coefficients – Boundary Layer Concept – Forced Convection – External Flow – Flow over Plates, Cylinders Spheres and Bank of tubes – Internal Flow – Free Convection – Flow over Vertical Plate, Horizontal Plate, Inclined Plate, Cylinders and Spheres, Nusselt's theory of condensation - Regimes of pool boiling and flow boiling, Correlations in boiling and condensation.

UNIT III HEAT EXCHANGERS **L - 6 T - 6**

Heat Exchanger Types - Overall Heat Transfer Coefficient – Fouling Factors - Analysis – LMTD method, - NTU method.

UNIT IV RADIATION **L - 6 T - 6**

Basic Concepts, Laws of Radiation – Wien's Displacement Law - Stefan Boltzmann Law, Kirchhoff Law – Black Body Radiation – Grey body radiation - Shape Factor – Electrical Analogy – Radiation Shields.

UNIT V MASS TRANSFER **L - 6 T - 6**

Basic Concepts – Diffusion Mass Transfer – Fick's Law of Diffusion – Introduction to Steady state Molecular Diffusion – Convective Mass Transfer – Momentum, Heat and Mass Transfer Analogy – Convective Mass Transfer Correlations (Concept only)

TOTAL: 30+30=60 periods

8. Text Books

1. Holman, J.P., Heat and Mass Transfer, 10e, McGraw Hill, 2011.
2. Sachdeva, R.C., Fundamentals of Heat and Mass Transfer, Fourth Edition, New Age International (P) Ltd., New Delhi, 2012

9. References

1. Yunus A. Cengel, Heat Transfer A Practical Approach – Tata McGraw Hill - 5e, 2015.
2. Frank P. Incropera and David P. Dewitt, Fundamentals of Heat and Mass Transfer, John Wiley & Sons, Seventh Edition, 2013.
3. Nag, P.K., Heat Transfer, Tata McGraw Hill, New Delhi, 3e, 2011.
4. Ozisik, M.N., Heat Transfer, McGraw Hill Book Co., 2003.
5. Kothadaraman, C. P., Fundamentals of Heat and Mass Transfer, Fifth Edition, New Age International (P) Ltd., New Delhi, 4e, 2012
6. Incropera F.P,, DeWitt D. P., "Fundamentals of Heat Transfer", 6th edition 2011

10. Revised Bloom's based Assessment Pattern

Revised Bloom's Category	Internal				University Examination %
	Unit Test-I %	Mid Term Test I%	Unit Test-II%	Mid Term Test II %	
Remember	40	40	40	40	20
Understand	60	40	60	40	60
Apply		20		20	20
Analyse					
Evaluate					
Create					

Revised Bloom's Category	Assignments	
	1 (CO1 &CO2) (max marks in %)	2 (CO3&CO4) (max marks in %)
Remember		
Understand		
Apply	**30**	**20**
Analyze	**70**	**80**
Evaluate		
Create		

COURSE CODE	STRENGTH OF MATERIALS LABORATORY	L	T	P	C
1151ME303		0	0	2	1

1. Preamble

To supplement the theoretical knowledge gained in strength of materials with practical testing for determining the strength of materials under externally applied loads.

2. Prerequisite

Strength Of Materials 1151ME106

3. Links to other Courses

Design of Machine Elements 1151ME111

4. Course Educational Objectives

Students undergoing this course will be exposed with:

- To understand the theoretical knowledge gained in Mechanics of Solids and conduct practical testing for estimation of material properties under externally applied loads.
- To understand and conduct the microscopic examination of various materials.

5. Course Outcomes

Upon the successful completion of the course, learners will be able to

CO Nos.	Course Outcomes	Level of learning domain (Based on revised Bloom's)
CO1	Compute the tensile strength, shear strength, impact strength of the given specimen using different testing methods (UTM, Torsion, Impact Test)	K3, S3
CO2	Analyze the hardness of the given specimen using different testing methods (Brinell, Vickers and Rockwell)	K3, S3
CO3	Predict the bending stress, modulus of rigidity, fatigue strength of the given specimen using different testing methods (compression test, deflection test, fatigue test)	K3, S3
CO4	Evaluate the strain value of the given specimen using Rosette strain gauge	K3, S3

(K3-Apply, S3-Skill Level 3)

6. Correlation of Cos with Programme Outcomes

COs	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
CO1	H	M			L	L						L	H	L
CO2	H	M			L	L						L	H	L
CO3	H	M			L	L						L	H	L

H- High; M-Medium; L-Low

7. Practical

S.NO Name of the Experiment	CO
1. Tension test on a mild steel rod	CO1
2. Double shear test on Mild steel and Aluminium rods	CO1
3. Torsion test on mild steel rod.	CO1
4. Impact test on metal specimen.	CO1
5.Hardness Testing - Brinnell, Vickers and Rockwell Hardness Tester	CO2
6. Fatigue test on Aluminium rod	CO3
7. Deflection test on beams	CO3
8. Compression test on helical springs	CO3
9. Strain Measurement using Rosette strain gauge	CO3

TOTAL: 15 periods

8. Rubrics for Internal Assessment

Performance	Excellent (5)	Very good (4)	Good (3)	Average (2)	Low (1)
Observation & Record(5)	On Time Submission with neat presentation	Submission on next day with presentation	Submission within two days' time	Submission within two weeks' time	Submission after two weeks' time
Record (5)	On Time Submission with neat presentation	Submission before next lab with presentation	Submission on next lab hour	Submission within two weeks' time	Submission after two weeks' time
Attendance(5)	Above 95%	95%-90%	85%-90%	80%-85%	75%- 80%

9. Rubrics for Lab Experiments

Performance Indicator	Excellent (100 %)	Very good (80 %)	Good (60 %)	Average (40%)	Low (20%)
Identify the Equipment (10)	Identify all Equipment required	Able to Identify most of the Equipment required	Able to Identify some important Equipment required	Able to Identify few Equipment required	Not able to Identify all Equipment required
Conducting experiment as per procedure/order & readings (20)	Able to conduct the experiment completely as per procedure with the specified/ required reading	Able to conduct the experiment completely as per procedure with few readings	Able to conduct the experiment partially as per procedure with few readings	Able to conduct the experiment partially as per procedure with wrong reading	unable to conduct the experiment completely as per procedure
Formulae & Calculations (40)	Able to write all the formulae and complete the calculations correctly	Able to write all the formulae and complete the calculations partially	Able to write some formulae and complete the calculations partially with mistake in units	Able to write some formulae and unable to complete the calculations	Unable to write all the formulae and complete the calculations
Tabulation & Result (20)	Able to formulate the tabulation completely with correct units and arrive the exact results	Able to formulate the tabulation completely with correct units and arrive the results with deviations	Able to formulate the tabulation completely with incorrect units and arrive the results with deviations	Able to formulate the tabulation partially with incorrect units and arrive the results with much deviations	Unable to formulate the tabulation completely.
Viva- voce (10)	Good Course knowledge in subject	Reasonably Answered	Partially answered	Partially answered with some clue	Attempt to answer

COURSE CODE	DYNAMICS OF MACHINERY LABORATORY	L	T	P	C
1151ME306		0	0	2	1

1. Preamble

This course helps students to correlate the theoretical knowledge of balancing to applications and to conduct experiment to measure moment of inertia, whirling speeds, and vibrations, sensitivity of governors and characteristics of gyroscopes.

2. Pre-Requisite

Dynamics of Machinery 1151ME110

3. Links to Other Courses:

Design of Machine Elements 1151ME111

4. Course Educational Objectives

Students undergoing this course will be provided with:

- To understand rigid body motions and forces for the transmission systems, and dynamics.
- To make the students understand the motion as well as power flows while in negotiating a curve.

5. Course Outcomes

Students undergoing this course are able to

CO Nos.	Course Outcomes	Level of learning domain (Based on revised Bloom's)
CO1	Conduct experiments to study the behavior of various machine components.	K3, S3
CO2	Conduct experiments to study the behavior of governors and gyroscopes.	K3, S3
CO3	Perform simple vibration experiments to determine the frequency and transmissibility.	K3, S3

(K3- Apply, S3- Skill level 3)

6. Correlation of COs with Programme Outcomes

Cos	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
CO1	M											L	L	
CO2	M											L	L	
CO3	M											L	L	

H- High; M-Medium; L-Low

7. Practical

List of Experiments

S.No	Name of the Experiment	CO
1	Determination of influence coefficients for multi-degree freedom suspension system.	CO 1
2	Determination of torsional frequencies for compound pendulum and flywheel system with lumped parameters.	
3	Perform balancing ozaf rotating masses for a given rotor	
4	Perform balancing of reciprocating masses for a given rotor	
5	Determination of moment of inertia by oscillation method for connecting rod and flywheel.	
6	Motorized Gyroscope-Determination of gyroscopic couple.	CO 2
7	Governors - Determination of sensitivity, effort, etc. for Watt, Porter, Proell, Hartnell governors	
8	Vibrating system - spring mass system-Determination of damping co-efficient of single degree of freedom system.	CO 3
9	Transverse vibration –free- Beam. Determination of natural frequency and deflection of beam.	
10	Transverse vibration for various end condition such as Free-Free, Fixed-Free for determination of natural frequency by free and forced vibration test.	

Total: 15 Periods

8. Rubrics for Internal Assessment

Performance	Excellent (5)	Very good (4)	Good (3)	Average (2)	Low (1)
Observation & Record(5)	On Time Submission with neat presentation	Submission on next day with presentation	Submission within two days' time	Submission within two weeks' time	Submission after two weeks' time
Record (5)	On Time Submission with neat presentation	Submission before next lab with presentation	Submission on next lab hour	Submission within two weeks' time	Submission after two weeks' time
Attendance(5)	Above 95%	95%-90%	85%-90%	80%-85%	75%- 80%

8. Rubrics for Lab Exam

Performance Indicator	**Excellent (100 %)**	**Very good (80 %)**	**Good (60 %)**	**Average (40%)**	**Low (20%)**
Identify the tools & Equipment (10)	Identify all the tools & Equipment required	Able to Identify most of the tools & Equipment required	Able to Identify some important tools & Equipment required	Able to Identify few tools & Equipment required	Not able to Identify all the tools & Equipment required
Conducting experiment as per procedure/order & readings (20)	Able to conduct the experiment completely as per procedure with the specified/ required reading	Able to conduct the experiment completely as per procedure with few readings	Able to conduct the experiment partially as per procedure with few readings	Able to conduct the experiment partially as per procedure with wrong reading	unable to conduct the experiment completely as per procedure
Formulae & Calculations (40)	Able to write all the formulae and complete the calculations correctly	Able to write all the formulae and complete the calculations partially	Able to write some formulae and complete the calculations partially with mistake in units	Able to write some formulae and unable to complete the calculations	Unable to write all the formulae and complete the calculations
Tabulation & Result (20)	Able to formulate the tabulation completely with correct units and arrive the exact results	Able to formulate the tabulation completely with correct units and arrive the results with deviations	Able to formulate the tabulation completely with incorrect units and arrive the results with deviations	Able to formulate the tabulation partially with incorrect units and arrive the results with much deviations	Unable to formulate the tabulation completely.
Viva- voce (10)	Good Course knowledge in subject	Reasonably Answered	Partially answered	Partially answered with some clue	Attempt to answer

COURSE CODE	MANUFACTURING TECHNOLOGY LABORATORY	L	T	P	C
1151ME302		0	0	2	1

1. Preamble
This course provides an opportunity to demonstrate the techniques of metal casting processes, welding processes and various types of manufacturing processes.

2. Pre-Requisite
Manufacturing Technology 1151ME104

3. Links to Other Courses
1 Engineering Metrology and Measurements 1151ME113
2 Machining and Machine Tools Technology 1151ME107

4. Course Educational Objectives
To understand the various manufacturing processes and machining related to casting, forming, joining of metals, moulding processes materials.

5. Course Outcomes
The students would be benefitted with the following outcomes:

CO Nos.	Course Outcomes	Level of learning domain (Based on revised Bloom's)
CO1	Demonstrate preparation of moulds for casting applications	K3, S3
CO2	Produce components as per the given drawing using the lathe machine	K3, S3
CO3	Make simple components / joints using welding equipment and tools and injection moulding machine	K3, S3

(K3 - Apply; S3 - Skill Level)

6. Correlation of COs with Programme Outcomes

CO s	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
CO1	H	L										L	H	L
CO2	H	L										L	H	L
CO3	H	L										L	H	L

H- High; M-Medium; L-Low

7. Practical

List of Experiments

S.NO.	Name of the Experiment	CO
1.	Preparation of sand mould with solid & split pattern.	CO1
2.	Preparation of sand mould with loose piece pattern.	CO1
3.	Preparation of sand mould with core.	CO1
4.	Eccentric turning operation in a Lathe.	CO2
5.	Taper turning using compound rest in a Lathe.	CO2
6.	Thread cutting and knurling operation in a Lathe.	CO2
7.	Boring and internal thread cutting in a Lathe.	CO2
8.	Arc welding.	CO3
9.	Gas Welding.	CO3
10.	Study of Brazing process.	CO3
11.	Study of Injection Moulding process.	CO3

Total = 15 periods

8. Rubrics for Internal Assessment

Performance	Excellent (5)	Very good (4)	Good (3)	Average (2)	Low (1)
Observation & Record(5)	On Time Submission with neat presentation	Submission on next day with presentation	Submission within two days time	Submission within two weeks time	Submission after two weeks time
Record (5)	On Time Submission with neat presentation	Submission before next lab with presentation	Submission on next lab hour	Submission within two weeks time	Submission after two weeks time
Attendance(5)	Above 95%	95%-90%	85%-90%	80%-85%	75%- 80%

9. Rubrics for Lab Experiments

Performance Indicator	Excellent (100 %)	Very good (80 %)	Good (60 %)	Average (40%)	Low (20%)
Identify the Equipment (10)	Identify all Equipment required	Able to Identify most of the Equipment required	Able to Identify some important Equipment required	Able to Identify few Equipment required	Not able to Identify all Equipment required
Conducting experiment as per procedure/order & readings (20)	Able to conduct the experiment completely as per procedure with the specified/ required reading	Able to conduct the experiment completely as per procedure with few readings	Able to conduct the experiment partially as per procedure with few readings	Able to conduct the experiment partially as per procedure with wrong reading	unable to conduct the experiment completely as per procedure
Formulae & Calculations (40)	Able to write all the formulae and complete the calculations correctly	Able to write all the formulae and complete the calculations partially	Able to write some formulae and complete the calculations partially with mistake in units	Able to write some formulae and unable to complete the calculations	Unable to write all the formulae and complete the calculations
Tabulation & Result (20)	Able to formulate the tabulation completely with correct units and arrive the exact results	Able to formulate the tabulation completely with correct units and arrive the results with deviations	Able to formulate the tabulation completely with incorrect units and arrive the results with deviations	Able to formulate the tabulation partially with incorrect units and arrive the results with much deviations	Unable to formulate the tabulation completely.
Viva- voce (10)	Good Course knowledge in subject	Reasonably Answered	Partially answered	Partially answered with some clue	Attempt to answer

COURSE CODE	MACHINING AND MACHINE TOOLS LABORATORY	L	T	P	C
1151ME304		0	0	2	1

1. Preamble
To provide the students an opportunity to learn about the functions and working of various special machines and its respective applications

2. Pre requisite
Manufacturing Technology 1151ME104

3. Links to other Courses
Computer Integrated Manufacturing 1152ME106

4. Course Educational Objectives:
Students undergoing this course will be provided with:
- Knowledge to operate various machines for special operations.
- Knowledge to Operate CNC machines to produce parts using G codes and M codes

5. Course Outcomes
Upon the successful completion of the course, learners will be able to

CO Nos.	Course Outcomes	Level of learning domain (Based on revised Bloom's)
CO1	Measure the shear angle and cutting force in metal cutting operation	K3,S3
CO2	Make components as per the given drawing using various special purpose machines	K3,S3
CO3	Produce simple parts using CNC lathe and CNC milling machines	K3, S3

(K3-Apply, S3-Skill level)

6. Correlation of Course Outcomes with Programme Outcomes

Cos	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
CO1	H											L	L	
CO2	H			L								L	M	H
CO3	H			L								L	M	H

H- High; M-Medium; L-Low

7. Practical

List of Experiments

S.NO	Name of the Experiment	CO
1	Measurement of shear angle and cutting force during metal cutting operation in a lathe	CO1
2	Machining of parts using Capstan lathe/ semi-automatic lathe	CO2
3	Machining MS round into Square / Hexagonal using Shaper and Milling machine	CO2
4	Internal keyway cutting on MS round using Slotting machine	CO2
5	Surface Grinding on MS flat	CO2
6	Milling of gears on the MS round	CO2
7	Step turning & thread cutting using CNC lathe	CO3
8	Taper turning using CNC lathe	CO3
9	Linear and circular interpolation using CNC milling machine	CO3
10	Peck Drilling in CNC milling machine	CO3

Total = 15 Periods

8. Rubrics for Internal Assessment

Performance	Excellent (5)	Very good (4)	Good (3)	Average (2)	Low (1)
Observation & Record(5)	On Time Submission with neat presentation	Submission on next day with presentation	Submission within two days' time	Submission within two weeks' time	Submission after two weeks' time
Record (5)	On Time Submission with neat presentation	Submission before next lab with presentation	Submission on next lab hour	Submission within two weeks' time	Submission after two weeks' time
Attendance(5)	Above 95%	95%-90%	85%-90%	80%-85%	75%- 80%

9. Rubrics for Lab Experiments

Performance Indicator	Excellent (100 %)	Very good (80 %)	Good (60 %)	Average (40%)	Low (20%)
Identify the Equipment (10)	Identify all Equipment required	Able to Identify most of the Equipment required	Able to Identify some important Equipment required	Able to Identify few Equipment required	Not able to Identify all Equipment required
Conducting experiment as per procedure/order & readings (20)	Able to conduct the experiment completely as per procedure with the specified/ required reading	Able to conduct the experiment completely as per procedure with few readings	Able to conduct the experiment partially as per procedure with few readings	Able to conduct the experiment partially as per procedure with wrong reading	unable to conduct the experiment completely as per procedure
Formulae & Calculations (40)	Able to write all the formulae and complete the calculations correctly	Able to write all the formulae and complete the calculations partially	Able to write some formulae and complete the calculations partially with mistake in units	Able to write some formulae and unable to complete the calculations	Unable to write all the formulae and complete the calculations
Tabulation & Result (20)	Able to formulate the tabulation completely with correct units and arrive the exact results	Able to formulate the tabulation completely with correct units and arrive the results with deviations	Able to formulate the tabulation completely with incorrect units and arrive the results with deviations	Able to formulate the tabulation partially with incorrect units and arrive the results with much deviations	Unable to formulate the tabulation completely.
Viva- voce (10)	Good Course knowledge in subject	Reasonably Answered	Partially answered	Partially answered with some clue	Attempt to answer

COURSE CODE	MECHATRONICS LABORATORY	L	T	P	C
1151ME305		0	0	2	1

1. Preamble

This course provides an introduction to the multidisciplinary field of engineering, modeling of Mechatronics systems; microprocessor programming and interfacing; architecture of PLC; selection and implementation of sensors and actuators.

2. Pre requisite

Basic Electrical and Electronics 1150

3. Links to other courses

Industrial Robotics 1154ME106

4. Course Educational Objectives

Students undergoing this course are expected to

- Inculcate Knowledge in mechanical, electronics and computing Engineering.
- Understand the terminologies of microprocessor programming, understand the principles of Sensors, Actuators and Control systems.
- Design solutions for the Mechatronics systems.

5. Course Outcomes

The students would be benefitted with the following outcomes:

CO Nos.	Course Outcomes	Level of learning domain (Based on revised Bloom's)
CO1	Demonstrate knowledge of various mechatronics system components	K3, S3
CO2	Interpret about various electrical drives and PLC	K3, S3
CO3	Design and analysis of drives using Automation studio and Lab view software	K3, S3

(K3-Apply, S3 – Skill level 3)

6. Correlation of COs with Programme Outcomes

Cos	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
CO1	H		L									L	H	M
CO2	H		L									L	H	M
CO3	H		L									L	H	M

H- High; M-Medium; L-Low

7. Practical

List of Experiments

S.No	Name of the Experiment	CO
1	Design of circuits with logic sequence using Electro pneumatic trainer kits.	CO 1
2	Stepper Motor Interfacing with 8051 Micro controller	
	(i) Full step resolution	CO 2
	(ii) Half step resolution	CO 2
3	Speed control of servo motor	CO 2
4	Circuits with multiple cylinder sequences in Electro pneumatic using PLC.	
5	Simulation of basic Hydraulic, Pneumatic and Electric circuits using automation studio software.	CO 3
6	Modeling and analysis of basic systems using LAB VIEW	CO 3
7	Computerized data logging system with control for process variables like pressure, flow and temperature.	CO 3

8. Rubrics for Internal Assessment

Performance	Excellent (5)	Very good (4)	Good (3)	Average (2)	Low (1)
Observation & Record(5)	On Time Submission with neat presentation	Submission on next day with presentation	Submission within two days time	Submission within two weeks time	Submission after two weeks time
Record (5)	On Time Submission with neat presentation	Submission before next lab with presentation	Submission on next lab hour	Submission within two weeks time	Submission after two weeks time
Attendance(5)	Above 95%	95%-90%	85%-90%	80%-85%	75%- 80%

9. Rubrics for Lab Experiments

Performance Indicator	Excellent (100 %)	Very good (80 %)	Good (60 %)	Average (40%)	Low (20%)
Identify the Equipment (10)	Identify all Equipment required	Able to Identify most of the Equipment required	Able to Identify some important Equipment required	Able to Identify few Equipment required	Not able to Identify all Equipment required
Conducting experiment as per procedure/order & readings (20)	Able to conduct the experiment completely as per procedure with the specified/ required reading	Able to conduct the experiment completely as per procedure with few readings	Able to conduct the experiment partially as per procedure with few readings	Able to conduct the experiment partially as per procedure with wrong reading	unable to conduct the experiment completely as per procedure
Formulae & Calculations (40)	Able to write all the formulae and complete the calculations correctly	Able to write all the formulae and complete the calculations partially	Able to write some formulae and complete the calculations partially with mistake in units	Able to write some formulae and unable to complete the calculations	Unable to write all the formulae and complete the calculations
Tabulation & Result (20)	Able to formulate the tabulation completely with correct units and arrive the exact results	Able to formulate the tabulation completely with correct units and arrive the results with deviations	Able to formulate the tabulation completely with incorrect units and arrive the results with deviations	Able to formulate the tabulation partially with incorrect units and arrive the results with much deviations	Unable to formulate the tabulation completely.
Viva- voce (10)	Good Course knowledge in subject	Reasonably Answered	Partially answered	Partially answered with some clue	Attempt to answer

COURSE CODE	FLUID MECHANICS AND MACHINERY LABORATORY	L	T	P	C
1151ME301		0	0	2	1

1. Preamble

This course provides an exposure to the properties and behaviour of fluids. It introduces dimensional analysis and enables application of the concepts in fluid machinery.

2. Pre-requisite

Fluid mechanics and machinery 1151ME103

3. Links to other courses

1 Heat and Mass Transfer 1151ME115
2 Applied Hydraulics & Pneumatics 1152ME102

4. Course Educational Objectives

Students, after undergoing this course would

- Apply fundamental knowledge of mathematics to modelling and analysis of fluid flow problems engineering.
- Illustrate the experiments in pipe flows and interpreting data from model studies to prototype cases.

5. Course Outcomes

Upon the successful completion of the course, learners will be able to

CO Nos.	Course Outcomes	Level of learning domain (Based on revised Bloom's)
CO1	Verify the Bernoulli's Theorem	K3, S3
CO2	Determine the performance of various flow measuring devices	K3, S3
CO3	Evaluate the performance and draw the characteristics curves of fluid pumps	K3, S3
CO4	Perform the characteristics study of Impulse, Reaction & Axial flow turbines	K3, S3

(K3 – Apply; S3 – Skill Level 3)

6. Correlation of COs with Programme Outcomes

Cos	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
CO1	H	L										L	M	L
CO2	H	L										L	M	L
CO3	H	L										L	M	L
CO4	H	L										L	M	L

H- High; M-Medium; L-Low

7. Practical

List of Experiments

S.No	Name of the Experiment	CO
1.	Verification of Bernoulli's theorem.	CO1
2.	Determine the Coefficient of discharge of given Orifice meter / Venturimeter.	CO2
3.	Determine the Coefficient of discharge of given Pitot tube.	CO2
4.	Determine the Friction Factor of fluid flow by Major loss / Minor loss.	CO2
5.	Calculate the rate of flow using Rotameter.	CO2
6.	Conduct experiment and draw the performance characteristic curves of Centrifugal Pump / Reciprocating Pump.	CO3
7.	Conduct experiment and draw the performance characteristic curves of Gear Pump /Jet Pump.	CO3
8.	Conduct experiment and draw the performance characteristic curves of Submersible Pump.	CO3
9.	Conduct experiment and draw the performance characteristic curves of Pelton Wheel Turbine.	CO4
10.	Conduct experiment and draw the performance characteristics curves of Francis Turbine.	CO4
11.	Conduct experiment and draw the performance characteristic curves of Kaplan Turbine.	CO4

TOTAL: 15 periods

8. Rubrics for Internal Assessment

Performance	Excellent (5)	Very good (4)	Good (3)	Average (2)	Low (1)
Observation & Record(5)	On Time Submission with neat presentation	Submission on next day with presentation	Submission within two days time	Submission within two weeks time	Submission after two weeks time
Record (5)	On Time Submission with neat presentation	Submission before next lab with presentation	Submission on next lab hour	Submission within two weeks time	Submission after two weeks time
Attendance(5)	Above 95%	95%-90%	85%-90%	80%-85%	75%- 80%

9. Rubrics for Lab Experiments

Performance Indicator	Excellent (100 %)	Very good (80 %)	Good (60 %)	Average (40%)	Low (20%)
Identify the Equipment (10)	Identify all Equipment required	Able to Identify most of the Equipment required	Able to Identify some important Equipment required	Able to Identify few Equipment required	Not able to Identify all Equipment required
Conducting experiment as per procedure/order & readings (20)	Able to conduct the experiment completely as per procedure with the specified/ required reading	Able to conduct the experiment completely as per procedure with few readings	Able to conduct the experiment partially as per procedure with few readings	Able to conduct the experiment partially as per procedure with wrong reading	unable to conduct the experiment completely as per procedure
Formulae & Calculations (40)	Able to write all the formulae and complete the calculations correctly	Able to write all the formulae and complete the calculations partially	Able to write some formulae and complete the calculations partially with mistake in units	Able to write some formulae and unable to complete the calculations	Unable to write all the formulae and complete the calculations
Tabulation & Result (20)	Able to formulate the tabulation completely with correct units and arrive the exact results	Able to formulate the tabulation completely with correct units and arrive the results with deviations	Able to formulate the tabulation completely with incorrect units and arrive the results with deviations	Able to formulate the tabulation partially with incorrect units and arrive the results with much deviations	Unable to formulate the tabulation completely.
Viva- voce (10)	Good Course knowledge in subject	Reasonably Answered	Partially answered	Partially answered with some clue	Attempt to answer

COURSE CODE	THERMAL ENGINEERING LABORATORY	L	T	P	C
1151ME307		0	0	2	1

1. Preamble

This course help students to correlate the theoretical knowledge of thermal engineering and IC engines to practical applications and to conduct experiments to measure Brake power, indicated power of two stroke and four stroke engine and viscosity, flash and fire point of different fuels.

2. Pre-Requisite

Engineering Thermodynamics. 1151ME102

3. Links to Other Courses

Heat and Mass Transfer 1151ME115

4. Course Educational Objectives

Students undergoing this course will be provided with:

- To understand the port timing and valve timing of two strokes and four stroke IC engines by doing experiments.
- To understand the performance of single cylinder and multi cylinder IC engines from load energy balance tests.

5. Course Outcomes

Upon the successful completion of the course, learners will be able to

CO Nos.	Course Outcomes	Level of learning domain (Based on revised Bloom's)
CO1	Draw the port and valve timing diagram of 2-stroke, 4-stroke IC engine.	K3, S3
CO2	Assess the performance of various IC engines by conducting different tests.	K3, S3
CO3	Measure the flash point, fire point and viscosity of lubricant and fuels used in IC engines.	K3, S3

(K3- Apply, S3- Skill level 3)

6. Correlation of COs with Programme Outcomes:

Cos	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
CO1	H	M	L	L		H						L	H	L
CO2	H	M	L	L		H						L	H	L
CO3	H	M	L	L		H						L	H	L

H- High; M-Medium; L-Low

7. Practical

List of Experiments

S.NO	Name of the Experiment	CO
1	Port timing diagram of two-stroke engine	CO1
2	Valve timing diagram of four stroke engine.	CO1
3	Performance test on two-stroke IC engine.	CO2
4	Performance test on four-stroke IC engine.	CO2
5	Morse Test on Multi-cylinder IC engine.	CO2
6	Heat balance test on four-stroke IC engine.	CO2
7	Determination of flash point and fire point of a lubricant	CO3
8	Determination of flash point and fire point of a fuel	CO3
9	Determination of viscosity of a lubricant.	CO3

Total = 15 Periods

8. Rubrics for Internal Assessment

Performance	Excellent (5)	Very good (4)	Good (3)	Average (2)	Low (1)
Observation & Record(5)	On Time Submission with neat presentation	Submission on next day with presentation	Submission within two days time	Submission within two weeks time	Submission after two weeks time
Record (5)	On Time Submission with neat presentation	Submission before next lab with presentation	Submission on next lab hour	Submission within two weeks time	Submission after two weeks time
Attendance(5)	Above 95%	95%-90%	85%-90%	80%-85%	75%- 80%

9. Rubrics for Lab Experiments

Performance Indicator	**Excellent (100 %)**	**Very good (80 %)**	**Good (60 %)**	**Average (40%)**	**Low (20%)**
Identify the Equipment (10)	Identify all Equipment required	Able to Identify most of the Equipment required	Able to Identify some important Equipment required	Able to Identify few Equipment required	Not able to Identify all Equipment required
Conducting experiment as per procedure/order & readings (20)	Able to conduct the experiment completely as per procedure with the specified/ required reading	Able to conduct the experiment completely as per procedure with few readings	Able to conduct the experiment partially as per procedure with few readings	Able to conduct the experiment partially as per procedure with wrong reading	unable to conduct the experiment completely as per procedure
Formulae & Calculations (40)	Able to write all the formulae and complete the calculations correctly	Able to write all the formulae and complete the calculations partially	Able to write some formulae and complete the calculations partially with mistake in units	Able to write some formulae and unable to complete the calculations	Unable to write all the formulae and complete the calculations
Tabulation & Result (20)	Able to formulate the tabulation completely with correct units and arrive the exact results	Able to formulate the tabulation completely with correct units and arrive the results with deviations	Able to formulate the tabulation completely with incorrect units and arrive the results with deviations	Able to formulate the tabulation partially with incorrect units and arrive the results with much deviations	Unable to formulate the tabulation completely.
Viva- voce (10)	Good Course knowledge in subject	Reasonably Answered	Partially answered	Partially answered with some clue	Attempt to answer

COURSE CODE	HEAT AND MASS TRANSFER LABORATORY	L	T	P	C
1151ME309		0	0	2	1

1. Preamble

This course deals with applying the knowledge obtained from the heat and mass transfer theory course to consolidate the concepts. It enables an understanding of the laws governing the heat transfer and mass transfer processes and helps in designing and performing various thermal equipment's.

2. Prerequisite

Thermal Power Engineering

3. Links to other courses

Power Plant Engineering

4. Course Educational Objectives

Students undergoing this course are expected:

- To apply the various methods on heat and mass transfer & their applications.
- To find the behavior of fluids in various modes of heat and mass transfer
- To design and identify various types of heat exchangers for different thermal applications.

5. Course Outcomes

Upon the successful completion of the course, learners will be able to

CO Nos.	Course Outcomes	Level of learning domain (Based on revised Bloom's)
CO1	Demonstrate the knowledge of thermal conductivity measurement.	K3, S3
CO2	Evaluate the Stefan Boltzmann constant and emissivity by radiation experiments.	K3, S3
CO3	Analyze the performance of various thermal system.	K3, S3
CO4	Evaluate the convective heat transfer coefficient of different materials.	K3, S3

(K3-Apply, S3 - Skill level)

6. Correlation of COs with Programme Outcomes

COs	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
CO1.	H	M	L	L	L							M	H	L
CO2.	H	M	L	L	L							M	H	L
CO3	H	M	L	L	L							M	H	L
CO4	H	M	L	L	L							M	H	L

H- High; M-Medium; L-Low

7. Practical

List of Experiments

Sl No	Name of the Experiment	CO No.
1	Determination of thermal conductivity using lagged pipe apparatus	CO1
2	Determination of thermal conductivity using guarded plate apparatus	
3	Determination of Stefan Boltzmann constant	CO2
4	Determination of radiation from a grey body	
5	Determination of COP of refrigerant	CO3
6	Experiment on parallel flow heat exchanger	
7	Experiment on counter flow heat exchanger	
8	Determine COP of air-conditioning test rig	
9	Determination of heat transfer coefficient using pin fin apparatus	CO4
10	Determination of convective heat transfer coefficient during natural convection	
11	Determination of convective heat transfer coefficient during forced convection	

TOTAL = 15 periods

8. Rubrics for Internal Assessment

Performance	Excellent (5)	Very good (4)	Good (3)	Average (2)	Low (1)
Observation & Record(5)	On Time Submission with neat presentation	Submission on next day with presentation	Submission within two days time	Submission within two weeks time	Submission after two weeks time
Record (5)	On Time Submission with neat presentation	Submission before next lab with presentation	Submission on next lab hour	Submission within two weeks time	Submission after two weeks time
Attendance(5)	Above 95%	95%-90%	85%-90%	80%-85%	75%- 80%

9. Rubrics for Lab Experiments

Performance Indicator	**Excellent (100 %)**	**Very good (80 %)**	**Good (60 %)**	**Average (40%)**	**Low (20%)**
Identify the Equipment (10)	Identify all Equipment required	Able to Identify most of the Equipment required	Able to Identify some important Equipment required	Able to Identify few Equipment required	Not able to Identify all Equipment required
Conducting experiment as per procedure/order & readings (20)	Able to conduct the experiment completely as per procedure with the specified/ required reading	Able to conduct the experiment completely as per procedure with few readings	Able to conduct the experiment partially as per procedure with few readings	Able to conduct the experiment partially as per procedure with wrong reading	unable to conduct the experiment completely as per procedure
Formulae & Calculations (40)	Able to write all the formulae and complete the calculations correctly	Able to write all the formulae and complete the calculations partially	Able to write some formulae and complete the calculations partially with mistake in units	Able to write some formulae and unable to complete the calculations	Unable to write all the formulae and complete the calculations
Tabulation & Result (20)	Able to formulate the tabulation completely with correct units and arrive the exact results	Able to formulate the tabulation completely with correct units and arrive the results with deviations	Able to formulate the tabulation completely with incorrect units and arrive the results with deviations	Able to formulate the tabulation partially with incorrect units and arrive the results with much deviations	Unable to formulate the tabulation completely.
Viva- voce (10)	Good Course knowledge in subject	Reasonably Answered	Partially answered	Partially answered with some clue	Attempt to answer

Integrated Core Course

Integrated Core Course					
Code	**Course**	**L**	**T**	**P**	**C**
Manufacturing Domain					
1151ME201	Engineering Metrology and Measurements	2	0	2	3
1151ME202	Finite Element Analysis	2	0	2	3
1151ME203	Computer Aided Design and Drafting	1	0	2	2

COURSE CODE	ENGINEERING METROLOGY AND MEASUREMETNS	L	T	P	C
1151ME201		2	0	2	3

1. Preamble

This course provides knowledge on various metrological equipment's available to measure the dimensions of the components and to understand the principles of Laser and advances in metrology.

2. Prerequisite

EngineeringPhysics - 1150PH101

3. Links to otherCourses:

Project Work

4. Course Educational Objectives

Students undergoing this course are expected to:

- Understand the significance of measurement, generalized measurement system.
- Have familiarity on the correct procedure to be adopted to measure the dimension of the components.
- Understand the principles of laser and advances in metrology

5. Course Outcomes

Upon the successful completion of the course, learners will be able to

CO Nos.	Course Outcomes	Level of learning domain (Based on revised Bloom's)
CO1	Generalise the importance of measuring system	K2
CO2	Demonstrate the concepts of linear and angular measurements to practical applications	K3
CO3	Illustrate the methods for form measurements.	K3
CO4	Describe the principles and applications of laser in metrology.	K3
CO5	Select the equipment and suitable technique to measure power, force and temperature.	K3

6. Correlation of Cos with Programme Outcomes

COs	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
CO1	H	L		L								L	M	L
CO2	H	l		L								L	M	L
CO3	H			L								L	M	L
CO4	H			L	L							L	M	L
CO5	H			L	L							L	M	L

H- High; M-Medium; L-Low

7. Course Content

UNIT I CONCEPT OF MEASUREMENT L- 6 P-6

General concept – Generalised measurement system-Units and standards-measuring instruments-sensitivity, readability, range of accuracy, precision-static and dynamic response-repeatability-systematic and random errors-correction, calibration, interchangeability.

Experiments: Demonstration on various measuring instruments of concept of measurement.

UNIT II LINEAR AND ANGULAR MEASUREMENT L-6 P-6

Linear measuring instruments: Vernier, micrometer, Slip gauges, limit gauges- Comparators: Mechanical, pneumatic and electrical. Angular measurements: -Sine bar, optical bevel protractor.

Experiments: Calibration of linear measuring instruments, Calibration of angle measuring instruments.

UNIT III FORM MEASUREMENT L-6 P-6

Measurement of screw threads-Thread gauges-measurement of gears-tooth thickness-constant chord and base tangent method –surface finish, straightness and flatness measurements.

Experiments: Measurement of thread parameters, Measurements of Gear Tooth Dimensions.

UNIT IV LASER AND ADVANCES IN METROLOGY L-6 P-6

Precision instruments based on laser-Principles- laser interferometer-application in linear, angular measurements and machine tool metrology, Coordinate measuring machine (CMM) - Constructional features – types, applications.

Experiments: Measurement of the taper angle used by profile projector, Measurement of straightness and flatness used by Autocollimator.

UNIT V MEASUREMENT OF POWER AND TEMPERATURE RELATED PARAMETER L-6 P-6

Measurement of power: mechanical, pneumatic, hydraulic and electrical type. Temperature: bimetallic strip, pressure thermometers, thermocouples.

Experiments: Measurement of Displacement,Temperature,Force and torque.

TOTAL = 60 periods

8. Text Books:

1. Jain. R.K., “Engineering Metrology”, Khanna Publishers, New Delhi, 2009.
2. Dr N. V. Raghavendra, Dr LKrishnamurthy., “Engineering Metrology and Measurements”, OUP India Publishers, 2013.

9. References:

1. Thomas G.Beckwith, RoyD.Marangoni, JohnH.Lienhard V, “Mechanical Measurements”, Pearson Education, 2007.
2. Alan S. Morris, “The Essence of Measurement”, Prentice Hall of India, 1997
3. A.K, “Instrumentation and Mechanical Measurements”, Galgotia Publications, 2005
4. A.M.Badadhe, “Metrology And Quality Control”, Technical Publications, Pune, 2006.
5. http://nptel.iitm.ac.in/

10. Revised Bloom's based Assessment Pattern

Revised Bloom's Category	Internal				University Examination %
	Unit Test- I %	Mid Term Test I%	Unit Test- II%	Mid Term Test II %	
Remember	40	40	40	40	20
Understand	60	40	60	40	60
Apply		20		20	20
Analyse					
Evaluate					
Create					

Revised Bloom's Category	Assignments	
	1 (CO1 &CO2) (max marks in %)	2 (CO3&CO4) (max marks in %)
Remember		
Understand		
Apply	**30**	**20**
Analyze	**70**	**80**
Evaluate		
Create		

COURSE CODE	**FINITE ELEMENT ANALYSIS**	**L**	**T**	**P**	**C**
1151ME202		**2**	**0**	**2**	**3**

1. Preamble

This course imparts the knowledge to develop a thorough understanding of the basic principles of the finite element analysis techniques with an ability to effectively use the tools of the analysis for solving practical problems arising in engineering applications.

2. Prerequisite

Strength of Materials	1151ME106

3. Links to other courses:

Analysis of Mechanical Systems	1152ME202

4. Course Educational Objectives

Students undergoing this course are expected to:

- Understand how to mathematically model physical systems and solve using numerical techniques.
- Select appropriate element and boundary conditions for various 1D & 2D Boundary value problems.
- Give exposure to software tools needed to analyze engineering problems.
- Expose to different applications of simulation and analysis tools.

5. Course Outcomes

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

CO Nos.	**Course Outcomes**	**Level of learning domain (Based on revised Bloom's)**
CO1	Illustrate the knowledge of mathematical principles of finite element analysis.	K2, S3
CO2	Apply finite element techniques to solve 1D problems.	K3, S3
CO3	Apply finite element techniques to solve 2D problems	K3, S3
CO4	Analyze Heat Transfer problems by finite element techniques	K4, S3
CO5	Analyze Dynamic analysis problems by finite element techniques	K4, S3

(K4-Analyze)

6. Correlation of COs with Programme Outcomes

COs	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
CO1	H	H	M		M							M	M	H
CO2	H	H	M		M							M	M	H
CO3	H	H	M		M							M	M	H
CO4	H	H	M		M							M	M	H
CO5	H	H	M		M							M	M	H

H- High; M-Medium; L-Low

7. Course Content

UNIT I INTRODUCTION 6 + 6

Mathematical Modeling of field problems in Engineering, Governing Equations, Boundary, Initial and Eigen Value problems, Weighted Residual Methods, Ritz Technique – Basic concepts of the Finite Element Method

Experiments: Demonstration on Ansys Working Environment, Creations of Key points, Lines, Surfaces.

UNIT II ONE-DIMENSIONAL PROBLEMS – BAR & TRUSS ELEMENTS 6 + 6

One Dimensional Second Order Equations, Discretization, Element types Linear and Higher order Elements, Derivation of Shape functions and Stiffness matrices and force vectors Assembly of Matrices

Experiments: Force and Stress analysis using link elements in Trusses, cables and bars Stress and deflection analysis in beams with different support conditions.

UNIT III TWO DIMENSIONAL SCALAR VARIABLE PROBLEMS 6 + 6

Second Order 2D Equations involving Scalar Variable Functions – Vibrational formulation –Finite Element formulation – Triangular elements and Quadrilateral elements- Shape functions and element matrices and vectors.

Experiments: Stress analysis of flat plates and simple shells. Stress analysis of Axi – symmetric components

UNIT IV APPLICATIONS IN HEAT TRANSFER 6 + 6

Heat Conduction: 1-D & 2-D Heat conduction problems, Slabs, fins, Transient Thermal Analysis, Applications for heat conduction and 2D stress analysis

Experiments: Thermal stress and heat transfer analysis of fins, plates.

UNIT V DYNAMIC ANALYSIS USING FINITE ELEMENT METHOD 6 + 6

Introduction – vibrational problems – equations of motion based on weak form – longitudinal vibration of bars – transverse vibration of beams – element equations – solution of eigenvalue problems.

Experiments: Modal analysis of Beams. Harmonic, transient analysis of simple systems.

TOTAL: 60 periods

8. Text Books

1. David V.Hutton, "Fundamentals of Finite Element Analysis", Tata McGraw-Hill Edition, 2005.

9. References

1. Rao,S.S., "The Finite Element Method in Engineering", Butterworth-Heinemann (An imprint of Elsevier), reprint 2012, Published by Elsevier India Pvt. Ltd., New Delhi.
2. Reddy, J.N., "Introduction to Non-Linear Finite Element Analysis", Oxford University Press, 2008.
3. Zienkiewicz.O.C, Taylor.R.L,& Zhu,J.Z "The Finite Element Method: Its Basis & Fundamentals", Butterworth-Heinemann (An imprint of Elsevier), 2007, India
4. Cook, R.D., Malkus, D. S., Plesha,M.E., and Witt,R.J " Concepts and Applications of Finite Element Analysis", Wiley Student Edition, 4th Edition, First Reprint 2007, Authorized reprint by Wiley India(P) Ltd., New Delhi,

10. Revised Bloom's based Assessment Pattern

Revised Bloom's Category	Internal			University Examination %
	Mid Term Test I%	Mid Term Test II %	Model Test %	
Remember	10	10		20
Understand	15	15		25
Apply	30	30	40	30
Analyse	35	35	60	25
Evaluate				
Create				

COURSE CODE	COMPUTER AIDED DESIGN AND DRAFTING	L	T	P	C
1151ME203		1	0	2	2

1. Preamble

This course imparts the knowledge to understand fundamental concepts of computer graphics and its tools in a generic framework and provide clear understanding of CAD systems for 3D modeling and viewing.

2. Prerequisite

Engineering Graphics 1150ME202

3. Links to other courses:

Surface Modeling and Assembly 1152ME203

4. Course Educational Objectives

Students undergoing this course are expected to:

- Understand the various stages in the design process and the role of computer graphic communication process.
- Understand the mathematics behind the use of computer for modeling of mechanical components.
- Familiarize with the computer applications in design and preparing drawings for various mechanical components.

5. Course Outcomes

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

CO Nos.	Course Outcomes	Level of learning domain (Based on revised Bloom's)
CO1	Describe the basics of CAD models, 2D & 3D Transformations	K2, S3
CO2	Describe the use of solid modelling and surface modelling	K2, S3
CO3	Illustrate the application of visual realism techniques	K2, S3
CO4	Apply CAD in tolerance analysis and mass properties	K3, S3
CO5	Apply the different CAD standards in 3D modelling & Assembly	K3, S3

(K3-Apply, S3-Skill Level)

6. Correlation of COs with Programme Outcomes

COs	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
CO1	H	H	M		M							M	M	H
CO2	H	H	M		M							M	M	H
CO3	H	H	M		M							M	M	H
CO4	H	H	M		M							M	M	H
CO5	H	H	M		M							M	M	H

H- High; M-Medium; L-Low

7. Course Content

UNIT I FUNDAMENTALS OF COMPUTER GRAPHICS 3 + 6

Product cycle- Design process - Computer Aided Design – Computer graphics – co-ordinate systems- 2D and 3D transformations

Experiments: Code of practice for Engineering Drawing, BIS specifications and 2D Drawings.

UNIT II GEOMETRIC MODELING 3 + 6

Solid Entities, Solid Representation, Boundary Representation (B-Rep), Sweeps representation, Constructive Solid Geometry (CSG)

Experiments: Drawing, Editing, Dimensioning, Plotting Commands, Layering Concepts.

UNIT III VISUAL REALISM 3 + 6

Need for hidden surface removal, Priority Algorithms– shading – coloring – computer animation

Experiments: Detailing, Assembly

UNIT IV PART ASSEMBLY 3 + 6

Mass properties - Assembly modeling – Inference of position and orientation –Geometric Dimensioning and Tolerancing

Experiments: Shaft couplings – Plummer block – Screw jack- Lathe Tailstock – Universal Joint – Machine Vice – Stuffing box- safety Valves - Non-return valves.

UNIT V CAD STANDARDS 3 + 6

Data exchange standards - Initial Graphics Exchange Specification (IGES), Standard for the Exchange of Product Data (STEP), ACIS and Data Exchange Format (DXF) - communication standards

Experiments: Connecting rod –Piston and crank shaft- Multi plate clutch- Preparation of Bill of materials and tolerance data sheet.

TOTAL: 45 periods

8. Text Books

1. Ibrahim Zeid "CAD/CAM -- Theory and Practice" 2nd Edition- McGraw Hill, International Edition, 2012.

9. References

1. Chris McMahon and Jimmie Browne "CAD/CAM Principles, practice and manufacturing management "Pearson education Asia, 2001.
2. William M Neumann and Robert F.Sproul "Principles of Computer Graphics", McGraw Hill Book Co. Singapore, 1989.
3. Donald Hearn and M. Pauline Baker "Computer Graphics"'. Prentice Hall, Inc, 1992.
4. Foley, Wan Dam, Feiner and Hughes – "Computer graphics principles & practice", Pearson Education - 2003.

10. Revised Bloom's based Assessment Pattern

Revised Bloom's Category	**Internal**		**University Examination %**
	Model Test- I %	**Model Test II%**	
Remember			10
Understand	15	15	15
Apply	85	85	75
Analyse			
Evaluate			
Create			

Programme Electives

Programme Electives - Domain Wise						
Sl. No.	**Code**	**Course**	**L**	**T**	**P**	**C**
Design Domain						
1	1152ME104	Composite Materials	3	0	0	3
2	1152ME109	Industrial Tribology	3	0	0	3
Manufacturing Domain						
3	1152ME102	Applied Hydraulics and Pneumatics	3	0	0	3
4	1152ME106	Computer Integrated Manufacturing	3	0	0	3
5	1152ME111	Jigs and Fixture	3	0	0	3
6	1152ME115	Non – Destructive Testing	3	0	0	3
7	1152ME118	Tool Design Engineering	3	0	0	3
8	1152ME124	Non Traditional Machining Processes	3	0	0	3
Thermal Domain						
9	1152ME105	Computational Fluid Dynamics	3	0	0	3
10	1152ME107	Fuels and Combustion	3	0	0	3
11	1152ME110	Internal Combustion Engines	3	0	0	3
12	1152ME116	Power Plant Engineering	3	0	0	3
13	1152ME117	Renewable Sources of Energy	3	0	0	3
14	1152ME120	Refrigeration and Air Conditioning	3	0	0	3
General						
15	1152ME108	Industrial Engineering and Management	3	0	0	3
16	1152ME122	Total Quality Management	3	0	0	3
17	1152ME119	Operations Research	3	0	0	3
18	1152ME112	Logistics and Supply Chain Management	3	0	0	3
19	1152ME113	Maintenance Engineering	3	0	0	3
Advanced Technology						
20	1152ME101	Additive Manufacturing Technology	3	0	0	3
21	1152ME103	Automobile Engineering	3	0	0	3
22	1152ME114	Nano Materials and Applications	3	0	0	3
23	1152ME123	Solar Energy Engineering	3	0	0	3
24	1152ME125	Advanced Welding Technology	3	0	0	3
25	1152ME126	Advanced Metal Casting Technology	3	0	0	3
26	1152ME127	Gas Dynamics and Jet Propulsion	3	0	0	3
27	1152ME128	Micromachining & Manufacturing	3	0	0	3
28	1152ME129	Advanced 3D Modelling using Unigraphics NX	2	0	2	3
29	1152ME301	Computer Aided Drawing Laboratory	0	0	2	1

Programme Electives - Domain Wise						
Sl. No.	**Code**	**Course**	**L**	**T**	**P**	**C**
Advanced Technology						
	1152ME138	Process Planning and Cost Estimation	3	0	0	3
	1152ME139	Design of Rotodynamic Pumps	3	0	0	3
	1152ME140	Welding Metallurgy and Weldability of Stainless Steels	3	0	0	3
	1152ME141	Finite Element Modelling of Composite Structures	3	0	0	3
	1152ME142	Integrated Product Design and Process Development	3	0	0	3
	1152ME143	System Modelling and Control Engineering	3	0	0	3
	1152ME144	Advanced Metal Forming Processes	3	0	0	3
	1152ME145	Material Characterization and Testing Methods	3	0	0	3
	1152ME146	Artificial Intelligence System in Manufacturing	3	0	0	3
	1152ME147	Laser Processing of Materials	3	0	0	3
	1152ME150	Advanced Metal Joining	3	0	0	3
	1152ME151	Engineering Applications of Pump	3	0	0	3
		Integrated Courses Under Program Elective				
	1152ME201	Surface Modelling and Assembly (Lab Dominated)	1	0	4	3
	1152ME202	Analysis of Mechanical Systems (Lab Dominated)	1	0	4	3
Laboratory Courses Under Program Elective						
1	1152ME301	Computer Aided Drawing Laboratory	0	0	2	1

COURSE CODE	COMPOSITE MATERIALS	L	T	P	C
1152ME104		3	0	0	3

1. Preamble

The course provides an introduction to the need, properties, application, and manufacturing processes of various composite materials.

2. Prerequisite

Engineering Materials and Metallurgy 1151ME117

3. Links to other courses

Project work

4. Course Educational Objectives

Students undergoing this course are expected to

- Understand the need of composites in structural and non-structural applications
- Know the, properties and application of different types of reinforcements and matrices
- Understand the fabrication techniques involved in the polymer, metal, and ceramic matrix composites

5. Course Outcomes

The students would be benefitted with the following outcomes:

CO Nos.	Course Outcomes	Level of learning domain (Based on revised Bloom's)
CO1	Describes various types of composite materials and their applications.	K2
CO2	Describe various manufacturing processes of Polymer Matrix Composite	K2
CO3	Apply the principles of mechanics for Metal Matrix Composites	K3
CO4	Explain the need of Ceramic Matrix Composites and their practical applications	K2
CO5	Describe the advances in composite materials	K2

(K3 – Apply)

6. Correlation of COs with Programme Outcomes

COs	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
CO1	H	L	L										M	L
CO2	H	L	L										M	L
CO3	H	L	L										M	L
CO4	H	L	L										M	L
CO5	H	L	L										M	L

H- High; M-Medium; L-Low

7. Course Content

UNIT I- ELEMENTS OF COMPOSITES **L-9**
Fundamentals of composites, characteristics, need for composites, Enhancement of properties, Reinforcements - glass fibers, boron fibers, carbon fibers, organic fibers, aramid fibers, ceramic fibers, oxide and nonoxide fibers, Forms of reinforcements - Roving , Woven fabrics Non-woven, random mats, whiskers, Matrix materials – Polymers - Thermosetting resins, thermoplastic resins , Metals, Ceramic materials

UNIT II- POLYMER MATRIX COMPOSITES **L-9**
Processing of polymer matrix composites- hand lay-up, Spray lay-up processes, Compression molding- SMC Reinforced reaction injection molding, Resin transfer molding, Pultrusion, Filament winding, Applications of polymer matrix composites.

UNIT III-METAL MATRIX COMPOSITES **L-9**
Characteristics of MMCs, Various types of Metal matrix composites, Advantages and limitations of MMCs, Effect of reinforcements on properties – Volume fraction – Rule of mixtures, Processing of MMCs - Liquid state processing- stir casting, squeeze casting, infiltration, solid state processing - Powder metallurgy, diffusion bonding, In situ processes, applications of MMCs

UNIT IV- CERAMIC MATRIX COMPOSITES **L-9**
Need for CMCs, Processing of CMCs- cold pressing and sintering, hot pressing, infiltration, chemical vapor deposition and chemical vapor impregnation, sol-gel and polymer pyrolysis, high temperature synthesis properties and applications of CMC.

UNIT V- ADVANCES IN COMPOSITES **L-9**
Carbon fiber composites – properties, chemical vapor deposition– oxidative etching, liquid phase oxidation carbon/carbon composites - properties and applications of C/C Composites, multifilament superconducting composites

TOTAL = 45 periods

8. Text Books

1. Ronald Gibson, Principles of Composite Material Mechanics, Tata McGraw Hill, 2013.
2. P.K.Mallicak, Fiber-reinforced composites, Monal Deklar Inc., New York, 2013.

9. References

1. F.L.Matthews & R.D.Rawlings, Composite Materials, Engg and Sci, Chapman & hall, London, 2001.
2. Micael hyer, Stress Analysis of Fiber - Reinforced Composite Materials, Tata McGraw Hill, 2006.
3. Ronald Gibson, Principles of Composite Material Mechanics, Tata McGraw Hill, 2001.
4. Sanjay.K.Majumdar, Composites Manufacturing, Kindle edition, CRC press, 2001.

10. Revised Bloom's based Assessment Pattern

Revised Bloom's Category	Internal				University Examination %
	Unit Test-I %	Mid Term Test I %	Unit Test-II %	Mid Term Test II %	
Remember	40	40	10	20	30
Understand	60	60	60	60	60
Apply			30	20	10
Analyse					
Evaluate					
Create					

Revised Bloom's Category	Assignments	
	1 (CO1 &CO2) (max marks in %)	2 (CO3&CO4) (max marks in %)
Remember	**30**	**10**
Understand	**70**	**80**
Apply		**10**
Analyze		
Evaluate		
Create		

COURSE CODE	INDUSTRIAL TRIBOLOGY	L	T	P	C
1152ME109		3	0	0	3

1. Preamble

This course provides knowledge of various engineering surfaces and friction in mechanical systems. It also introduces concepts associated with devices such as design of surfaces lubrication of surfaces, wear and tear.

2. Prerequisite

Engineering Materials and Metallurgy 1151ME117

3. Links to other courses

Project Work

4. Course Educational Objectives

Students undergoing this course are expected to

- Describes the material characteristics and friction problems arising due to the advanced technology
- Explains and provides knowledge on the wear theory and wear measuring instruments.
- Analysis of various types of bearing control methods for solving the problems arising due to them
- Discusses the various lubrication method and testing method
- Description of surface modification methods and marginal lubrication method and its impacts on sustainable development and its control methods

5. Course Outcomes

The students would be benefitted with the following outcomes:

CO Nos.	Course Outcomes	Level of learning domain (Based on revised Bloom's)
CO1	Describes the friction characteristics metals, and friction metals energy and their advantages and disadvantages.	K2
CO2	Discusses the various types wear and measurement of wear	K2
CO3	Analysis and classification of various Viscous flow between very close parallel plates measures to solve the problems.	K2
CO4	Distinguishes between hydrodynamic lubrication, Boundary Lubrication and Solid Lubrication Hydrostatic Lubrication.	K2
CO5	Assessment of Materials for fluid film bearings and Materials for marginally lubricated and dry bearings.	K2

(K3 - apply)

6. Correlation of COs with Programme Outcomes

Cos	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
CO1	M	L										M	M	L
CO2	M	L										M	M	L
CO3	M	L										M	M	L
CO4	M	L										M	M	L
CO5	M	L										M	M	L

H- High; M-Medium; L-Low

7. Course Content

UNIT I SURFACES AND FRICTION L – 9
Topography of Engineering surfaces- Contact between surfaces - Sources of sliding Friction – Adhesion ploughing- Friction characteristics of metals - Friction of nonmetals- Friction of ceramic materials and polymers - Rolling friction - Source of rolling friction -Stick slip motion - Measurement of friction.

UNIT II WEAR L – 9
Types of wear - Simple theory of sliding wear mechanism -Abrasive wear – Materials for adhesive and abrasive wear situations - Corrosive wear - Surface fatigue wear situations - Corrosive wear-Surface fatigue wear – Wear of ceramics and polymers – Wear measurements.

UNIT III FILM LUBRICATION THEORY L –9
Fluid film in simple shear - Viscous flow between very close parallel plates - Shear stress variation Reynolds equation for film lubrication - High speed unloaded journal bearings - Loaded journal bearings –The Somerfield diagram.

UNIT IV LUBRICANTS AND LUBRICATION TYPES L – 9
Types and properties of Lubricants - Testing methods - Hydrodynamic Lubrication - Elasto hydrodynamic lubrication- Boundary Lubrication - Solid Lubrication Hydrostatic Lubrication.

UNIT V SURFACE ENGINEERING AND MATERIALS FOR BEARINGS L – 9
Surface modifications - Transformation hardening - Surface fusion - Thermo chemical processes – Surface coatings - Plating and anodizing - Materials for rolling element bearings - Materials for fluid film bearings - Materials for marginally lubricated and dry bearings.

TOTAL: 45 periods

8. Text Books

1. Hutchings, I. M., Tribology, Friction and Wear of Engineering Material, Edward Arnold, London, 1992.
2. Williams, J. A., Engineering Tribology, Oxford University Press,1994.

9. Reference Books

1. Stolarski T. A., Tribology in Machine Design, Industrial Press Inc., 1990.
2. Bowden, E. P., and Tabor. D., Friction and Lubrication, Heinemann Educational Books Ltd., 1974
3. Cameron, A., Basic Lubrication theory, Longman, U.K., 1981
4. Neale, M. J., (Editor), Tribology Handbook, Newnes Butter worth, Heinemann, U.K., 1975
5. Nptel

10. Revised Bloom's based Assessment Pattern

Revised Bloom's	Internal	University

Category	Unit Test-I %	Mid Term Test I %	Unit Test-II %	Mid Term Test II %	Examination %
Remember	40	40	40	40	40
Understand	60	60	60	60	60
Apply					
Analyse					
Evaluate					
Create					

Revised Bloom's Category	**Assignments**	
	1 (COs addressed CO1,CO2) (max marks in %)	**2 (COs addressed CO3,CO4) (max marks in %)**
Remember	**20**	**10**
Understand	**40**	**40**
Apply	**40**	**50**
Analyse		
Evaluate		
Create		

COURSE CODE	APPLIED HYDRAULICS AND PNEUMATICS	L	T	P	C
1152ME102		3	0	0	3

1. Preamble

This course provides adequate knowledge in hydraulics and pneumatics circuits and their role in manufacturing industries. It also introduces PLC and its applications.

2. Prerequisite

1	Basic Electrical Engineering	1150EE101
2	Basic Electronic Engineering	1150EC101

3. Links to other courses

1	Industrial Robotics	1154ME106
2	Mechatronics system	1151ME109

4. Course Educational Objectives

Students undergoing this course are expected:

- To understand the fundamentals of fluid power transmission systems
- To design various hydraulic and pneumatic system components.

5. Course Outcomes

Upon the successful completion of the course, learners will be able to

CO Nos.	Course Outcomes	Level of learning domain (Based on revised Bloom's)
CO1	Correlate the basics of hydraulics to the performance of fluid power systems.	K2
CO2	Describe the working principle of hydraulic systems including pumps and control components.	K3
CO3	Understand the working principle of pneumatic systems and their components.	K2
CO4	Understand and Design various types of hydraulic and pneumatic power circuits.	K3
CO5	Understand and design various types of applications in fluid power circuits.	K3

(K3 - Apply)

6. Correlation of CO's with Programme Outcomes

Cos	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
CO1	H	L	L									L	M	L
CO2	H	L	L									L	M	L
CO3	H	L	L									L	M	L
CO4	H	L	L									L	M	L
CO5	H	L	L									L	M	L

H- High; M-Medium; L-Low

7. Course Contents

UNIT I FLUID POWER SYSTEMS AND FUNDAMENTALS L-9

Introduction to fluid power, Advantages of fluid power, Application of fluid power system. Types of fluid power systems, General types of fluids – Properties of hydraulic fluids –Fluid power symbols. Basics of Hydraulics-Applications of Pascal's Law

UNIT II HYDRAULIC SYSTEM COMPONENTS L-9

Sources of Hydraulic Power: Pumping theory – Pump classification –construction and working of pumps – Variable displacement pumps, pump performance. Actuators: Linear hydraulic actuators– Single acting and double acting cylinders, Rotary actuators – Fluid motors.

Control Components: Direction control valve – Valve terminology - Various center positions. Shuttle valve – check valve – pressure control valve – pressure reducing valve, sequence valve. Flow control valves – Fixed and adjustable. Safety valves

UNIT III PNEUMATIC SYSTEM COMPONENTS L-9

Pneumatic Components: Properties of air. Compressors. FRL Unit – Air control valves, Quick exhaust valves and pneumatic actuators- cylinders, air motors. Basics of low cost automation

UNIT IV FLUIDICS &PNEUMATIC CIRCUIT DESIGN L-9

Fluidics – Introduction to fluidic devices, simple circuits Introduction to Electro Hydraulic Pneumatic logic circuits, PLC applications in fluid power control, Sequential circuit design for simple applications using classic, cascade, step counter, logic with Karnaugh- Veitch Mapping and combinational circuit design methods.

UNIT V FLUID POWER CIRCUITS L-9

Speed control circuits, synchronizing circuit, Pneumo hydraulic circuit, Accumulators and Intensifiers-Accumulator circuits, Intensifier circuits. Servo systems – Hydro Mechanical servo systems, Electro hydraulic servo systems and proportional valves.

Deceleration circuit, hydrostatics transmission circuits, control circuits for reciprocating drives in machine tools, Material handling equipments. Fluid power circuits; failure and troubleshooting.

TOTAL: 45 periods

8. Text Books

1. Majumdar S.R., "Pneumatic systems – Principles and maintenance", Tata McGraw Hill, 2008
2. Anthony Esposito, "Fluid Power with Applications", Pearson Education 2009.

9. References

1. Majumdar S.R., "Oil Hydraulics", Tata McGraw-Hill, 2000.
2. Harry L. Stevart D.B, "Practical guide to fluid power", Taraoeala sons and Port Ltd.Broadey, 2010.
3. Michael J, Prinches and Ashby J. G, "Power Hydraulics", Prentice Hall, 2011.
4. Dudelyt, A. Pease and John T. Pippenger, "Basic Fluid Power", Prentice Hall, 2011.

10. Revised Bloom's based Assessment Pattern

Revised Bloom's Category	Internal				University Examination %
	Unit Test 1 %	Mid Term Test 1 %	Unit Test 2 %	Mid Term Test 2 %	
Remember	10	10	10	10	10
Understand	60	60	60	60	60
Apply	30	30	30	30	30
Analyse					
Evaluate					
Create					

Revised Bloom's Category	Assignments	
	1 (COs addressed CO1,CO2) (max marks in %)	2 (COs addressed CO3,CO4) (max marks in %)
Remember	**20**	**10**
Understand	**40**	**40**
Apply	**40**	**50**
Analyse		
Evaluate		
Create		

COURSE CODE	COMPUTER INTEGRATED MANUFACTURING	L	T	P	C
1152ME106		3	0	0	3

1. Preamble

This course provides basic knowledge about computer integrated manufacturing and it deals with grouping technology which is one of the most important technology followed in leading industries.

2. Prerequisite

Machining And Machine Tools Technology 1151ME107

3. Links to other courses

Project Work

4. Course Educational Objectives

Students undergoing this course are expected to:

- Gain knowledge in group technology, and computer aided planning and control
- Gain knowledge on how computers are integrated at various levels of planning and manufacturing.
- Understand the role of FMS in Industries.

5. Course Outcomes

Upon the successful completion of the course, learners will be able to

CO Nos.	Course Outcomes	Level of learning domain (Based on revised Bloom's)
CO1	Describe elements related to computer integrated manufacturing systems.	K2
CO2	Posses knowledge of group technology concepts and automatic shop floor control processes.	K3
CO3	Understand the computer aided process planning and CIM implementation techniques.	K2
CO4	Describe various types and components of flexible manufacturing system.	K3
CO5	Understand modern manufacturing systems in industries.	K2

6. Correlation of CO's with Programme Outcomes

Cos	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
CO1	H	L			L							L	M	L
CO2	H	L			L							L	M	L
CO3	H	L			L							L	M	L
CO4	H	L			L							L	M	L
CO5	H	L			L							L	M	L

H- High; M-Medium; L-Low

7. Course Content

UNIT- I: Introduction to CIM **L-9**

The meaning and origin of CIM- the changing manufacturing and management scene - External communication - islands of automation and software-dedicated and open systems - product related activities of a company- marketing engineering - production planning - plant operations - physical distribution- business and financial management.

UNIT- II: Group Technology and Shop Floor Control **L-9**

History of group technology- role of G.T. in CAD/CAM integration - part families - classification and coding - DCLASS and MICLASS and OPITZ coding systems-facility design using G.T. -benefits of G.T. - cellular manufacturing.

Shop floor control-phases -factory data collection system -automatic identification methods- Bar code technology-automated data collection system.

UNIT-III: COMPUTER AIDED PROCESS PLANNING AND CIM IMPLEMENTATION **L-9**

Process planning - role of process planning in CAD/CAM integration - approaches to computer aided process planning -variant approach and generative approaches CIM and company strategy - system modeling tools -IDEF models - activity cycle diagram - CIM open system architecture (CIMOSA) - manufacturing enterprise wheel-CIM architecture - Product data management-CIM implementation software.

UNIT –IV: FLEXIBLE AND AUTOMATED MANUFACTURING SYSTEMS **L-9**

FMS-components of FMS - types -FMS workstation -material handling and storage systems- FMS layout -computer control systems-automated work flow-automated assembly systems-dead locks in automated manufacturing systems -PETRINET models applications-development of software for FMS integration- application and benefits.

UNIT- V: OTHER MANUFACTURING SYSTEMS IN CIM **L-9**

Lean manufacturing – Agile manufacturing – Just in time – implementation in industries – Concurrent Engineering – Material Requirement Planning (MRP 1) – Manufacturing Resource Planning (MRP II) – Enterprise Resource Planning (ERP) - Advantages and limitations of above supporting systems.

TOTAL= 45 periods

8. Text Books

1. Mikell. P. Groover “Automation, Production Systems and Computer Integrated Manufacturing”, 3rd edition, Pearson Education 2008.
2. CAD/CAM/CIM by P. Radhakrishnan, S. Subramanyan, V. Raju, New age publication,2nd edn,2004.

9. References

1. Mikell. P. Groover and Emory Zimmers Jr.,“CAD/CAM”, Prentice hall of India Pvt.Ltd., 1998.
2. James A. Regh and Henry W. Kreabber, “Computer Integrated Manufacturing”, Pearson Edu 2nd edn, 2005.
3. Chris McMahon and Jimmie Browne, “CAD CAM Principles, Practice and Manufacturing Management”, Pearson Education 2nd edition, 2005.
4. Ranky, Paul G., “Computer Integrated Manufacturing”, Prentice hall of India Pvt. Ltd., 2005.
5. Yorem Koren, “ Computer Integrated Manufacturing”, McGraw Hill, 2005.

10. Revised Bloom’s based Assessment Pattern

Revised Bloom's Category	Internal				University Examination %
	Unit Test 1 %	Mid Term Test 1 %	Unit Test 2 %	Mid Term Test 2 %	
Remember	50	20	50	20	20
Understand	50	40	50	40	40
Apply		40		40	40
Analyse					
Evaluate					
Create					

Revised Bloom's Category	**Assignments**	
	1 (COs addressed CO1,CO2) (max marks in %)	**2 (COs addressed CO3,CO4) (max marks in %)**
Remember	**20**	**10**
Understand	**40**	**40**
Apply	**40**	**50**
Analyse		
Evaluate		
Create		

COURSE CODE	JIGS AND FIXTURES	L	T	P	C

1152ME111		**3**	**0**	**0**	**3**

1. Preamble
This course provides the knowledge on different locating and clamping, pressing, bending and forming techniques and principles.

2. Prerequisite
Machining And Machine Tools Technology 1151ME107

3. Links to other courses
1 Additive Manufacturing Technology 1152ME118

4. Course Educational Objectives
Students undergoing this course are expected to:
- Understand the functions and design principles of Jigs, fixtures and press tools
- Understand the principles of bending drawing and forming techniques

5. Course Outcomes
Upon the successful completion of the course, learners will be able to

CO Nos.	Course Outcomes	Level of learning domain (Based on revised Bloom's)
CO1	Interpret Jigs and fixtures, locating methods, mechanical actuation and tolerances	K2
CO2	Explain the principles of various types of fixtures	K2
CO3	Describe the press working terminologies and elements of die	K2
CO4	Apply design and development principles of bending, drawing, blank development and dies	K3
CO5	Apply computer aids for sheet metal forming and other forming operations	K3

5. Correlation of CO's with Programme Outcomes

Cos	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
CO1	H	L	L									L	M	L
CO2	H	L	L									L	M	L
CO3	H	L	L									L	M	L
CO4	H	L	L			L						L	M	L
CO5	H	L	L			L						L	M	L

H- High; M-Medium; L-Low

7. Course Content

Note: Use of P S G Design Data Book is permitted in the University examination

UNIT I LOCATING AND CLAMPING PRINCIPLES L-9

Objectives of tool design- Function and advantages of Jigs and fixtures – Basic elements – principles of location – Locating methods and devices – Redundant Location – Principles of clamping – Mechanical actuation – pneumatic and hydraulic actuation Standard parts – Drill bushes and Jig buttons – Tolerances and materials used.

UNIT II JIGS AND FIXTURES L-9

Design and development of jigs and fixtures for given component- Types of Jigs – Post, Turnover, Channel, latch, box, pot, angular post jigs – Indexing jigs – General principles of milling, Lathe, boring, broaching and grinding fixtures – Assembly, Inspection and Welding fixtures – Modular fixturing systems- Quick change fixtures.

UNIT III PRESS WORKING TERMINOLOGIES AND ELEMENTS OF CUTTING DIES L-9

Press Working Terminologies – operations – Types of presses – press accessories – Computation of press capacity – Strip layout – Material Utilization – Shearing action – Clearances – Press Work Materials – Center of pressure- Design of various elements of dies – Die Block – Punch holder, Die set, guide plates – Stops – Strippers – Pilots – Selection of Standard parts – Design and preparation of four standard views of simple blanking, piercing, compound and progressive dies.

UNIT IV BENDING AND DRAWING DIES L-9

Difference between bending and drawing – Blank development for above operations – Types of Bending dies – Press capacity – Spring back – knockouts – direct and indirect – pressure pads – Ejectors – Variables affecting Metal flow in drawing operations – draw die inserts – draw beads- ironing – Design and development of bending, forming, drawing, reverse redrawing and combination dies – Blank development for axisymmetric, rectangular and elliptic parts – Single and double action dies.

UNIT V OTHER FORMING TECHNIQUES L-9

Bulging, Swaging, Embossing, coining, curling, hole flanging, shaving and sizing, assembly, fine Blanking dies – recent trends in tool design- computer Aids for sheet metal forming Analysis – basic introduction – tooling for numerically controlled machines- setup reduction for work holding – Single minute exchange of dies – Poka Yoke.

TOTAL: 45 PERIODS

8. Text Books

1. Joshi, P.H. "Jigs and Fixtures", Second Edition, Tata McGraw Hill Publishing Co., Ltd., New Delhi, 2004.
2. Joshi P.H "Press tools – Design and Construction", wheels publishing, 1996

9. References

1. Venkataraman. K., "Design of Jigs Fixtures & Press Tools", Tata McGraw Hill, New Delhi, 2005.
2. Donaldson, Lecain and Goold "Tool Design", 3rd Edition, Tata McGraw Hill, 2000.
3. Kempster, "Jigs and Fixture Design", Third Edition, Hoddes and Stoughton, 1974.
4. Hoffman "Jigs and Fixture Design", Thomson Delmar Learning, Singapore, 2004.
5. ASTME Fundamentals of Tool Design Prentice Hall of India. 6. Design Data Hand Book, PSG College of Technology, Coimbatore.

10. Revised Bloom's based Assessment Pattern

Revised Bloom's Category	Internal				University Examination %
	Unit Test 1 %	Mid Term Test 1 %	Unit Test 2 %	Mid Term Test 2 %	
Remember	30	20	20	10	10
Understand	70	80	80	40	50
Apply				50	40
Analyse					
Evaluate					
Create					

Revised Bloom's Category	Assignments	
	1 (COs addressed CO1,CO2) (max marks in %)	2 (COs addressed CO3,CO4) (max marks in %)
Remember	**20**	**10**
Understand	**40**	**40**
Apply	**40**	**50**
Analyse		
Evaluate		
Create		

COURSE CODE	NON DESTRUCTIVE TESTING	L	T	P	C
1152ME115		3	0	0	3

1. Preamble

To study and understand the various non-destructive evaluation and testing methods, theory and their industrial applications.

2. Prerequisite

Engineering Materials and Metallurgy 1151ME117

3. Links to other courses

Project Work

4. Course Educational Objectives

Students undergoing this course are expected to:

- Explain the importance and different methods of NDT.
- Explain procedural steps involved in Liquid Penetrate and Eddy Current Testing.
- Describe the fundamental principle and testing procedures of Magnetic Particle Inspection and Thermograph.
- Explain the principles and different testing methods of Ultrasonic and Radiography Testing methods.
- Explain the principles and different testing methods of radiography

5. Course Outcomes

Upon the successful completion of the course, learners will be able to

CO Nos.	Course Outcomes	Level of learning domain (Based on revised Bloom's)
CO1	Obtain the fundamental knowledge about different NDT methods.	K2
CO2	Explain the principles and testing knowledge of LPT, ECT & ACT methods for product testing.	K2
CO3	Understand the materials and testing procedure for Magnetic Particle Testing & Thermography Testing.	K2
CO4	Describe the knowledge about Ultrasonic Testing for products.	K2
CO5	Explain the principles and techniques in Radiography Testing.	K2

6. Correlation of CO's with Programme Outcomes

Cos	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
CO1	H		L			L						L	M	
CO2	H		L			L						L	M	
CO3	H		L			L						L	M	
CO4	H		L			L	L					L	M	
CO5	H		L			L	L					L	M	

H- High; M-Medium; L-Low

7. Course Content

UNIT I: BASICS OF NDT **L-9**

Introduction to various non-destructive methods, Comparison of Destructive and Non-destructive Tests, Codes, standards, specification and procedures. Visual Inspection, Optical aids used for visual inspection, Applications. Physical principles & procedure for penetrant testing, Penetrant testing materials, Penetrant testing methods-water washable, Post – Emulsification methods, Advantages and Limitations, Applications. Case studies by taking various manufacturing defects.

UNIT II: EDDY CURRENT TESTING & ACOUSTIC EMISSION **L-9**

Principles, Instrumentation for ECT, Absolute, differential probes, Techniques – High sensitivity techniques, Phased array ECT, Advantages and Limitations, Applications. Principle of AET, Procedure, Instrumentation, Advantages and Limitations, Applications. Case studies on both ECT and AE.

UNIT III: MAGNETIC PARTICLE TESTING & THERMOGRAPHY **L-9**

Principle of MPT, procedure used for testing a component, Equipment used for MPT, Magnetizing techniques, Advantages and Limitations, Applications. Principle of Thermography, Infrared Radiometry, Active thermography measurements, Advantages and Limitations, Applications, Case studies based on MPT and Thermography.

UNIT IV: ULTRASONIC TESTING **L-9**

Principle, Ultrasonic transducers, Ultrasonic Flaw detection Equipment, Modes of display A- scan, B-Scan, C- Scan, Applications, Inspection Methods - Normal Incident Pulse-Echo Inspection, Normal Incident Through-transmission Testing, Angle Beam Pulse-Echo testing, Advantages and Limitations, Applications, Case studies.

UNIT V: RADIOGRAPHY **L-9**

Principle of Radiography, Types, Effect of radiation on Film, Radiographic imaging, Inspection Techniques – Single wall single image, Double wall Penetration, Multiwall Penetration technique, Real Time Radiography, Advantages and Limitations, Applications. Case studies.

Total: 45 Periods

8. Text Books

1. Baldev Raj, Jeyakumar,T., Thavasimuthu,M., "Practical Non Destructive Testing" Narosa publishing house, New Delhi, 2006.

9. References

1. Krautkramer. J., "Ultra Sonic Testing of Materials", 1st Edition, Springer – Verlag Publication, New York, 1996.
2. Peter J. Shull "Non Destructive Evaluation: Theory, Techniques and Application" Marcel Dekker, Inc., New York, 2002.

10. Revised Bloom's based Assessment Pattern

Revised Bloom's Category	Internal				University Examination %
	Unit Test 1 %	Mid Term Test 1 %	Unit Test 2 %	Mid Term Test 2 %	
Remember	10	10	10	10	10
Understand	50	20	20	20	50
Apply	40	40	70	70	40
Analyse					
Evaluate					
Create					

Revised Bloom's Category	Assignments	
	1 (COs addressed CO1,CO2) (max marks in %)	2 (COs addressed CO3,CO4) (max marks in %)
Remember	**20**	**10**
Understand	**40**	**40**
Apply	**40**	**50**
Analyse		
Evaluate		
Create		

COURSE CODE	TOOL DESIGN ENGINEERING	L	T	P	C
1152ME118		3	0	0	3

1. Preamble

This course provides an introduction to the basic components and techniques of Tool engineering & its classification, materials heat treatment etc., Understanding of press tools & basic plastic moulding, analysis of mold flow and tool maintenance.

2. Prerequisite

Machining And Machine Tools Technology 1151ME107

3. Links to other courses

Project Work

4. Course Educational Objectives

Students undergoing this course are expected to

- Describe the manufacturing of cutting tools, plastic tools & press tools

5. Course Outcomes

The students would be benefitted with the following outcomes:

CO Nos.	Course Outcomes	Level of learning domain (Based on revised Bloom's)
CO1	Describe the classification, properties and applications of various cutting tools	K2
CO2	Use multi point cutting tools in real applications.	K2
CO3	Demonstrate knowledge on process of heat treatments in making cutting tools.	K2
CO4	Design press tools and sheet metal forming processes	K2
CO5	Design injection moulding and die casting tools	K2

6. Correlation of COs with Programme Outcomes

Cos	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
CO1	H	L										L	M	L
CO2	H	L										L	M	L
CO3	H	L			L							L	M	L
CO4	H	L	L		L							L	M	L
CO5	H	L	L		L							L	M	L

H- High; M-Medium; L-Low

7.Course Content

UNIT-I CUTTING TOOLS L-9

Materials-properties, classification, selection, insert and coated tools, tool wear, and tool life. Recent developments and applications. Single Point Tools: Nomenclature, types and styles, Introduction of HSS and carbide insert type tools for turning, boring, shaping, planning and slotting operations. Design of form tools. Tools and holders for CNC applications, tools for dry machining.

UNIT-II MULTIPOINT CUTTERS L-9

Nomenclature, classification and selection, construction methods, cutter setting, design and manufacture of drills, reamers, taps, dies, thread chasers, milling cutters, broaches, hobs and gear shaper cutters. Grinding- wheel specification and selection.

UNIT-III TOOL MATERIALS & HEAT TREATMENT L-9

Standards and specifications of materials – Tool materials, metals and non-metals - Selection of metal tool materials, Hardening, annealing of tool steels and its types. Aus tempering, Mar tempering and Isothermal annealing for tool steels,. Tool failures due to improper heat treatment like overheating, improper quenching and loading. ION Nitrating, Vacuum carburizing, Chemical Vapour deposition. Heat treatment of non-ferrous materials-Aluminum Alloys.

UNIT-IV ROLE OF DESIGN L-9

Construction & design: single point tools, drills, reamers, ground thread taps, periphery cutting tools, broach, hobs –Selection & application role of design in the performance of cutting tools on ferrous and nonferrous work materials.

UNIT-V PRESS TOOLS L-9

Design and manufacture of die sets for sheet metal components-simple, compound and progressive dies for punching and blanking operations. Dies for drawing and bending operations. Selection of presses and tools

TOTAL: 45 Periods

8. Text Books

1. Donaldson C and LeCain C H, "Tool Design", Tata McGraw Hill Publishing Company Ltd., New Delhi, 2004.
2. Bhattacharyya A, "Metal Cutting Theory and Practice", New Central Books Agency (P) Ltd, Calcutta, 2000.
3. Cracknell P C and Dyson R W, "Handbook of Thermoplastics Injection Mould Design", Chapman and Hall, 1993.
4. Mikell P Groover, "Fundamentals of Modern Manufacturing", John Wiley and Sons, Singapore, 2004.

9. References

1. SME, "Manufacturing Engineers Hand Book", 1998. 2. Rodin P, "Design and Production of Metal cutting Tools", MIR Publishers, Moscow, 1968

10. Revised Bloom's based Assessment Pattern

Revised Bloom's Category	Internal				University Examination %
	Unit test – I %	Mid Term - I %	Unit test – II %	Mid Term -II %	
Remember	30	20	30	20	20
Understand	70	50	70	50	50
Apply		30		30	30
Analyse					
Evaluate					
Create					

Revised Bloom's Category	Assignments	
	1 (COs addressed CO1,CO2) (max marks in %)	2 (COs addressed CO3,CO4) (max marks in %)
Remember	**20**	**10**
Understand	**40**	**40**
Apply	**40**	**50**
Analyse		
Evaluate		
Create		

COURSE CODE	NON TRADITIONAL MACHINING PROCESSES	L	T	P	C
1152ME124		3	0	0	3

1. Preamble

This course addresses additive manufacturing principles, variety and its concept, scope of additive manufacturing and areas of application..

2. Prerequisite

Machining and Machine Tools Technology 1151ME107

3. Links to other courses

Nil

4. Course Educational Objectives

Students undergoing this course are expected to:

- Acquire a functional understanding of non-traditional manufacturing equipment.
- Understand the terminology used in non-traditional manufacturing industries.
- To provide knowledge on the classification of non-traditional machining process.
- Know about various process parameters and their influence on performance and their applications.
- Impart knowledge on various energy involved in non-traditional machining process.

5. Course Outcomes

Upon the successful completion of the course, learners will be able to

CO Nos.	Course Outcomes	Level of learning domain (Based on revised Bloom's)
CO1	Understand the need of Non Traditional Machining Processes and able to Classify various processes	K2
CO2	Recognize the role of mechanical energy in non-traditional machining processes.	K3
CO3	Apply the knowledge on machining electrically conductive material through electrical energy in non-traditional machining processes.	K2
CO4	Understand the concept of machining the hard material using chemical energy andelectrochemical energy.	K2
CO5	Familiarity with various thermal energy based nontraditional machining processes.	K3

6. Correlation of CO's with Programme Outcomes

Cos	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
CO1	H	L										L	H	
CO2	H	L										L	H	
CO3	H	L										L	H	
CO4	H	L										L	H	
CO5	H	L										L	H	

H- High; M-Medium; L-Low

7. Course Content

UNIT I UNCONVENTIONAL MACHINING PROCESS L-9
Introduction - Need - Classification - Energies employed in the processes - Brief overview of Abrasive jet machining(AJM), Water jet machining(WJM), Ultrasonic machining(USM), Electric discharge machining(EBM), Electro-chemical machining(ECM), Electron beam machining(EBM), Laser beam machining(LBM), Plasma arc machining(PAM).

UNIT II MECHANICAL ENERGY BASED PROCESSES L-9
Abrasive Jet Machining, Water Jet Machining and Ultrasonic Machining - Working Principles, Equipment, Process parameters, Material removal rate, Applications.

UNIT III ELECTRICAL ENERGY BASED PROCESSES L-9
Electric Discharge Machining - Working Principles, Equipment, Process Parameters, Material removal rate, Electrode / Tool, Power Circuits, Tool Wear, Dielectric, Flushing, Wire cut EDM - Applications.

UNIT IV CHEMICAL AND ELECTRO-CHEMICAL ENERGY BASED PROCESSES L-9
Chemical machining - Etchants, Maskants - techniques. Electro-chemical machining – Working principle, Equipment, Process Parameters, Material removal rate, Electrical circuit. Electro-chemical grinding - Electro-chemical honing - Applications.

UNIT V THERMAL ENERGY BASED PROCESSES L-9
Laser Beam machining, Plasma Arc Machining - Principles, Equipment. Electron Beam Machining - Principles, Equipment, Types, Beam control techniques, Material removal rate - Applications.

BEYOND THE SYLLABUS
Abrasive water jet machining- Micro EDM- Electric discharge grinding and drilling- Electro-stream drilling- Electro-chemical deburring.

Total: 45 Periods

8. Text Books

1. P. K. Mishra, Non-Conventional Machining, Narosa Publishing House, New Delhi, 2007.
2. P. C. Pandey and H.S. Shan, Modern Machining Processes, Tata McGraw Hill Publishing Company Pvt Ltd., New Delhi, 2008.
3. Joao Paulo Davim, Nontraditional Machining Processes: Research Advances, Springer, New York, 2013.

9. **Reference Books**

1. Paul De Garmo, J.T. Black, and Ronald.A. Kohser, Material and Processes in Manufacturing, Prentice Hall of India Pvt. Ltd., New Delhi, 2011.
2. Vijaya Kumar Jain, Advanced Machining Processes, Allied Publishers Pvt. Ltd., New Delhi, 2005.
3. Hassan El-Hofy, Advanced Machining Processes: Nontraditional and Hybrid Machining Processes, McGraw-Hill Professional, New Delhi, 2005

10. Revised Bloom's based Assessment Pattern

Revised Bloom's Category	Internal				University Examination %
	Unit Test 1 %	Mid Term Test 1 %	Unit Test 2 %	Mid Term Test 2 %	
Remember					
Understand	70	70	70	70	70
Apply	30	30	30	30	30
Analyse					
Evaluate					
Create					

Revised Bloom's Category	Assignments	
	1 (COs addressed) (max marks in %)	2 (COs addressed) (max marks in %)
Remember		
Understand	70	70
Apply	30	30
Analyse		
Evaluate		
Create		

COURSE CODE	COMPUTATIONAL FLUID DYNAMICS	L	T	P	C
1152ME105		3	0	0	3

1. **Preamble**
This course explains the evaluation of thermal problems and their possible solutions using computational methods. It enables the student to amalgamate their knowledge of fluid mechanics, mathematics, heat transfer, with computational techniques to solve problems.

2. **Prerequisite**
Heat and Mass Transfer 1151ME115

3. **Links to other courses**
CAD and Applied FEA 1151ME116

4. **Course Educational Objectives**
Students undergoing this course are expected to
   - Explain about governing equations, discretization schemes, numerical methods, turbulence modeling, mesh quality and independence test, numerical errors, computational techniques and boundary conditions.
   - Analyse various types of flow and their control methods for solving them.

5. **Course Outcomes**
The students would be benefitted with the following outcomes:

CO Nos.	Course Outcomes	Level of learning domain (Based on revised Bloom's)
CO1	Solve the initial and boundary value problems using finite difference method.	K3
CO2	Solve steady state and transient heat conduction problems.	K3
CO3	Solve the incompressible flow problems using SIMPLE algorithm and finite difference method.	K3
CO4	Solve the convective heat transfer problems using finite volume method and solve heat conduction and incompressible flow problems using FEA.	K3
CO5	Solve turbulence problems using various models	K3

(K3 – Apply)

6. **Correlation of COs with Programme Outcomes**

Cos	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
CO1	M	L			L							L	M	H
CO2	M	L	L	L	L							L	M	H
CO3	M	L	L	L	L							L	M	H
CO4	M	L	L	L	L							L	M	H
CO5	M	L	L	L	L							L	M	H

H- High; M-Medium; L-Low

7. Course Content

Unit I: Governing Differential Equation and Finite Difference Method **L- 9**
Classification, Initial and Boundary conditions – Initial and Boundary Value problems – Finite difference method, Central, Forward, Backward difference, Uniform and non-uniform Grids, Numerical Errors, Grid Independence Test.

Unit II: Conduction Heat Transfer **L- 9**
Steady one-dimensional conduction, two and three dimensional steady state problems, Transient one-dimensional problem, Two-dimensional Transient Problems. Conduction equation transient problems (one/ two/ three dimensional problems), adaptive grid, Introduction to upwind.

Unit III: Incompressible Fluid Flow **L- 9**
Governing Equations, Stream Function – Verticity method, Determination of pressure for viscous flow, SIMPLE Procedure of Patankar and Spalding, Computation of Boundary layer flow, finite difference approach

Unit IV: Convection Heat Transfer and FEM **L- 9**
Steady One-Dimensional and Two-Dimensional Convection – diffusion, unsteady one-dimensional convection – diffusion, unsteady two-dimensional convection – Diffusion – Introduction to finite element method – solution of steady heat conduction by FEM – Incompressible flow – simulation by FEM.

Unit V: Turbulence Models **L-9**
Algebraic Models – One equation model, K – ϵ Models, Standard and High and Low Reynolds number models, Prediction of fluid flow and heat transfer using standard codes.

TOTAL: 45 Periods

8. Text Books

1. Anderson, J. D., Computational Fluid Dynamics, McGraw Hill International, New York, 1995
2. Malalasekhara, “Computational Fluid Dynamics”, PHI,

9. References

1. Muralidhar, K., and Sundararajan, T., “Computational Fluid Flow and Heat Transfer”, Narosa Publishing House, New Delhi, 1995.
2. Subas, V.Patankar “Numerical heat transfer fluid flow”, Hemisphere Publishing Corporation, 1980.
3. Anderson, D.A., Tannehill, J.I., and Pletcher, R.H., “Computational fluid Mechanics and Heat Transfer “ Hemisphere Publishing Corporation, New York, USA,1984.
4. Fletcher, C.A.J. “Computational Techniques for Fluid Dynamics 1” Fundamental and General Techniques, Springer – Verlag, 1987.

10. Revised Bloom's based Assessment Pattern

Revised Bloom's Category	**Internal**				**University Examination %**
	Unit Test-I %	**Mid Term Test I %**	**Unit Test-II %**	**Mid Term Test II %**	
Remember	30	30	20	20	40
Understand	60	60	60	60	60
Apply	10	10	20	20	
Analyse					
Evaluate					
Create					

Revised Bloom's Category	**Assignments**	
	1 (COs addressed CO1,CO2) (max marks in %)	**2 (COs addressed CO3,CO4) (max marks in %)**
Remember	**20**	**10**
Understand	**40**	**40**
Apply	**40**	**50**
Analyse		
Evaluate		
Create		

COURSE CODE	FUELS AND COMBUSTION	L	T	P	C
1152ME107		3	0	0	3

1. **Preamble**
This course makes an attempt to bring students various types of fuels (like liquid, solid and gaseous fuels) that are available depend on various factors such as costs, availability, storage, handling, pollution and landed boilers, furnaces and other combustion equipments. The knowledge of the fuel properties helps in selecting the right fuel for the right purpose and for the efficient use of the fuel

2. **Prerequisite**
Engineering Chemistry 1150CH101

3. **Links to other courses:**
Project Work

4. **Course Educational Objectives**
Students undergoing this course are expected to
   - Describes the environmental problems arising due to the advanced technology
   - Explains and provides knowledge on the energy resources and their management without wastage and prevention of over-exploitation.
   - Analysis of various types of pollution and its control methods for solving the problems arising due to them

5. **Course Outcomes**
The students would be benefitted with the following outcomes:

CO Nos.	Course Outcomes	Level of learning domain (Based on revised Bloom's)
CO1	Understand the characteristics of fuels, determination of calorific values and analysis of flue gases.	K3
CO2	Understand the concepts of solid and liquid fuel properties and production process of solid and liquid fuels.	K2
CO3	Understand the properties, production and determination of calorific values of gaseous fuels.	K3
CO4	Understand the concepts of combustion mechanism for solid, liquid and gaseous fuels, mass and volume basis calculation.	K3
CO5	Explain the function and design of burning equipment.	K3

(K2 – Understand)

6. **Correlation of COs with Programme Outcomes**

COs	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
CO1	H											L	M	
CO2	H						L					L	M	
CO3	H						L					L	M	
CO4	H						L					L	M	
CO5	H						L					L	M	

H- High; M-Medium; L-Low

7. Course Content

UNIT- I CHARACTERIZATION L–9

Fuels - Types and Characteristics of Fuels - Determination of Properties of Fuels - Fuels Analysis - Proximate and Ultimate Analysis - Moisture Determination - Calorific Value - Gross & Net Calorific Values - Calorimetry - DuLong's Formula for CV Estimation - Flue gas Analysis - Orsat Apparatus - Fuel & Ash Storage & Handling - Spontaneous Ignition Temperatures.

UNIT- II SOLID FUELS & LIQUID FUELS L-9

(a) Solid Fuels

Types - Coal Family - Properties - Calorific Value - ROM, DMMF, DAF and Bone Dry Basis - Ranking - Bulk & Apparent Density - Storage - Washability - Coking & Caking Coals – Renewable Solid Fuels - Biomass - Wood Waste - Agro Fuels - Manufactured Solid Fuels.

(b) Liquid Fuels

Types - Sources - Petroleum Fractions - Classification - Refining - Properties of Liquid Fuels - Calorific Value, Specific Gravity, Flash & Fire Point, Octane Number, Cetane Number etc, - Alcohols - Tar Sand Oil - Liquefaction of Solid Fuels.

UNIT III GASEOUS FUELS L-9

Classification - Composition & Properties - Estimation of Calorific Value - Gas Calorimeter. Rich & Lean Gas - Wobbe Index - Natural Gas - Dry & Wet Natural Gas - Stripped NG - Foul & Sweet NG - LPG - LNG - CNG - Methane - Producer Gas - Gasifiers - Water Gas - Town Gas - Coal Gasification - Gasification Efficiency - Non - Thermal Route - Biogas - Digesters - Reactions - Viability - Economics.

UNIT –IV COMBUSTION: STOICHIOMETRY & KINETICS L-9

Stoichiometry - Mass Basis & Volume Basis - Excess Air Calculation - Fuel & Flue Gas Compositions - Calculations - Rapid Methods - Combustion Processes - Stationary Flame - Surface or Flameless Combustion - Submerged Combustion - Pulsating & Slow Combustion Explosive Combustion. Mechanism of Combustion - Ignition & Ignition Energy - Spontaneous Combustion – Introduction to flame velocity, premixed and diffusion combustion - Flame Propagation - Solid, Liquid & Gaseous Fuels Combustion - Flame Temperature - Theoretical, Adiabatic & Actual - Ignition Limits - Limits of Inflammability.

UNIT- V COMBUSTION EQUIPMENTS L-9

Coal Burning Equipments - Types - Pulverized Coal Firing - Fluidized Bed Firing - Fixed Bed &Recycled Bed - Cyclone Firing - Spreader Stokers - Vibrating Grate Stokers - Sprinkler Stokers,Traveling Grate Stokers. Oil Burners - Vaporizing Burners, Atomizing Burners - Design of Burners. Gas Burners - Atmospheric Gas Burners - Air Aspiration Gas Burners - Burners Classification according to Flame Structures - Factors Affecting Burners & Combustion.

TOTAL: 45 periods

8. Text Books

1. Samir Sarkar, Fuels & Combustion, 2nd Edition, Orient Longman, 1990
2. Bhatt, Vora Stoichiometry, 2nd Edition, Tata McGraw Hill, 1984
3. Blokh AG,Heat Transfer in Steam Boiler Furnace, Hemisphere Publishing Corpn, 1988.

9. References

1. Civil Davies, Calculations in Furnace Technology, Pergamon Press, Oxford, 1966
2. Sharma SP, Mohan Chander, Fuels & Combustion, Tata McGraw Hill, 1984

10. Revised Bloom's based Assessment Pattern

Revised Bloom's Category	Internal				University Examination %
	Unit Test-I %	Mid Term Test I %	Unit Test-II %	Mid Term Test II %	
Remember	20	20	20	20	20
Understand	60	60	60	70	70
Apply	20	20	20	10	10
Analyse					
Evaluate					
Create					

Revised Bloom's Category	Assignments	
	1 (COs addressed CO1,CO2) (max marks in %)	2 (COs addressed CO3,CO4) (max marks in %)
Remember	**20**	**10**
Understand	**40**	**40**
Apply	**40**	**50**
Analyse		
Evaluate		
Create		

COURSE CODE	INTERNAL COMBUSTION ENGINES	L	T	P	C
1152ME110		3	0	0	3

1. Preamble

This course provides the fundamentals operation of internal combustion engines, their performance, fuel requirements and environmental impact. Students study the design features and operating characteristics of different types of internal combustion engines, alternate fuels and recent developments in IC engines.

2. Prerequisite

Applied Engineering Thermodynamics 1151ME108

3. Links to other courses

Automobile Engineering 1152ME103

4. Course Educational Objectives

Students undergoing this course are expected to:

- Understand the operation of internal combustion engines.
- Understand the factors affecting the performance of internal combustion engines
- Understand the need of alternate fuels and recent techniques in IC engines

5. Course Outcomes

Upon the successful completion of the course, learners will be able to

CO Nos.	Course Outcomes	Level of learning domain (Based on revised Bloom's)
CO1	Understand the working principle of SI engines, combustion mechanism and thermodynamic analysis.	K3
CO2	Understand the working principle of CI engines, concepts of knocking and combustion mechanism and thermodynamic analysis.	K3
CO3	Describe the formation of emission, various methods to reduce emissions and their measuring equipment.	K3
CO4	Explain the different types of alternative fuels and its production process.	K2
CO5	Explain the recent developments in IC engines	K2

(K3 – Apply)

6. Correlation of CO's with Programme Outcomes

Cos	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
CO1	H	M										L	M	
CO2	H	M										L	M	
CO3	H	M										L	M	
CO4	H	M										L	M	
CO5	H	M										L	M	

H- High; M-Medium; L-Low

7. Course Content

Unit I **L-9**

Spark Ignition Engines Spark ignition engine- Mixture requirements - Feedback control - Carburetors -Fuel injection systems Monopoint and Multipoint injection -Stages of combustion - Normal and Abnormal combustion Factors affecting knock-Combustion chambers- Introduction to Thermodynamic analysis of S.I. engine combustion. Combustion stoichiometry

Unit II **L-9**

Compression Ignition Engines States of combustion in C.I. Engine –Combustion knock in CI engines – Knock comparison in SI and CI Engines-Methods of controlling knock- Direct and indirect injection systems - Combustion chambers - Fuel spray behavior-spray structure, spray penetration and evaporation-Air motion-Turbo charging-Introduction to Thermodynamic analysis of C.I. Engine combustion. Physical factors affecting ignition delay.

Unit III **L-9**

Pollutant Formation and Control Pollutant - Sources and types - formation of NOx - Hydrocarbon emission mechanism - Carbon monoxide formation - Particulate emissions – Measurement of exhaust emissions-Methods of controlling emissions- Catalytic converters and Particulate traps. Euro and BS norms .introduction to supercharger after treatment device - EPC

Unit IV **L-9**

Alternative Fuels Bio-fuels: Alcohol, Hydrogen, Natural Gas and Liquefied Petroleum Gas – Properties – Suitability - Engine Modifications - Merits and Demerits as fuels. Biodiesel production process.Seminar.

Unit V **L-9**

Recent Trends Lean Burn Engines - Stratified Charge Engines – Gasoline: Direct Injection Engine – Common rail Diesel injection system (CDRI)- Homogeneous charge compression ignition - Plasma Ignition – Ignition Measurement techniques. Exhaust gas recirculation

Total: 45 Hours

8. Text books

1. V. Ganesan, Internal Combustion Engines, Tata McGraw Hill Publishing Company Pvt Ltd., New Delhi, 2007

9. References

1. John B. Heywood, Internal Combustion Engine Fundamentals, Tata McGraw Hill Publishing Company Pvt Ltd., New Delhi,2008
2. S. Rowland Benson and N. D. Whitehouse., Internal combustion Engines, Vol.I and II, Pergamon Press.
3. H. N. Gupta Fundamentals of Internal Combustion Engineering, Prentice Hall of India Pvt Ltd, New Delhi, 2006.
4. R. B. Mathur and R. P. Sharmal Internal Combustion Engines, Dhanpat Rai Publications, 2008. 5. http://www.gtmresearch.com/report/third-and- fourth – generation- bio fuels.

10. Revised Bloom's based Assessment Pattern

Revised Bloom's Category	Internal				University Examination %
	Unit Test 1 %	Mid Term Test 1 %	Unit Test 2 %	Mid Term Test 2 %	
Remember	50	10	50	10	10
Understand	50	50	50	60	50
Apply		40		30	40
Analyse					
Evaluate					
Create					

Revised Bloom's Category	Assignments	
	1 (COs addressed CO1,CO2) (max marks in %)	2 (COs addressed CO3,CO4) (max marks in %)
Remember	**20**	**10**
Understand	**40**	**40**
Apply	**40**	**50**
Analyse		
Evaluate		
Create		

COURSE CODE	POWER PLANT ENGINEERING	L	T	P	C
1152ME116		3	0	0	3

1. Preamble:

This course makes an attempt to bring students in direct contact with different types of power plants and their working. Empower the students to amalgamate their knowledge of basic engineering thermodynamics, heat transfer and thermal power engineering.

2. Prerequisite

Machining And Machine Tools Technology 1151ME107

3. Links to other courses

Project Work

4. Course Educational Objectives

Students undergoing this course are expected to

- Describes the working of steam power plant and different types of boilers
- Explains and provides knowledge on the components of hydel and nuclear power plants.
- Analysis of various types of non-conventional energy resources for power generation
- Discusses the various methods of gas turbine power plants.
- Description of power plant economics and the various effects of pollution.

5. Course Outcomes

Upon the successful completion of the course, learners will be able to

CO Nos.	Course Outcomes	Level of learning domain (Based on revised Bloom's)
CO1	Understand the operation of steam power plant and its components.	K2
CO2	Understand the operation of hydroelectric and nuclear power plants and its components.	K2
CO3	Understand the operation of diesel and gas turbine power plants and its components.	K2
CO4	Understand the operation of various non-conventional power generation systems.	K2
CO5	Analysis of power generation cost and make the students familiar about environmental pollution.	K4

6. Correlation of CO's with Programme Outcomes

Cos	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
CO1	H	M					L					L	M	L
CO2	H	M					L					L	M	L
CO3	H	M					L					L	M	L
CO4	H	M					L					L	M	L
CO5	H	M					L				L	L	M	L

H- High; M-Medium; L-Low

7. Course Content

UNIT- I STEAM POWER PLANTS **L - 9**

Layout of steam power plants & various components, high pressure and supercritical boilers - La Mout , Loeffler , Bension & Velox boilers , fluidized Bed combustion , fluidized bed boilers , classification , Co -generation. Fuel and Ash handling, combustion equipments for burning coal - Mechanical stokers, Pulverisers , steam condensers- different types, cooling towers - Different types, Drought system - different types, chimney height calculation, Merits and De- merits of steam power plants

UNIT- II HYDEL AND NUCLEAR POWER PLANTS **L-9**

Layout of hydel power plants, Essential elements, selection of turbines, governing of water turbine, Micro hydel development, pumped storage hydel plants, Merits and Demerits of hydel power plants. Layout of Nuclear power plant, Nuclear energy - Fission and Fusion, Nuclear reactor - Essential elements, Types of reactors- Pressurized water reactor, boiling water reactor, Gas cooled reactor, Fast breeder reactor, Waste disposal and safety, merits and demerits of nuclear power plants.

UNIT III DIESEL AND GAS TURBINE POWER PLANTS **L-9**

Layout of Diesel power plants, components, selection of Engine type, Application, Advantages and Disadvantages of Diesel power plants. Layout of Gas turbine power plants, Essential components, Fuels, Gas turbine plant materials, types of gas turbine plants, methods to improve performance - inter cooling, Reheating and regeneration, combine cycle power generation, merits and demerits of gas turbine power plants.

UNIT IV NON- CONVENTIONAL POWER GENERATION **L-9**

MHD power plants, Geothermal power plants, Ocean thermal energy conversion (OTEC), Tidal power plants, wind power plants, solar thermal energy conversion, energy from Biomass ,Fuel cell, merits and demerits of various non- conventional power generation systems.

UNIT V POWER PLANT ECONOMICS & POLLUTION **L-9**

Load curve, Load duration curve, cost of electrical energy, Fixed and operating costs, Energy rate (tariff), types of tariffs, Economics of load sharing, comparison of economics of various power plants. Pollution from thermal and other power plants.

TOTAL: 45 periods

8. Text Books

1. P. K. Nag,"Power Plant Engineering", Tata McGraw-Hill Education, 2002.
2. R.K.Rajput, "A Text Book of Power system Engineering", Laxmi Publications; First edition (2006)

9. References

1. Manoj kumar Gupta "Power plant Engineering", MS/PHI, 2008

10. Revised Bloom's based Assessment Pattern

Revised Bloom's Category	**Internal**				**University Examination %**
	Unit Test 1 %	**Mid Term Test 1 %**	**Unit Test 2 %**	**Mid Term Test 2 %**	
Remember	10	10	10	10	10
Understand	20	20	20	20	20
Apply	40	40	70	70	40
Analyse	30	30			30
Evaluate					
Create					

Revised Bloom's Category	**Assignments**	
	1 (COs addressed CO1,CO2) (max marks in %)	**2 (COs addressed CO3,CO4) (max marks in %)**
Remember	**20**	**10**
Understand	**40**	**40**
Apply	**40**	**50**
Analyse		
Evaluate		
Create		

COURSE CODE	RENEWABLE SOURCES OF ENERGY	L	T	P	C
1152ME117		3	0	0	3

1. Preamble

This course helpful for the students to enhance their knowledge in renewable sources and empower the students to understand the need of renewable source, utilization of techniques and its advantages

2. Prerequisite

Environmental Science and Engineering

3. Links to other courses:

Project Work

4. Course Educational Objectives

Students undergoing this course are expected to

- Describes the need of utilization of renewable resources
- Explains and provides knowledge on the solar, Wind, bio mass, Geothermal and Ocean Energy resources and technologies
- Discusses the Direct energy conversion and its various forms

5. Course Outcomes

The students would be benefitted with the following outcomes:

CO Nos.	Course Outcomes	Level of learning domain (Based on revised Bloom's)
CO1	Understand the basic concepts of solar energy, measurement of solar radiation, solar thermal collector and its performance.	K3
CO2	Understand the principle of photovoltaic energy conversion and thermal energy storage system.	K2
CO3	Understand the principle of wind energy conversion and various biomass energy conversion methods.	K2
CO4	Explain the principle of geothermal energy conversion and various ocean energy conversion technologies.	K2
CO5	Explain the principle of different direct energy conversion technologies.	K2

6. Correlation of COs with Programme Outcomes

Cos	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
CO1	M						L					L	L	
CO2	M						L					L	L	
CO3	M						L					L	L	
CO4	M						L					L	L	
CO5	M						L					L	L	

H- High; M-Medium; L-Low

7. Course Content

UNIT- I PRINCIPLES OF SOLAR RADIATION L – 9

The solar energy , Environmental impact of solar power, physics of the sun, the solar constant, extraterrestrial and terrestrial solar radiation, solar radiation on titled surface, Instruments for measuring solar radiation and sun shine, solar radiation data. Solar energy collection: Flat plate and concentrating collectors, classification of concentrating collectors, orientation and thermal analysis, advanced collectors.

UNIT- II SOLAR ENERGY STORAGE AND APPLICATIONS L – 9

Different methods, Sensible, latent heat and stratified storage, solar ponds. Solar Applications- solar heating/cooling technique, solar distillation and drying, photovoltaic energy conversion.; behaviour of solar cells; cell properties; system components; applications; grid connection; system design, RAPS applications.

UNIT III WIND ENERGY & BIO –MASS L – 9

Sources and potentials, horizontal and vertical axis windmills, performance characteristics, interaction of wind and rotor; fatigue; process of electricity generation and wind farms.
BIO-MASS: Principles of Bio-Conversion, Anaerobic/aerobic digestion, types of Bio-gas digesters, gas yield, combustion characteristics of bio-gas, utilization for cooking, I.C.Engine operation and economic aspects. Ethanol production technology from both yeasts and bacteria including GMOs.

UNIT –IV GEOTHERMAL & OCEAN ENERGY L – 9

Resources, types of wells, methods of harnessing the energy, potential in India. Ocean energy: OTEC, Principles utilization, setting of OTEC plants, thermodynamic cycles. Tidal and wave energy: Potential and conversion techniques, mini-hydel power plants, and their economics.

UNIT- V DIRECT ENERGY CONVERSION L – 9

Need for DEC, Carnot cycle, limitations, principles of DEC. Thermo-electric generators, seebeck, peltier and joul Thomson effects, Figure of merit, materials, applications, MHD generators, principles, dissociation and ionization, hall effect, magnetic flux, MHD accelerator, MHD Engine, power generation systems, electron gas dynamic conversion, economic aspects. Fuel cells, principles, faraday's law's, thermodynamic aspects, selection of fuels and operating conditions.

TOTAL: 45 periods

8. Text Books

1. S.Rao, Non-conventional, renewable and conventional energy, Khanna Publishers ,New Delhi, 2005
2. Boyle, G. Renewable energy, Power for a sustainable future. OxfordUniversity press, Oxford, UK, 2004.

9. References

1. John Twidell & Tony Weir, Renewable Energy resources, Routledge, 2015
2. Kemp, W.H. The Renewable Energy Handbook, Aztext Press Ontario, Canada, 2009
3. Duffie, J. A. & W. A. Beckman, Solar Engineering of Thermal Processes, 3rd ed. John Wiley & Sons, Inc. 2006.
4. Demirbas, A. Biorefineries – for biomass upgrading facilities, Springerpublishers, 2010.

10. Revised Bloom's based Assessment Pattern

Revised Bloom's Category	**Internal**				**University Examination %**
	Unit Test 1 %	**Mid Term Test 1 %**	**Unit Test 2 %**	**Mid Term Test 2 %**	
Remember	10	10	10	10	10
Understand	20	20	20	20	20
Apply	40	40	70	70	40
Analyse	30	30			30
Evaluate					
Create					

Revised Bloom's Category	**Assignments**	
	1 (COs addressed CO1,CO2) (max marks in %)	**2 (COs addressed CO3,CO4) (max marks in %)**
Remember	**20**	**10**
Understand	**40**	**40**
Apply	**40**	**50**
Analyse		
Evaluate		
Create		

COURSE CODE	REFRIGERATION AND AIR CONDITIONING	L	T	P	C
1152ME120		3	0	0	3

1. Preamble

This course will be helpful for the students to enhance their knowledge in Refrigeration and Air Conditioning.

2. Prerequisite

Thermal Engineering 1151ME112

3. Links to other courses:

Project Work

4. Course Educational Objectives

On successful completion of this course students will be able to understand:

- Perform calculations relating to heat exchangers,
- About refrigeration and air conditioning cycles.
- Apply knowledge on various refrigeration cycles, system components and refrigerants to design refrigeration and air-conditioning systems.
- Factors which affect energy efficiency and total environmental warming impact.
- About thermal insulations

5. Course Outcomes

The students would be benefitted with the following outcomes:

COs	Course Outcomes	CO3. Level of learning domain (Based on revised Bloom's)
CO1	Understand the working principle of various refrigeration systems and solve the related problems.	K3
CO2	Understand the function of refrigeration components and its performance, properties of refrigerants and applications.	K3
CO3	Apply the concepts of psychometric process to solve the problems.	K3
CO4	Understand the estimation of cooling load and design of air distribution system.	K3
CO5	Explain the working principle of various air conditioning systems and its components.	K2

(K2- Understand)

6. Correlation of CO's with Programme Outcomes:

Cos	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
CO1	H	L					L					L	M	L
CO2	H	L					L					L	M	L
CO3	H	L					L					L	M	L
CO4	H	L					L					L	M	L
CO5	H	L					L					L	M	L

H- High; M-Medium; L-Low

7. Course Content

UNIT I REFRIGERATION SYSTEMS AND THEIR CYCLES L- 9
Review of thermodynamic principles of refrigeration, Vapour compression cycle, actual vapour compression cycle, cascade system- cycle analysis and performance calculations. Aircraft refrigeration system. Vapour absorption refrigeration system. Ammonia water and Lithium Bromide water systems. Steam jet refrigeration system

UNIT II COMPRESSORS, REFRIGERANTS AND APPLICATIONS OF REFRIGERATION SYSTEMS L- 9
Compressors – reciprocating & rotary (element treatment) – condensers – evaporators. Refrigerants – properties – selection of refrigerants – refrigeration plant controls – testing and charging of refrigeration units Applications to refrigeration systems – ice plant – food storage plants – milk – chilling plants – refrigerated cargo ships – cryogenic in medicine and biological uses

UNIT III PSYCHOMETRY L-9
Review of fundamental properties of psychometric – use of psychometric charts – psychometric processes – Grand and Room Sensible Heat Factors – by pass factor – requirements of comfort air conditioning –factors governing optimum effective temperature, recommended design conditions and ventilation standards.

UNIT IV COOLING LOAD ESTIMATION L - 9
Types of load – design of space cooling load – Heat transmission through building. Solar radiation – infiltration – internal heat sources (sensible and latent) – outside air and fresh air load – estimation of total load – duct design – air distribution system

UNIT IV AIR CONDITIONING SYSTEMS L- 9
Domestic, commercial and industrial systems – central air conditioning systems – applications: car, industry, stores, and public buildings. Air conditioning equipments – air cleaning and air filters – humidifiers – dehumidifiers – air washers – Thermal insulation of air conditioning systems.

TOTAL: 45 periods

8. TEXT BOOKS
1. Arora, S. C. and Domkundwar, S., A course in Refrigeration and Air conditioning, Dhanpat Rai (P) Ltd., New Delhi, 1997
2. Khurmi R.S., and Gupta, J. K., A text book of Refrigeration and Air Conditioning, Eurasia Publishing housing (P) Ltd, New Delhi, 2002

9. REFERENCES
1. Manohar Prasad, Refrigeration and Air conditioning, New Age International (P) Ltd, New Delhi, 1999.
2. Ashrae Hand Book’, 4 Vol., Current Ed., Carrier Air Conditioning Co., ‘Hand Book of Air Conditioning’, Prentice Hall of India, 1974

10. Revised Bloom's based Assessment Pattern

Revised Bloom's Category	Internal				University Examination %
	Unit Test 1 %	Mid Term Test 1 %	Unit Test 2 %	Mid Term Test 2 %	
Remember	10	10	10	10	10
Understand	20	20	20	20	20
Apply	40	40	70	70	40
Analyse	30	30			30
Evaluate					
Create					

Revised Bloom's Category	Assignments	
	1 (COs addressed CO1,CO2) (max marks in %)	2 (COs addressed CO3,CO4) (max marks in %)
Remember	**20**	**10**
Understand	**40**	**40**
Apply	**40**	**50**
Analyse		
Evaluate		
Create		

COURSE CODE	INDUSTRIAL ENGINEERING AND MANAGEMENT	L	T	P	C
1152ME108		3	0	0	3

1. Preamble

This course makes an attempt to bring students in direct contact with the working environment of an industry. It empowers the students to amalgamate their knowledge of production, process planning & control, maintenance and system analysis.

2. Prerequisite

Machining And Machine Tools Technology 1151ME107

3. Links to other courses

Project Work

4. Course Educational Objectives

Students undergoing this course are expected to

- Be familiar with fundamentals of various science and technological subjects and thus acquire the capability to applying them.
- Equip knowledge and skills necessary for entry-level placement in MNC's.
- Develop capacity to understand professional and ethical responsibility and to display skills required for continuous and lifelong learning and up gradation.

5. **Course Outcomes**

The students would be benefitted with the following outcomes:

CO Nos.	Course Outcomes	Level of learning domain (Based on revised Bloom's)
CO1	Understand about various production system and various layouts	K2
CO2	Describe about Process Planning and Control.	K2
CO3	Discuss on various types of method study and work measurement.	K2
CO4	Solve inventory control problems using various models	K2
CO5	Explain the concept of system analysis and maintenance.	K2

(K2 – Comprehend)

6. Correlation of COs with Programme Outcomes

Cos	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
CO1	L											L	M	
CO2	L				L							L	M	
CO3	L				L			L				L	M	
CO4	L				L							L	M	
CO5	L				L			L				L	M	

H- High; M-Medium; L-Low

7. Course Content

UNIT- I PRODUCTION SYSTEM L–9
Industrial engineering - Concept, History and development, Applications, Roles of Industrial engineer. Production management, Industrial engineering versus production management, Operations Management. Production system – Analysis, Input output model, Productivity, Factors affecting productivity. Plant layout, Process layout, Product layout, Combination layout, fixed position layout, Flow pattern, and Workstation design

UNIT- II PROCESS PLANNING AND CONTROL L-9
Process planning – definition, procedure, Process selection, Machine capacity, process sheet, process analysis, process chart – symbols, outline process chart, flow process chart. Group technology – functional and group layout, classification and coding system, formation of component family.Production planning, economic batch quantity, loading, scheduling. Production control – dispatching, routing. Progress control – bar, curve, Gantt chart, route & schedule chart, line of balance

UNIT III WORK STUDY L-9
Work study – definition, need, advantages, objectives of method study and work measurement, method study procedure, flow diagram, string diagram, multiple activity chart, operation analysis, analysis of motion, principles of motion economy, design of work place layout & ergonomics, therbligs, SIMO chart, stop watch procedure, micro & macro motion study. Predetermined motion time system, work sampling – principle, procedure.

UNIT –IV INVENTORY MANAGEMENT L-9
Inventory – control, classification, management, objectives, functions. Economic order quantity, Inventory models, ABC analysis, Material Requirement Planning (MRPI), Manufacturing Resource Planning(MRP II), Operating cycle, Just in Time manufacturing system, KANBAN technique, lean manufacturing, Supply chain management. Material handling – functions, principles, Engineering and economic factors, Material handling equipment – selection, maintenance, types.

UNIT- V SYSTEM ANALYSIS AND MAINTENANCE L-9
System concept - system analysis, systems engineering, techniques, applications.Value analysis – aim, technique, procedure, advantages, value engineering, value control, types of values.Re-engineering, Business process re-engineering.Plant maintenance – objectives, importance, maintenance engineer – duties, functions and responsibilities. Types – breakdown, scheduled, preventive, predictive - seminar

TOTAL = 45 periods

8. Text Books

1. O. P. Khanna, *Industrial Engineering and Management*, Dhanpat Rai and Sons, New Delhi, 2008
2. Hamdy M. Taha, *Operations Research, an Introduction*, McMillan Co.,2008

9. References

1. J. A. Tompkins and J. A. White, *Facilities planning*, John Wiley, 2010.
2. Benjamin W. Neibel, *Motion and time study*, Richard .D .Irwin Inc., 2006.
3. Lee J. Krajewski, Larry P.Ritaman, *Operations Management* ,Addison Wesley,2007.
4. Ravi Shankar, *Industrial Engineering and Management*, Golgotia Publications Pvt Ltd, NewDelhi, 2009.

10. Revised Bloom's based Assessment Pattern

Revised Bloom's Category	Internal				University Examination %
	Unit Test-I %	Mid Term Test I %	Unit Test-II %	Mid Term Test II %	
Remember	30	20	30	20	20
Understand	70	50	70	50	50
Apply		30		30	30
Analyse					
Evaluate					
Create					

Revised Bloom's Category	Assignments	
	1 (COs addressed CO1,CO2) (max marks in %)	2 (COs addressed CO3,CO4) (max marks in %)
Remember	**20**	**10**
Understand	**40**	**40**
Apply	**40**	**50**
Analyse		
Evaluate		
Create		

COURSE CODE	TOTAL QUALITY MANAGEMENT	L	T	P	C
1152ME122		3	0	0	3

1. Preamble
To provide comprehensive knowledge about the principles, practices, tools and techniques of Total quality management.

2. Pre-requisite:
NIL

3. Links to other courses
Project Work

4. Course Educational Objectives
Students undergoing this course are expected
- To understand the various principles, practices of TQM to achieve quality.
- To learn the various statistical approaches for Quality control.
- To understand the TQM tools for continuous process improvement.
- To learn the importance of ISO and Quality systems

5. Course Outcomes
The students would be benefitted with the following outcomes:

CO Nos.	Course Outcomes	Level of learning domain (Based on revised Bloom's)
CO1	Understand the various principles of TQM to achieve quality.	K2
CO2	Learn the various statistical approaches for Quality control.	K2
CO3	Understand the TQM tools for continuous process improvement.	K2
CO4	Understand the TQM tools for QFD.	K2
CO5	Learn the importance of ISO and Quality systems	K2

(K2 – Understand)

6. Correlation of COs with Programme Outcomes

Cos	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
CO1	L				L	L	L	L	L		L	L	L	
CO2	L				L	L	L	L	L		L	L	L	
CO3	L	L	L	L	L	L	L	L	L			L	L	
CO4	L				L	L	L	L	L			L	L	
CO5	L				L	L	L	L	L			L	L	

H- High; M-Medium; L-Low

7. Course Content

UNIT I INTRODUCTION **L-9**

Introduction - Need for quality - Evolution of quality - Definition of quality - Dimensions of manufacturing and service quality - Basic concepts of TQM - Definition of TQM – TQM Framework - Contributions of Deming, Juran and Crosby – Barriers to TQM.

UNIT II TQM PRINCIPLES **L-9**

Leadership – Strategic quality planning, Quality statements - Customer focus – Customer orientation, Customer satisfaction, Customer complaints, Customer retention – Employee involvement – Motivation, Empowerment, Team and Teamwork, Recognition and Reward, Performance appraisal - Continuous process improvement – PDSA cycle, 5s, Kaizen – Supplier partnership – Partnering, Supplier selection, Supplier Rating.

UNIT III TQM TOOLS & TECHNIQUES I **L-9**

The seven traditional tools of quality – New management tools – Six-sigma: Concepts, methodology, applications to manufacturing, service sector including IT – Bench marking – Reason to bench mark, Bench marking process – FMEA – Stages, Types.

UNIT IV TQM TOOLS & TECHNIQUES II **L-9**

Quality circles – Quality Function Deployment (QFD) – Taguchi quality loss function – TPM – Concepts, improvement needs – Cost of Quality – Performance measures.

UNIT V QUALITY SYSTEMS **L-9**

Need for ISO 9000- ISO 9000-2000 Quality System – Elements, Documentation, Quality auditing- QS 9000 – ISO 14000 – Concepts, Requirements and Benefits – Case studies of TQM implementation in manufacturing and service sectors including IT.

TOTAL: 45 PERIODS

8. Text Book

1. Dale H.Besterfiled, et at., “Total Quality Management”, Pearson Education Asia, Third Edition, Indian Reprint (2006).

9. Reference Books

1. James R. Evans and William M. Lindsay, “The Management and Control of Quality”, 6th Edition, South-Western (Thomson Learning), 2005.
2. Oakland, J.S. “TQM – Text with Cases”, Butterworth – Heinemann Ltd., Oxford, 3rd Edition, 2003.
3. Suganthi,L and Anand Samuel, “Total Quality Management”, Prentice Hall (India) Pvt. Ltd.,2006.
4. Janakiraman,B and Gopal, R.K, “Total Quality Management – Text and Cases”, Prentice Hall (India) Pvt. Ltd., 2006.

10. Revised Bloom's based Assessment Pattern

Revised Bloom's Category	Internal				University Examination %
	Unit Test-I %	Mid Term Test I %	Unit Test-II %	Mid Term Test II %	
Remember	30	20	30	20	20
Understand	70	50	70	50	50
Apply		30		30	30
Analyse					
Evaluate					
Create					

Revised Bloom's Category	Assignments	
	1 (COs addressed CO1,CO2) (max marks in %)	2 (COs addressed CO3,CO4) (max marks in %)
Remember	**20**	**10**
Understand	**40**	**40**
Apply	**40**	**50**
Analyse		
Evaluate		
Create		

COURSE CODE	OPERATIONS RESEARCH	L	T	P	C
1152ME119		3	0	0	3

1. Preamble
To impart knowledge and techniques for optimization in engineering and business problems.

2. Prerequisite
Engineering Mathematics II 1150MA103

3. Links to other courses
Project Work

4. Course Educational Objectives
Students undergoing this course are expected to:

- The students can be able to solve the Engineering and Business problems by using optimization techniques.
- Develop the skills of the students in the areas of Linear Programming, Transportation, Assignment, Scheduling, Network Models, Inventory control Replacement model and Queuing theory.
- Serve as a prerequisite for the Project work and specialized studies in the research.

5. Course Outcomes
Upon the successful completion of this course, the learners will be able to

CO Nos.	Course Outcomes	Level of learning domain (Based on revised Bloom's)
CO1	Develop linear programming model and solve for optimisation.	K3
CO2	Solve the challenging real world problems using transportation, assignment and scheduling approaches.	K3
CO3	Understand the applications of networking models and solving the problems.	K3
CO4	Solve problems in inventory and replacements using available models.	K3
CO5	Apply the techniques of queuing theory for real-world applications.	K3

(K3-Apply)

6. Correlation of Cos with Programme Outcomes

COs	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
CO1	H	M	L	L	L	L						L	M	L
CO2	H	M	L	L	L	L						L	M	L
CO3	H	M	L	L	L	L						L	M	L
CO4	H	M	L	L	L	L			L		L	L	M	L
CO5	H	M	L	L	L	L						L	M	L

H-High; M-Medium: L-Low

7. Course Content

UNIT I LINEAR PROGRAMMING L- 9

Formulation of linear programming problems – Graphical method of solution– solving LPP using simplex algorithm – Degeneracy- Duality theory- Big-M method and artificial variables. Integer programming, dual simplex method

UNIT II TRANSPORTATION AND ASSIGNMENT PROBLEM L- 9

Mathematical model, balanced and unbalanced Transportation and assignment problem, MODI method – northwest corner method- least cost method – Vogel's approximation methods – travelling salesman problem – assignment problem – types- Hungarian method – flow of scheduling – Johnson's algorithm – N Jobs two machines, N jobs three machines – 2 jobs N machines problems.

UNIT III NETWORK MODELS L- 9

Shortest route problem – Maximal flow problem – Minimal spanning tree problem – Project networks- CPM, PERT – project costing and control. Softwares related to LP, CPM and PERT

UNIT IV INVENTORY CONTROL AND REPLACEMENT L- 9

Types of inventory- Inventory cost – EOQ – Deterministic inventory problems – EOQ with price breaks– EOQ with storage limitations – probabilistic inventory problems , single period without setup cost, with setup cost – replacement policy – considering money value remains constant – money value changes with time – individual – group replacement policy

UNIT V QUEUEING THEORY L- 9

Queueing system – Characteristics – symbols – Single server queuing models – Multiserver queueing models- Simulation – Monte Carlo technique.

TOTAL: 45 Periods

8. Text Books

1. Handy, A. Taha, "Operations Research", 9th Edition, Prentice Hall of India, New Delhi, 2013
2. R.Panneerselvam, "Operations Research", PHI, Fourth Print, 2008.
3. N. D Vohra, Quantitative Techniques in Management, Tata McGraw Hill, 2010.
4. J.K Sharma " Operations research" theory and applications, Mac Millan, 2009

9. References

1. Hillier, F.S. and Liebermann, G.J., "Introduction to Operations Research", 8th Edition, McGraw Hill, 2010.
2. Philip and Ravindran, "Operationl Research", John Wiley, 2010.
3. Tulsian and Pasdey V., "Quantitative Techniques", Pearson – Asia 2010.

10. Revised Bloom's based Assessment Pattern

Revised Bloom's Category	Internal				University Examination %
	Unit test – I %	Mid Term -I %	Unit test – II %	Mid Term -II %	
Remember	30	20	30	20	20
Understand	70	50	70	50	50
Apply		30		30	30
Analyse					
Evaluate					
Create					

Revised Bloom's Category	Assignments	
	1 (COs addressed CO1,CO2) (max marks in %)	2 (COs addressed CO3,CO4) (max marks in %)
Remember	**20**	**10**
Understand	**40**	**40**
Apply	**40**	**50**
Analyse		
Evaluate		
Create		

COURSE CODE	LOGISTICS AND SUPPLY CHAIN MANAGEMENT	L	T	P	C
1152ME112		3	0	0	3

1. Preamble

This course provides an update to the knowledge of the students about existing logistical and supply-chain practices within the private and public sector of society. Students gain knowledge on applying logistics and supply-chain principles to achieve competitive advantage.

2. Prerequisite

Operations Research

3. Links to other courses

Project work

4. Course Educational Objectives

Students undergoing this course are expected to:

- Understand the existing SCM practices, logistical principles and integrated logistical approaches in the private and public sectors.
- Understand the strategic role of a supply-chain , key strategic drivers of supply-chain performance and analytical methodologies for supply-chain analysis

5. Course Outcomes

Upon the successful completion of the course, learners will be able to

CO Nos.	Course Outcomes	Level of learning domain (Based on revised Bloom's)
CO1	Explain the goal of supply-chain and logistics and the impact of supply-chain decisions.	K2
CO2	Explain about logistics management	K2
CO3	Illustrate about the network design	K2
CO4	Describe about sourcing and inventory management	K2
CO5	Describe about the latest trends in logistics	K3

(K3 – Apply)

6. Correlation of CO's with Programme Outcomes

Cos	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
CO1	H	L				L						L	L	L
CO2	H	L				L					L	L	L	L
CO3	H	L				L						L	L	L
CO4	H	L			L	L					L	L	L	L
CO5	H	L			L	L						L	L	L

H- High; M-Medium; L-Low

7. Course Content

UNIT I INTRODUCTION L-9

Defining Supply Chain management and logistics management.Evolution. Supply Chain – Fundamentals, , and Importance. Supply chain strategy, Enablers/ Drivers of Supply Chain Performance. Supply Chain relationships – customer relationship management

UNIT II LOGISTICS MANAGEMENT L-9

Logistics – functions, objectives, solution. Customer Service. Warehousing and Material Storage, Material Handling, Transportation and Packaging – 3PL and 4PL.

UNIT III NETWORK DESIGN L-9

Distribution Network Design – Role, Factors Influencing, Options, Value Additions.Models for Facility Location and Capacity allocation.Impact of uncertainty on Network Design. Network Design decisions using Decision trees.

UNIT IV SOURCING AND INVENTORY MANAGEMENT L-9

Sourcing – Make vs buy decision, Creating World Class Supply base, World Wide Sourcing Inventory Management – managing cycle inventory, safety inventory. Value of information, Bullwhip effect, Coordination in supply chain, Analysing impact of supply chain redesign on the inventory

UNIT V CURRENT TRENDS L-9

E-Business – Framework and Role of Supply Chain in e- business and b2b practices. Supply Chain IT Framework.E-Supply Chains, E – Logistics- eSRM, eLRM, eSCM, Agile Supply Chains. Reverse Logistics, Global Logistics.

TOTAL: 45 PERIODS

8. TEXT BOOKS

1. Bowersox Donald J, Logistical Management – The Integrated Supply Chain Process" Tata McGraw Hill, 2000
2. Sunil Chopra and Peter Meindl, Supply Chain Management-Strategy Planning and Operation, Prentice Hall, 2007.

9. REFERENCES

1. Donald J. Bowersox, David J. Closs and M. Bixby Cooper, "Supply Chain Logistics Management", Tata McGraw Hill, 2008
2. Altekar Rahul V, Supply Chain Management-Concept and Cases, Prentice Hall India, 2005.
3. Joel D. Wisner, G. Keong Leong, Keah-Choon Tan, "Principles of Supply Chain Management- A Balanced Approach", South-Western, Cengage Learning 2005
4. Naraya Rangarj, G. Raghuram, Mandyam M. Srinivasan, "Supply Chain Management for Competitive Advantage – Concepts and Cases", Tata McGraw Hill, 2009
5. R.P. Mohanty and S.G. Deshmukh, " Supply Chain Management", Biztantra, 2005

Web resources:

10. Revised Bloom's based Assessment Pattern

Revised Bloom's Category	Internal				University Examination %
	Unit Test 1 %	Mid Term Test 1 %	Unit Test 2 %	Mid Term Test 2 %	
Remember	10	10	10	10	10
Understand	50	50	20	20	50
Apply	40	40	70	70	40
Analyse					
Evaluate					
Create					

Revised Bloom's Category	Assignments	
	1 (COs addressed CO1,CO2) (max marks in %)	2 (COs addressed CO3,CO4) (max marks in %)
Remember	**20**	**10**
Understand	**40**	**40**
Apply	**40**	**50**
Analyse		
Evaluate		
Create		

COURSE CODE	MAINTENANCE ENGINEERING	L	T	P	C
1152ME113		3	0	0	3

1. Preamble

This course develops the skills of the students in the areas of maintenance engineering. Students gain knowledge on different categories like preventive maintenance, condition monitoring. The repair methods of machines and material handling equipments are explained with illustrations.

2. Prerequisite

Manufacturing Technology 1151ME104

3. Links to other courses

Project Work

4. Course Educational Objectives

Students undergoing this course are expected to:

- Understand the principles, functions and practices of maintenance planning and policies
- Explain the different maintenance categories like Preventive maintenance, condition monitoring and repair of machine elements.

5. Course Outcomes

Upon the successful completion of the course, learners will be able to

CO Nos.	Course Outcomes	Level of learning domain (Based on revised Bloom's)
CO1	Describe the principles, functions and practices of maintenance planning	K2
CO2	Explain various categories of maintenance	K2
CO3	illustrate some of the methods and instruments used for condition monitoring	K2
CO4	Demonstrate the repair methods for basic machine elements	K2
CO5	Explain the repair methods for material handling equipments	K2

(K2 – Remember)

6. Correlation of CO's with Programme Outcomes

Cos	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
CO1	L		L				L						L	
CO2	L		L				L						L	
CO3	L		L	L		L	L						L	
CO4	L		L	L		L	L						L	
CO5	L		L	L		L	L						L	

H- High; M-Medium; L-Low

7. Course Content

UNIT I PRINCIPLES AND PRACTICES OF MAINTENANCE PLANNING L-9
Basic Principles of maintenance planning – Objectives and principles of planned maintenance activity – Importance and benefits of sound Maintenance systems – Reliability and machine availability – MTBF, MTTR and MWT – Factors of availability – Maintenance organization – Maintenance economics. Lean management system

UNIT II MAINTENANCE POLICIES – PREVENTIVE MAINTENANCE L-9
Maintenance categories – Comparative merits of each category – Preventive maintenance, maintenance schedules, repair cycle - Principles and methods of lubrication – TPM.

UNIT III CONDITION MONITORING L-9
Condition Monitoring – Cost comparison with and without CM – On-load testing and off-load testing – Methods and instruments for CM – Temperature sensitive tapes – Pistol thermometers – wear-debris analysis

UNIT IV – REPAIR METHODS FOR BASIC MACHINE ELEMENTS L-9
Repair methods for beds, slideways, spindles, gears, lead screws and bearings – Failure analysis – Failures and their development – Logical fault location methods – Sequential fault location.

UNIT V – REPAIR METHODS FOR MATERIAL HANDLING EQUIPMENT L-9
Repair methods for Material handling equipment - Equipment records –Job order systems -Use of computers in maintenance.

TOTAL: 45 periods

8. Text Books

1. Srivastava S.K., "Industrial Maintenance Management", - S. Chand and Co., 2002
2. Bhattacharya S.N., "Installation, Servicing and Maintenance", S. Chand and Co., 1995

9. References:

1. White E.N., "Maintenance Planning", I Documentation, Gower Press, 1979.
2. Garg M.R., "Industrial Maintenance", S. Chand & Co., 1987.
3. Higgins L.R., "Maintenance Engineering Hand book", McGraw Hill, 5th Edition, 2008.
4. Armstrong, "Condition Monitoring", BSIRSA, 1988.
5. Davies, "Handbook of Condition Monitoring", Chapman &Hall, 1996.
6. "Advances in Plant Engineering and Management", Seminar Proceedings - IIPE, 1996

10. Revised Bloom's based Assessment Pattern

Revised Bloom's Category	Internal				University Examination %
	Unit Test 1 %	Mid Term Test 1 %	Unit Test 2 %	Mid Term Test 2 %	
Remember	10	10	10	10	10
Understand	50	50	20	20	50
Apply	40	40	70	70	40
Analyse					
Evaluate					
Create					

Revised Bloom's Category	Assignments	
	1 (COs addressed CO1,CO2) (max marks in %)	2 (COs addressed CO3,CO4) (max marks in %)
Remember	**20**	**10**
Understand	**40**	**40**
Apply	**40**	**50**
Analyse		
Evaluate		
Create		

COURSE CODE	ADDITIVE MANUFACTURING SYSTEM	L	T	P	C
1152ME101		3	0	0	3

1. Preamble

This course addresses additive manufacturing principles, variety and its concept, scope of additive manufacturing and areas of application..

2. Prerequisite

Machining and Machine Tools Technology 1151ME107

3. Links to other courses

Computer Aided Design and FEA 1151ME116

4. Course Educational Objectives

Students undergoing this course are expected to:

- Know the principles, methods, areas of usage, possibilities and limitations as well as environmental effects of the additive manufacturing technologies
- Be familiar with the characteristics of various materials that are used in additive manufacturing.

5. Course Outcomes

Upon the successful completion of the course, learners will be able to

CO Nos.	Course Outcomes	Level of learning domain (Based on revised Bloom's)
CO1	Describe the differences and of the application of a range of additive manufacturing processes	K3
CO2	Select and use correct CAD formats in the manufacture of a 3D printed part.	K3
CO3	Understand the operating principles, capabilities, and limitations of liquid and solid based additive manufacturing system, including fused deposition modeling and stereolithography.	K2
CO4	Appreciate the operating principles, capabilities and limitations of powder based additive manufacturing system, including 3D printing and laser sintering .	K2
CO5	Describe the important process parameters for bio-manufacturing and determine the suitable additive technique for bio-manufacturing.	K3

(K3 – Apply)

6. Correlation of CO's with Programme Outcomes

Cos	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
CO1	M				M		M					L	L	
CO2	M				M		M					L	L	
CO3	M				M		M					L	L	
CO4	M				M		M					L	L	
CO5	M				M		M					L	L	

H- High; M-Medium; L-Low

7. Course Content

UNIT I-INTRODUCTION L-9
Overview – History – Need-Classification -Additive Manufacturing Technology in product development-Materials for Additive Manufacturing Technology – Tooling – Applications.

UNIT II-CAD & REVERSE ENGINEERING L-9
Basic Concept – Digitization techniques – Model Reconstruction – Data Processing for Additive Manufacturing Technology: CAD model preparation – Part Orientation and support generation – Model Slicing –Tool path Generation – Softwares for Additive Manufacturing Technology: MIMICS, MAGICS.

UNIT III-LIQUID BASED AND SOLID BASED ADDITIVE MANUFACTURING SYSTEMS L-9
Classification – Liquid based system – Stereolithography Apparatus (SLA)- Principle, process, advantages and applications – Solid based system –Fused Deposition Modeling – Principle, process, advantages and applications, Laminated Object Manufacturing

UNIT IV-POWDER BASED ADDITIVE MANUFACTURING SYSTEMS L-9
Selective Laser Sintering – Principles of SLS process – Process, advantages and applications, Three Dimensional Printing – Principle, process, advantages and applications- Laser Engineered Net Shaping (LENS), Electron Beam Melting.

UNIT V-MEDICAL AND BIO-ADDITIVE MANUFACTURING L-9
Customized implants and prosthesis: Design and production. Bio-Additive Manufacturing- Computer Aided Tissue Engineering (CATE) – Case studies

TOTAL: 45 PERIODS

8. Text Books

1. Chua C.K., Leong K.F., and Lim C.S., “Rapid prototyping: Principles and applications”, Third Edition, World Scientific Publishers, 2010.
2. Gebhardt A., “Rapid prototyping”, Hanser Gardener Publications, 2003.

9. References

1. Liou L.W. and Liou F.W., “Rapid Prototyping and Engineering applications : A tool box for prototype development”, CRC Press, 2007.
2. Kamrani A.K. and Nasr E.A., “Rapid Prototyping: Theory and practice”, Springer, 2006.
3. Hilton P.D. and Jacobs P.F., “Rapid Tooling: Technologies and Industrial Applications”, CRC press, 2000.
4. Dougles Bryden, “CAD and Protyping for Product Design”, 2014

10. Revised Bloom's based Assessment Pattern

Revised Bloom's Category	Internal				University Examination %
	Unit Test 1 %	Mid Term Test 1 %	Unit Test 2 %	Mid Term Test 2 %	
Remember					
Understand	70	70	70	70	70
Apply	30	30	30	30	30
Analyse					
Evaluate					
Create					

Revised Bloom's Category	Assignments	
	1 (COs addressed CO1,CO2) (max marks in %)	2 (COs addressed CO3,CO4) (max marks in %)
Remember	**20**	**10**
Understand	**40**	**40**
Apply	**40**	**50**
Analyse		
Evaluate		
Create		

COURSE CODE	AUTOMOBILE ENGINEERING	L	T	P	C
1152ME103		**3**	**0**	**0**	**3**

1. Preamble

This course provides an introduction to vehicle structure, engine, power transmission system, steering system, brakes and suspension, It also provides an introduction to engine emissions and their control and offers various alternative fuels that can be used in automobiles.

2. Prerequisite

Basic Engineering Thermodynamics 1151ME102

3. Links to other courses

1	Heat and Mass Transfer	1151ME115
2	Internal Combustion Engines	1152ME110
3	Fuels and Combustion	1152ME107

4. Course Educational Objectives

Students undergoing this course are expected to

- Describe the concept of chassis and various subsystems of automobile.
- Explain about fundamental principles, construction and working of different subsystems of engines used in automobiles
- Analyse various types of emissions and suggest ways to reduce them.

5. Course Outcomes

Upon the successful completion of the course, learners will be able to

CO Nos.	Course Outcomes	Level of learning domain (Based on revised Bloom's)
CO1	Explain the construction of vehicle structure, working principle of internal combustion engines and its components.	K2
CO2	Understand the operation of various engine auxiliary systems and battery.	K2
CO3	Understand the function of transmission system and cooling systems.	K2
CO4	Understand the concepts of steering system, braking system and suspension system and construction of wheels and tyres.	K2
CO5	Understand the concepts of engine emissions, emission control and alternative fuels.	K2

6. Correlation of CO's with Programme Outcomes

Cos	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
CO1	H	L	L									L	M	
CO2	H	L	L									L	M	
CO3	H	L	L									L	M	
CO4	H	L	L									L	M	
CO5	H	L	L	L		L	L	L			L	L	M	

H- High; M-Medium; L-Low

7. Course Content

UNIT I VEHICLE STRUCTURE AND ENGINES L-9

Introduction: General classification of automobiles, layout of chassis, types of drives of automobile. Chassis and body – Body parts, functions, material and vehicle construction. Engines – Types of Engines, components, functions and materials, working principle, comparison of four stroke and two stroke engines.

UNIT II ENGINE AUXILIARY SYSTEMS L-9

Carburetor–Working principle- Electronic fuel injection system – Mono-point and Multi - Point Injection Systems – Battery coil and magneto ignition systems, electronic ignition systems. Construction, Operation and Maintenance of Lead Acid Battery - principle and construction of starter motor, alternator, working of different starter drive units.Supercharging and Turbo charging.

UNIT III TRANSMISSION AND COOLING SYSTEMS L-9

Clutch – Types and Construction – Gear Boxes, Manual and Automatic –Flywheel-Torque converters– Propeller shaft – Slip Joint – Universal Joints – Differential and Rear Axle – Hotchkiss Drive. Need for cooling system, Types of cooling system: air cooling system, liquid cooling system, forced circulation system, pressure cooling system.

UNIT IV STEERING, BRAKES AND SUSPENSION L-9

Wheels and Tyres - Steering Geometry – Power Steering – Types of Front Axle – Classification of brakes, drum brakes and disc brakes, constructional details, theory of braking, parking brake, braking material, hydraulic system, vacuum assisted system, air brake system, antilock braking system. Need of suspension system, types of suspension, suspension springs, constructional details and characteristics of leaf, coil and torsion bar springs, independent suspension, rubber suspension, pneumatic suspension, shock absorbers.

UNIT V EMISSION, EMISSION CONTROL AND ALTERNATIVE FUELS L-9

Mechanism of HC, NOx and CO formation in four stroke and two stroke SI engines, smoke and particulate emissions in CI engines, NO_x formation and control. Noise pollution from automobiles, measurement and standards.Design of engine, optimum selection of operating variables for control of emissions, catalytic converters, catalysts.Fuel modifications -Use of Natural Gas, LPG, Biodiesel, Gasohol and Hydrogen in Automobiles - Electric and Hybrid Vehicles, Fuel Cells.

TOTAL: 45 periods

8. Text Books

1. Ganesan, V., Internal Combustion Engines, Tata McGraw-Hill, New Delhi, 2012.
2. Kirpal Singh, Automobile Engineering- Vol. I and II, Standard Publishers, New Delhi, 2011.
3. Ramalingam. K .K, Automobile Engineering, Scitech publications,2011.

9. References

1. Kamaraju Ramakrishna, Automobile Engineering, PHI Learning pvt. Ltd., New delhi-2012.
2. Mathur M.L. and Sharma. 'A Course in Internal Combustion Engines', R.P. Dhanpat Rai Publications, 2009.
3. K. M. Gupta, Automobile Engineering- Vol I and II, Umesh Publications, 2007
4. G B S Narang, Automobile Engineering, Khanna publishers, New Delhi, 2005.
5. Crouse, W.H., and Anglin, D.L., Automotive Mechanics, Tata McGraw Hill, New Delhi, 2005.

10. Revised Bloom's based Assessment Pattern

Revised Bloom's Category	Internal				University Examination %
	Unit Test 1 %	Mid Term Test 1 %	Unit Test 2 %	Mid Term Test 2 %	
Remember	10	10	10	10	10
Understand	60	60	60	60	60
Apply	30	30	30	30	30
Analyse					
Evaluate					
Create					

Revised Bloom's Category	Assignments	
	1 (COs addressed CO1,CO2) (max marks in %)	2 (COs addressed CO3,CO4) (max marks in %)
Remember	**20**	**10**
Understand	**40**	**40**
Apply	**40**	**50**
Analyse		
Evaluate		
Create		

COURSE CODE	NANOMATERIALS AND APPLICATIONS	L	T	P	C
1152ME114		3	0	0	3

1. Preamble

This course provides insight into the fundamental and basic principles of nano materials.

2. Prerequisite

Engineering Materials and Metallurgy 1151ME117

3. Links to other courses

Project Work

4. Course Educational Objectives

- To understand the fundamentals of nanomaterial strength and its mechanical behavior.
- To understand the analysis involved in zero dimensional, one dimensional nano structured materials and characterization.

5. Course Outcomes

The students would be benefitted with the following outcomes:

CO Nos.	Course Outcomes	Level of learning domain (Based on revised Bloom's)
CO1	Enumerate various types of nano materials and their comparisons with conventional materials.	K2
CO2	Describe the theory involved in zero dimensional nanomaterials	K2
CO3	Explain the principle analysis of one-dimensional nanomaterials.	K2
CO4	Describe the super hard coatings and nano structured materials.	K2
CO5	To study the characterization of nanomaterials.	K2

(K3 – Apply)

6. Correlation of COs with Programme Outcomes

COs	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
CO1	L											L	L	
CO2	L						L					L	L	
CO3	L											L	L	
CO4	L											L	L	
CO5	L				L							L	L	

H- High; M-Medium; L-Low

7. Course Content

UNIT I INTRODUCTION TO NANOMATERIALS L-9
Amorphous, Crystalline, microcrystalline, quasicrystalline and nanocrystalline materials- historical development of nanomaterials – Nanomaterials classification (Gleiter's Classification) – properly changes done to size effects, Hall – petch, inverse Hall- petch effects - polymeric nanostructures

UNIT II ZERO DIMENSIONAL NANOMATERIALS L-9
Nanoparticles – Properties – Processing – Liquid state processing - Sol-gel process, wet chemical synthesis – Vapour state processing , Aerosol processing, solid state processing – mechanical, mechanochemical synthesis – Application of nanoparticle. Quantum Dots – Quantum confinement – Pauli's Exclusion Principle – Processing – Optical lithography – MOCVD – Droplet epitaxy - Applications.

UNIT III ONE DIMENSIONAL NANOMATERIALS L-9
Carbon nanotubes – Old and new forms of carbon – Structure of CNT and classification – Processing – Solid carbon based production techniques – Gaseous carbon based production technique - growth mechanisms – Applications.Nanowire – processing – Laser ablation – Oxide assisted growth – carbo thermal reactions – Thermal evaporation – Temperature based synthesis – Electro spinning – Vapour–Solid growth (VS growth) - vapour – liquid – solid growth (VLS technique) – Applications.

UNIT IV SUPER HARD COATINGS AND BULK NANOSTRUCTURED MATERIALS L-9
Superhard coating – types – characteristics – thermal stability – case studies – Applications. Bulk nanostructure formation – Equal Channel Angular pressing (ECAP) –High Pressure Torsion(HPT), Accumulative roll bending – Reciprocating extrusion - compression,cyclic close die forging – Repetitive corrugation and straightening – Grain refinement mechanisms.

UNIT V CHARACTERIZATION OF NANOMATERIALS L-9
Nano indentation – Types of nanoindenter – Force actuation-Displacement measurement- factors affecting nanoindentation- Atomic Force Microscope (AFM) – Scanning Tunneling Microscope (STM) – Electrostatic Force Mode (EFM) – Magnetic Force Mode (MFM) – Scanning Electron Microscope (SEM) – Transmission Electron Microscope (TEM).

TOTAL: 45 periods

8. Text Books

1. Carl C. Koch (ed.), "Nanostructured Materials", Processing, Properties and Potential Applications, Noyes Publications, Norwich, New York, U.S.A.
2. Bhusan, Bharat (Ed), "Springer Handbook of Nanotechnology", 2nd Edition, 2007.

9. References

1. Mark Ratner and Daniel Ratner, "Nano Technology", Pearson Education, New Delhi, 2003.
2. Charles P. Poole Jr., Frank J. Ownes, 'Introduction to Nanotechnology", WileyInterscience, 2003.
3. G. Wilde, "Nanostructured Materials', Elsevier, 2008.
4. Bamberg, D., Grundman, M. and Ledentsov, N.N., "Quantum Dot Heterostructures", Wiley,
1999.
5. G Timp (ed), "Nanotechnology", AIP press/Springer, 1999.

10. Revised Bloom's based Assessment Pattern

Revised Bloom's Category	Internal				University Examination %
	Unit Test-I %	Mid Term Test I %	Unit Test-II %	Mid Term Test II %	
Remember	40	40	40	40	40
Understand	60	60	60	60	60
Apply					
Analyse					
Evaluate					
Create					

Revised Bloom's Category	Assignments	
	1 (COs addressed CO1,CO2) (max marks in %)	2 (COs addressed CO3,CO4) (max marks in %)
Remember	**20**	**10**
Understand	**40**	**40**
Apply	**40**	**50**
Analyse		
Evaluate		
Create		

COURSE CODE	SOLAR ENERGY ENGINEERING	L	T	P	C
1152ME123		3	0	0	3

1. Preamble
To understand the fundamentals of solar energy and its conversion techniques for both thermal and electrical energy applications.

2. Prerequisite

Basic Mechanical Engineering

3. Links to other courses

Project work

4. Course Educational Objectives
Students undergoing this course are expected to:

- Understand the origin of solar energy and learn the solar radiation principles
- Learn the solar energy conversion principles and technologies
- Understand the environmental merits, applications and prospects of solar energy

5. Course Outcomes
Upon the successful completion of this course, the learners will be able to

CO Nos.	Course Outcomes	Level of learning domain (Based on revised Bloom's)
CO1	Understand the basic concepts of solar energy, measurement of solar radiation and estimation of solar radiation.	K2
CO2	Explain the working principle of solar thermal collector and its performance.	K3
CO3	Understand the characteristic of PV cell, solar array and estimation of solar cell load.	K3
CO4	Describe the various forms of solar passive architecture and different kinds of thermal storage devices.	K2
CO5	Understand the different applications of solar energy devices.	K2

6. Correlation of Course Outcomes with Programme Outcomes

COs	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
CO1	M	L				L	L					L	M	L
CO2	M	L				L	L					L	M	L
CO3	M	L				L	L					L	M	L
CO4	M	L				L	L					L	M	L
CO5	M	L				L	L					L	M	L

H-High; M-Medium: L-Low

7. Course Content

UNIT I INTRODUCTION TO SOLAR ENERGY L- 9

Basics of solar energy - Brief history of solar energy utilization - Various approaches of utilizing solar energy – Source of radiation - Blackbody radiation – solar constant. Solar angles - day length, angle of incidence on tilted surface - Sunpath diagrams – shadow determination - extraterrestrial characteristics - measurement and estimation on horizontal and tilted surfaces. Measurement of diffuse, global and direct solar radiation: pyrheliometer, pyranometer, sunshine recorder.

UNIT II SOLAR THERMAL COLLECTORS L- 9

Flat plate collector – Thermal analysis - Evaculated tubular collector – Concentrator collectors - classification - design and performance parameters - Pool and Air collectors - Construction – Function - Suitability – Comparison - Storage Tank. Concentrating Dish Systems - Concentrating Linear Fresnel Reflectors - Hybrid Systems. Tracking systems - compound parabolic concentrators - parabolic trough concentrators - concentrators with point focus - Heliostats – performance of the collectors.

UNIT III SOLAR PHOTOVOLTAIC SYSTEMS L- 9

Semiconductor – properties - energy levels - basic equations of semiconductor devices physics. Solar cells - p-n junction: homo and hetro junctions - Structure and working of Solar Cells - Types, Electrical properties and Behaviour of Solar Cells - Cell properties and design - PV Cell Interconnection and Module Fabrication - PV Modules and arrays - Basics of Load Estimation. Schematics, Components, Batteries, Charge Conditioners - Balance of system components for DC and/or AC Applications. Centralized and decentralized SPV systems - stand alone - hybrid and grid connected system - System installation - operation and maintenance.

UNIT IV SOLAR PASSIVE ARCHITECTURE AND ENERGY STORAGE L- 9

Thermal comfort - concept of solar temperature and its significance - heat transmission in buildings- bioclimatic classification – passive heating concepts: direct heat gain - indirect heat gain - isolated gain and sunspaces - passive cooling concepts: evaporative cooling - radiative cooling - shading - paints and cavity walls for cooling - roof radiation traps - earth air-tunnel – energy efficient landscape design. Necessity of storage for solar energy- Chemical energy storage - Thermal energy storage - Thermal Flywheels - Compressed air- Rechargeable batteries.

UNIT V APPLICATIONS OF SOLAR ENERGY L-9

Integral Collector Storage System - Thermosyphon System - Antifreeze Systems. Solar Water Heaters - Solar Heated Pools.Liquid Type Solar Heating System With / Without Storage - Heat Storage Configurations - Heat Delivery Methods - Air-Type Solar Heating Systems - Solar Refrigeration and Air Conditioning.Solar Cooking – Distillation - Desalination – Solar Still - Solar Ponds – Solar Drying – Solar Chimney.Photovoltaic Power Systems - System Integration - Energy Storage - Stand-Alone Systems - Grid-Connected Systems - PV System in Buildings.

TOTAL: 45 periods

8. Text Books

1. Sukhatme and Nayak, Solar Energy: Principles Of Thermal Collection And Storage, Tata McGraw.Hill,2008
2. Garg H P., Prakash J., Solar Energy: Fundamentals & Applications, Tata McGraw Hill, 2000.
3. Chetan Singh Solanki, Solar Photovoltaics – Fundamentals, Technologies and Applications, Prentice Hall India, 2015.

9. References

1.D. Yogi Goswami, Frank Kreith, Jan. F. Kreider, "Principles of Solar Engineering", 2nd Edition, Taylor & Francis, 2000, Indian reprint, 2003
2.Edward E. Anderson, "Fundamentals for solar energy conversion", Addison Wesley Publ. Co., 1983.
3.Duffie and W. A. Beckman, Solar Engineering of Thermal Processes, Third Edition, John Wiley and Sons, 2006
4.G. N. Tiwari and M. K. Ghosal, "Fundamentals of Renewable energy Sources", Narosa Publishing House, New Delhi, 2007
5.H.P.Garg, S.C.Mullick, A.K.Bhargava, D.Reidal, Solar Thermal Energy Storage, Springer, 1985
6.H P Garg, M Dayal, G Furlan, Physics and Technology of Solar Energy- Volume I: Solar Thermal Applications, Springer, 1987
7.Kreider, J.F. and Frank Kreith, Solar Energy Handbook, McGraw Hill, 1981.

10. Revised Bloom's based Assessment Pattern

Revised Bloom's Category	Internal				University Examination %
	Unit test – I %	**Mid Term -I %**	**Unit test – II %**	**Mid Term -II %**	
Remember	50				20
Understand	50	60	70	70	60
Apply		40	30	30	20
Analyse					
Evaluate					
Create					

Revised Bloom's Category	**Assignments**	
	1 (COs addressed co1,co2) (max marks in %)	**2 (COs addressed co3,co4) (max marks in %)**
Remember	**30**	
Understand	**30**	**70**
Apply	**40**	**30**
Analyse		
Evaluate		
Create		

COURSE CODE 1152ME125	ADVANCED WELDING TECHNOLOGY	L	T	P	C
		3	0	0	3

1. Preamble
This course will help the students understand the advanced welding processes and the process parameters.

2. Pre-requisite
Manufacturing Technology

3. Links to other courses
Project work

4. Course Educational Objectives
1. To impart knowledge on various advanced welding processes so that the students can apply them in engineering industry applications.
2. To develop the knowledge on the design of welded joints and the quality control of weldments.

5. Course outcomes

CO Nos.	Course Outcomes	Level of learning domain (Based on revised Bloom's)
CO1	Apply the knowledge of solid state welding process for engineering applications	K3
CO2	Understand the principles of radiant energy metal joining process.	K2
CO3	Understand the fundamental principles of special arc welding process	K2
CO4	Understand the knowledge of plasma arc in metal joining and cutting process	K2
CO5	Understand the knowledge of design principles in weld joints. Apply the concept of quality control and testing of weldments in industrial environment	K2

6. Correlation of COs with Programme Outcomes

COs	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
CO1	H				L							M	H	
CO2	H				L							M	H	
CO3	H				L							M	H	
CO4	H				L							M	H	
CO5	H				L							M	H	

H- High; M-Medium; L-Low

7. Course content

UNIT 1 SOLID STATE WELDING PROCESSES L-9
Fundamental principles, survey of the various pressure welding processes and their applications. Friction, friction stir, explosive, diffusion, and Ultrasonic welding – principles of operation, process characteristics and application.

UNIT 2 ELECTRON AND LASER BEAM WELDING L-9
Heat generation and regulation, equipment details in typical set-up, electron beam welding in different degrees of vacuum, advantages and disadvantages, applications.Laser Welding: Principles of operation, advantages, and limitations, applications.

UNIT 3 ELECTRO SLAG WELDING L-9
Heat generation, principles of operations, wire and consumable guide techniques, selection of current, voltage and other process variables, nature of fluxes and their choice. Electro-gas welding: Principle and applications. Narrow gap welding, Under Water welding. Rapid Arc Welding, Welding Automation

UNIT 4 PLASMA WELDING L-9
Special features of plasma arc- transferred and non transferred arc, key hole and puddle-in mode of operation, micro low and high current plasma arc welding and their applications, plasma cutting, surfacing and applications.

UNIT 5 TESTING AND DESIGN OF WELDMENT L-9
Design and quality control of welds. Edge preparation types of joints, welding symbols. Stresses in butt and fillet welds – weld size calculations. Design for fatigue. Testing – tensile, bend hardness. Impact, notch and fatigue tests.Life assessment of weldments.

Theory: 45 periods

8. Text Book.

1. Nadkarni S.V., "Modern Arc Welding Technology", Oxford IBH Publishers, 1996.

9. References

1. Schwartz M.M, "Metals Joining Manual",McGraw Hill Books, 2001.
2. Tylecote R.F,"The Solid Phase Welding of Metals",Edward Arnold Publishers Ltd, London, 2000.
3. Parmer R.S., "Welding Engineering and Technology", Khanna Publishers,2002.
4. Carrry B., "Modern Welding Technology", Prentice Hall Pvt Ltd., 2002.
5. Nadkarni S.V., "Modern Arc Welding Technology", Oxford IBH Publishers, 1996.
6. Schwariz, M.M., "Source book on innovative welding processes",American Society for Metals (OHIO), 2004.
7. Christopher Davis. "Laser Welding- Practical Guide".Jaico Publishing House, 2002.

10. Revised Bloom's based Assessment Pattern

Revised Bloom's Category	**Internal**				**University Examination %**
	Unit test – I %	**Mid Term -I %**	**Unit test – II %**	**Mid Term -II %**	
Remember	50				20
Understand	50	60	70	70	60
Apply		40	30	30	20
Analyse					
Evaluate					
Create					

Revised Bloom's Category	**Assignments**	
	1 (COs addressed co1,co2) (max marks in %)	**2 (COs addressed co3,co4) (max marks in %)**
Remember	**30**	
Understand	**30**	**70**
Apply	**40**	**30**
Analyse		
Evaluate		
Create		

COURSE CODE 1152ME126	ADVANCED METAL CASTING TECHNOLOGY	L	T	P	C
		3	0	0	3

1. Preamble
This course will help the students understand the advanced metal casting techniques and their applications.

2. Pre-Requisite
Manufacturing Technology

3. Links to other courses
Project work

4. Course Educational Objectives
Students undergoing this course will able

- To understand the basic principles of metal casting
- To know the various types of melting practices
- To broaden the understanding of casting design principles
- To know about casting defects and remedial measures

5. Course Outcomes
After the successful completion of the course, students will be able to

CO Nos.	Course Outcomes	Level of learning domain (Based on revised Bloom's)
CO1	Describe methods of Moulding Processes.	K2
CO2	Understand the various types of melting practices & furnaces.	K2
CO3	Understand the working principles of Special Casting processes.	K2
CO4	Describe the Basics of casting Design.	K2
CO5	Understand the causes & remedies of castings defects and Quality Control Systems.	K2

6. Correlation of COs with Programme Outcomes

CO s	*PO1*	*PO2*	*PO3*	*PO4*	*PO5*	*PO6*	*PO7*	*PO8*	*PO9*	*PO10*	*PO11*	*PO12*	PSO1	PSO2
CO1	H						L					L	H	
CO2	H						L					L	H	
CO3	H						L					L	H	
CO4	H						L					L	H	
CO5	H						L					L	H	

H- High; M-Medium; L-Low

7. Course Content

UNIT I MOULDING PRACTICES L-9

Basic principles of casting processes- patterns- Pattern design- materials and construction.
Moulding: Materials for moulding- Foundry sand control- Different types of cores- Core making processes- Materials for core making- Moulding and core making machines. Recent developments in core mould making- Cold set process

UNIT II MELTING PRACTICES L-9

Foundry furnaces - Selection of furnaces - Crucibles oil fired furnaces - Electric furnaces - Cupola furnace,
melting practice for cast iron, aluminum alloys, copper alloys and magnesium alloys- - fluxing, degassing.-safety considerations

UNIT III RECENT TRENDS IN CASTING L-9

Pressure die casting - Permanent mould casting - Centrifugal casting - Precision investment casting - Shell moulding - CO2 moulding, continuous casting - Squeeze casting – Electro slag casting - Near Net Techniques. Introduction to Rapid prototyping applications in casting process.

UNIT IV CASTING DESIGN L-9

Concept of solidification, directional solidification, role of chilling, Casting design -principles of gating- functions of riser, types of riser, bottom pouring and top pouring. Introduction to Design considerations for Castings, Casting design softwares.

UNIT V CASTING DEFECTS AND QUALITY CONTROL L-9

Defects in castings and its remedies- - inspection of castings-
Quality control and quality assurances, Non Destructive testing – Dye penetrant – magnetic particle – X-ray, ultrasonic-Statistical quality control in foundry.

Total: 45 periods

8. Text Books

1. Richard W Heine, 2003, Principles of Metal Casting, Tata McGraw Hill Education Private Limited, Park ohio USA,
2. Ramana Rao T. V, Metal Casting: Principles and Practice, New Age International, 2010

9. References

1. Metal Casting Principles and Techniques,Yury . S. Lerner, Nageswara Rao Posinasetti,American Foundry Society,December 2013.
2. Foundry Technology,Peter R. Beeley,Butterworth-Heinemann, 2001 - Technology & Engineering
3. Jain, P.L., “Principles of Foundry Technology”, 4th Edition, Tata McGraw Hill Pub., Co. Ltd., 2008.
4. Heine, R.W.,Carl Loper, and Rosenthal, P.C., “Principles of Metal Casting”, 2nd Edition, Tata McGraw Hill Pub. Co. Ltd., 2008

10. Revised Bloom's based Assessment Pattern

Revised Bloom's Category	**Internal**				**University Examination %**
	Unit test – I %	**Mid Term -I %**	**Unit test – II %**	**Mid Term -II %**	
Remember	50				20
Understand	50	60	70	70	60
Apply		40	30	30	20
Analyse					
Evaluate					
Create					

Revised Bloom's Category	**Assignments**	
	1 (COs addressed co1,co2) (max marks in %)	**2 (COs addressed co3,co4) (max marks in %)**
Remember	**30**	
Understand	**30**	**70**
Apply	**40**	**30**
Analyse		
Evaluate		
Create		

COURSE CODE	GAS DYNAMICS AND JET PROPULSION	L	T	P	C
1152ME127		3	0	0	3

1. Preamble
This course will help the students understand the fundamentals of as dynamics and jet propulsion.

2. Pre-Requisite
Basic Engineering Thermodynamics

3. Links to other courses
Project work

4. Course Educational Objectives
Students undergoing this course are expected to:

- To understand the theoretical concepts about compressible flow.
- To understand the isentropic flow with variable area
- To understand the flow in a constant area duct with friction
- To understand the flow in a constant area duct with heat transfer
- To understand the effects of normal and oblique shock wave on flow parameter
- To understand the construction, operation and performance of different types of aircrafts and rocket engines.

5. Course Outcomes
The students would be benefitted with the following outcomes:

CO Nos.	Course Outcomes	Level of learning domain (Based on revised Bloom's)
CO1	Apply the concepts of compressible flow and isentropic flow with variable area to solve the problems.	K3
CO2	Understand the concepts of Fanno flow and Rayleigh flow to solve the problems.	K3
CO3	Understand the concepts shock waves and solve the problems.	K3
CO4	Understand the construction and operation of various types of aircraft engines and its performance.	K3
CO5	Understand the construction and operation of various types of rocket engines and its performance.	K3

(K2 - Understand, K3-Apply)

6. Correlation of CO's with Programme Outcomes

Cos	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
CO1	H	L					L					L	H	
CO2	H	L					L					L	H	
CO3	H	L					L					L	H	
CO4	H	L					L					L	H	
CO5	H	L					L					L	H	

H- High; M-Medium; L-Low

7. Course Content

UNIT ICOMPRESSIBLE FLOW AND ISENTROFIC FLOW WITH VARIABLE AREA L -9

Energy and momentum equations of compressible fluid flows- Various regions of flows - Reference velocities - Stagnation state – Mach wave and Mach cone - Effect of Mach number on compressibility. Isentropic flow with variable area - Nozzle and Diffuser- Use of gas tables.

UNIT II FLOW IN CONSTANT AREA DUCTS L-9

Flow in constant area ducts with friction (Fanno flow) – Fanno curves and Fanno flow equation - Variation of flow properties and variation of Mach number with duct length - Flow in constant area ducts with heat transfer (Rayleigh flow) - Rayleigh curves and Rayleigh flow equation - Variation of flow properties.

UNITIII NORMAL AND OBLIQUE SHOCK WAVES L- 9

Governing equations - Variation of flow parameters across the normal shock – Prandtl-Meyer equation - Impossibility of a shock in subsonic flow – Supersonic wind tunnels - Flow with oblique shock waves (elementary treatment only).

UNIT IV JET PROPULSION L- 9

Types of jet engines - Theory of jet propulsion - Energy flow through jet engines - Performance of turbo jet engines - Thrust augmentation.

.

UNIT V ROCKET PROPULSION L-9

Types of rocket engines - Applications -Theory of rocket propulsion - Performance study – flow through rocket nozzles - Solid and liquid propellants – Propellant feeding systems.

TOTAL: 45 Periods

8. Text Books

1. S. M. Yahya., Fundamental of Compressible Flow, New Age International Pvt Ltd. New Delhi,

9. Reference

1. S. M. Yahya., Gas Tables for Compressible Flow, New Age International Pvt Ltd., New Delhi
2. E. Rathakrishnan, Gas Dynamics, Prentice Hall of India, New Delhi, 2008
3. Patrich.H. Oosthvizen, William E. Carscallen, Compressible fluid flow, Tata McGraw Hill Publishing Company Pvt Ltd., New Delhi,2004
4. Cohen. H., R. E. C Rogers and Sravanamutoo, Gas Turbine Theory, Addison Wesley Ltd.
5. P. Balachandran, Fundamental of Compressible Fluid Dynamics, Prentice Hall of India, New Delhi, 2009.

10. Revised Bloom's based Assessment Pattern

Revised Bloom's Category	Internal				University Examination %
	Unit test – I %	Mid Term -I %	Unit test – II %	Mid Term -II %	
Remember	50				20
Understand	50	60	70	70	60
Apply		40	30	30	20
Analyse					
Evaluate					
Create					

Revised Bloom's Category	Assignments	
	1 (COs addressed co1,co2) (max marks in %)	2 (COs addressed co3,co4) (max marks in %)
Remember	**30**	
Understand	**30**	**70**
Apply	**40**	**30**
Analyse		
Evaluate		
Create		

Course code	MICROMACHINING AND MANUFACTURING	L	T	P	C
1152ME128		3	0	0	3

1. Preamble

This course provides an overview to the basic concepts and techniques of micro manufacturing, manufacturing methods, micro finishing process and nano fabrication.

2. Pre-Requisite

Nil

3. Links to Other Courses

Machining and machine tool technology 1151ME107
Non Traditional machining processes 1152ME124

4. Course Educational Objectives

Students undergoing this course are expected to:

- Understand the principles of various micro manufacturing methods.
- Explain the processes used for micro finishing.
- Acquire knowledge on hybrid fabrication techniques.

5. Course Outcomes

The students would be benefitted with the following outcomes:

CO Nos	Course outcomes	Level of learning domain (Based on revised Bloom's)
CO1	Understand the need of miniaturization and able to classify different approaches of micro manufacturing	K2
CO2	Demonstrate about manufacturing methods used in micro manufacturing	K2
CO3	Explain various unconventional machining process employed for micro machining	K2
CO4	Describe various processes to achieve micro level finishing	K2
CO5	Demonstrate about various nano fabrication techniques	K2

6. Correlation of COs with Programme Outcomes

COs	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
CO1	H				L				L	L		L	H	L
CO2	H				L				L	L		L	H	L
CO3	H				L				L	L		L	H	L
CO4	H				L				L	L		L	H	L
CO5	H				L				L	L		L	H	L

H-High; M-Medium; L-Low

7. Course Content

UNIT I INTRODUCTION **L-9**

Introduction to Meso, Micro and Nano manufacturing, Miniaturization and applications, classification-subtractive, additive, micro forming, micro casting , micro joining. Applications of Micro products in IT and telecommunications, Automotives, Medicine

UNIT II MANUFACTURING METHODS **L-9**

Material deposition – PVD, CVD, LIGA, Traditional micromachining-Theory of micromachining-Chip formation-size effect in micromachining, micro turning, micro drilling, micro milling, Diamond turn machining-material removal mechanism

UNIT III ADVANCED MACHINING **L-9**

Introduction to mechanical and beam energy based micro machining processes- Ultrasonic micro machining, Focused Ion Beam machining, Laser Beam micro machining

UNIT IV FINISHING PROCESSES **L-9**

Micro finishing processes- Abrasive Flow Machining, Magnetic Abrasive Finishing, Magneto Rheological Abrasive Flow Machining, Magneto Rheological Finishing. Hybrid micromachining – Electro Chemical Spark Micro Machining, Electro Discharge Grinding, Electrolytic In Process Dressing Grinding

UNIT V NANO FABRICATION **L-9**

Nano machining techniques – Top/Bottom up Nano fabrication techniques - Sub micron lithographic technique, conventional film growth technique, Chemical etching, Quantum dot fabrication techniques

One day visit, to any relevant industry, is mandatory for the completion of this course.

Total: 45 periods

8. TEXT BOOKS:

1. "INTRODUCTION TO MICROMACHINING", V.K.JAIN published by NAROSA publishers, New Delhi(2009)
2. "MICROMANUFACTURING PROCESSES", by V.K.JAIN, CRC Press

9. REFERENCES:

1. Franssila. S., "INTRODUCTION TO MICRO FABRICATION", John Wiley and sons Ltd., UK, 2004, ISBN: 978-0-470-85106-7
2. Madore, J, "FUNDAMENTAL OF MICRO FABRICATION", CRC Press, 2002.
3. Jackson, M.J., "MICRO FABRICATION AND NANO MANUFACTURING", CRC Press, 2006.

10. Revised Bloom's based Assessment Pattern

Revised Bloom's category	Internal				University examination %
	Unit Test I %	Mid Term test I %	Unit Test II %	Mid Term test II %	
Remember	50	50	50	50	50
Understand	50	50	50	50	50
Apply					
Analyse					
Evaluate					
Create					

Revised Bloom's category	Assignments	
	1 (CO1 & CO2) (max marks in %)	2 (CO3 & CO4) (max marks in %)
Remember	50	50
Understand	50	50
Apply		
Analyse		
Evaluate		
Create		

COURSE CODE	COURSE TITLE	L	T	P	C
1152ME129	ADVANCED 3D MODELLING USING UNIGRAPHICS NX	2	0	2	3

Course Category: Program Elective (for Mechanical, Automobile and Aeronautical Branches)

Course Content:

UNIT I INTRODUCTION TO UNIGRAPHICS **L-6, P-6**

Introduction to Unigraphics NX, About NX Gateway, Getting Started, NX Graphical User Interface - Title bar, Menu bar, Toolbar, Radial toolbar, Selection bar, Cue and status line, Dialog rail, Resource bar, Navigators,HD3D tools, Integrated browser, Palettes, Roles, Full screen, View orientation-trimetric, isometric, View commands, Rotate ,Pan, Zoom in/out, Quick pick, Quick pick, categories, Coordinate system- absolute coordinate system, WCS, Absolute coordinate, Work coordinate system. View triad, Multiple graphics window, Information window, Keyboard accelerators, Dialog box File management - Creating new files, Opening files and Saving files.

UNIT II SKETCHER **L-6, P-6**

Creating Sketches - Profile, Line, Arc, Circle, Fillet, Chamfer, Rectangle, Polygon, Studio pline, Fit spline, Ellipse, Conic Editing sketches - Quick trim, Quick extend, Make corner, Offset curve, Pattern curve, Mirror curve, Intersection point, Derived lines Constraints - Geometric constraints, Auto constraint, Inferred constraint, Dimensional constraints, Auto dimension, Animate dimension, Continuous auto dimension. Basic terminologies - Feature, Body, Solid body, Sheet, Face, Section curves, Guide curves. Creating Primitives - Block, Cylinder, Cone, Sphere, Boss, Pocket, Emboss, Slot, Groove. Feature modeling commands-Creating Extrude features, Creating Revolve features.

UNIT III PART MODELING **L-6, P-6**

Datums - Creating Datum planes, Axis, Point. Creating Sweep Features-Swept, Sweep along guide, variable sweep, Creating Tube feature Hole - General hole, Drill size holes, Screw clearance holes, Threaded holes Dart, Thread, Shell, Draft, Draft body, Scale Creating Blend and Chamfer. Instance feature - Rectangular array, Circular array, Pattern face, Mirror feature, Mirror body Feature Operations -To Divide face, Trim body , Split body, Boolean commands, User defined feature, Creating Feature group, Layer settings, To measure distance between geometries, To measure angle between geometries, To measure bodies and face geometries, To find geometric properties. Synchronous Modeling.

UNIT IV ASSEMBLY **L-6, P-6**

Introduction to Assembly Modeling, Assembly approaches Assembly constrains - Angle, Bond, Centre, Concentric, Distance, Fit, Parallel, Perpendicular, Touch align Component array - Linear array, Circular array, Feature instance array Moving a component, Replacing component, Repositioning component, Mirroring assembly. Creating a New Component, Creating a new parent, Assembly clearance, creating exploded views, Assembly sequencing with motion. Creating deformable parts, finding degrees of freedom. Assembly envelopes.

UNIT V DRAFTING AND DETAILING **L-6, P-6**

Creating the Sheets and Editing the Sheets, Standard settings. Creating drawing views- Base view, Drawing view, projected view. Section view- Simple section, Stepped section , Half section, Revolved section, Folded section, Unfolded section, Pictorial section, Half pictorial section, Break out section Detail view Creating Broken view Appling dimensions- Inferred Dimension, Horizontal Dimension, Vertical Dimension, Parallel Dimension, Perpendicular dimension, Angular dimension, Cylindrical Dimension, Hole dimension, Diameter Dimension, Chamfer Dimension, Radius or Radius of Curvature Dimension, Radius to Centre, Folded Radius, Thickness Dimension, Arc Length, Horizontal Chain Dimension, Vertical Chain Dimension, Horizontal Baseline Dimension, Vertical Baseline Dimension, Ordinate Dimension. Creating Annotations, Datum feature, symbols, feature control frame, placing datum target symbol. Creating the Centerline, Axis, Hatch and fill options Creating Table and Part list.

TOTAL: 30+30=60 PERIODS

COURSE CODE	COMPUTER AIDED DRAWING LABORATORY	L	T	P	C
1152ME301		0	0	2	1

1. Preamble:

To introduce the basic design & drafting concepts of mechanical components by using modeling software package.

2. Prerequisite:

- Engineering Graphics - 1150ME202

3. Link to Other Courses:

- CAD & Applied FEA Laboratory – 1151ME310

4. Course Educational Objectives:

Students undergoing this course will be provided with:

- Drafting practice using computer in assembly and modelling.

5. Course Outcomes:

Students undergoing this course are able to

CO Nos.	Course Outcomes	Level of learning domain (Based on revised Bloom's)
CO1	Create drawings of various components and structures using Auto cad software.	K3,S3
CO2	Create 2D and 3D models of components.	K3,S3
CO3	Create assembly drawing of components.	K3,S3
CO4	Demonstrate knowledge of CAD software.	K3, S3

6. Correlation of Course Outcomes with Programme Outcomes :

COs	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
CO1	H				H					M		L	H	M
CO2	H				H					M		L	H	M
CO3	H				H					M		L	H	M
CO4	H				H					M		L	H	M

H- High; M-Medium; L-Low

7.List of Experiments:

1. Drawing of simple objects using the options offset, mirroring, arrays.
2. Drawing of a title block with necessary text and projection symbols.
3. Drawing of front view, top view and side view of simple solids.
4. Assembly of Plummer Block.
5. Assembly of Screw Jack.
6. Assembly of Tail Stock.
7. Assembly drawing of Connecting Rod.
8. Drawing section view of prism, pyramid and cylinder and cone.
9. Creation of 3D models of simple objects and obtaining 2D multi view drawing from 3D models.
10. Using of Boolean operation in 3D models. **Total = 30 periods**

8.Assessment Pattern - Rubrics for Internal Assessment

Performance	Excellent (5)	Very good (4)	Good (3)	Average (2)	Low (1)
Observation (5)	On Time Submission with neat presentation	Submission before next lab with presentation	Submission on next lab hour	Submission within two weeks time	Submission after two weeks time
Record (5)	On Time Submission with neat presentation	Submission before next lab with presentation	Submission on next lab hour	Submission within two weeks time	Submission after two weeks time
Attendance(5)	Above 95%	95%-90%	85%-90%	80%-85%	75%- 80%

9. Rubrics for Model/ University Examination:

Performance	**Excellent (100 %)**	**Very good (80 %)**	**Good (60 %)**	**Average (40%)**	**Low (20%)**
Interpretation of drawing (20)	Interpret the drawing with exact scale and with proper dimensioning by using the shortcuts or using proper commands	Interpret the drawing with exact scale and with proper dimensioning	Interpret the drawing with relevant scale and without proper dimensioning	Not able to interpret the drawing but able to use some basic tools like line, circle.	Blank screen
Execution of the drawing in software (40)	Able to complete the drawing in proper scale and able to take print out	Completeness of drawing without title block	Completeness of drawing without dimensioning and title block	Completeness of partial drawing	Incomplete drawing.
Dimensioning (10)	Proper dimensioning with appropriate arrow mark	Some critical dimensioning missing	Missing of tolerance limits in dimensioning	Majority of dimensioning missing	No dimensions
Oral (10)	Good Course knowledge in subject	Reasonably Answered	Partially answer	Attempt to answer	Little answer
Print out with Title block & Viva voce (20)	Able to take print out in A4 format.	Title block missing	Drawing out of the A4 format	Not able to fit in the A4 format but drawing available	Not able to take print out

COURSE CODE	ADVANCED METAL FORMING PROCESSES	L	T	P	C
1152ME144		3	0	0	3

1. Preamble :

This course addresses metal forming principles, the issues in forming, analysis and the methods of overcoming them during real time application.

2. Prerequisite:

1 Manufacturing Technology 1151ME104

3. Links to other courses:

1 Project work

4. Course Educational Objectives :

Students undergoing this course are expected to:

- Know the principles, methods, areas of applications, possibilities and limitations as well as environmental effects of the various metal forming processes
- Be familiar with the different tests and methods of controlling friction during the metal forming processes.

5. Course Outcomes :

Upon the successful completion of the course, learners will be able to

CO Nos.	Course Outcomes	Level of learning domain (Based on revised Bloom's)
CO1	Apply the concepts of metal forming processes in manufacturing	K2
CO2	Identify the impact of interfacial friction in metal forming processes	K2
CO3	Understand the principles of various tribo-tests to quantify interfacial friction	K2
CO4	Solve simple problems related to forming processes by employing softwares	K2
CO5	Understand the difference between various bulk metal forming and sheet metal forming processes	K2

(K3 – Apply)

6. Correlation of CO's with Programme Outcomes:

Cos	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
CO1	H	H					L						H	
CO2	H	H					L						H	
CO3	H	H					L						H	M
CO4	H	H			M		L						H	M
CO5	H	H					L						H	L

H- High; M-Medium; L-Low

7. **Course Content:**

UNIT I OVERVIEW OF METAL FORMING PROCESSES L-9

Overview – Classification of metal forming processes – Advantages, disadvantages and limitations – Metal forming process in product development – Materials – Tooling in metal forming.

UNIT II IMPACT OF INTERFACIAL FRICTION L-9

Basic Concept – effects of interfacial friction – defects in bulk metal forming - impact of strain rate in forming processes – various lubricants used in forming processes.

UNIT III TRIBO-TESTS L-9

Basic concept – classification – ring compression test – simple upsetting test – spike forging test – double cup extrusion test – forward cup backward rod extrusion test - Principle, process, advantages, disadvantages and limitations

UNIT IV ANALYZING METAL FORMING USING SOFTWARE L-9

Rigidplastic and Viscoelastic analysis – viscoplastic analysis, FEA in metal forming processes - Softwares for analyzing metal forming processes: Deform3D.

UNIT V SHEET METAL FORMING PROCEESSES L-9

Forming diagram – various sheet metal forming processes - impact of strain rate – Defects and method of overcoming them

TOTAL : 45 PERIODS

8. **Text Books :**

1. Altan, T., Oh, S.-I., Gegel, H.L., Metal Forming Fundamentals and Applications, ASM International, 1983

2 P.N. Rao, "Manufacturing Technology: Foundry, Forming and Welding", McGraw Hills, New York, 4e (Volume 1) 2013.

9. References:

1. ASM Handbook, Forming and forging, Vol.14, ASM International, 1988.
2. Serope Kalpajian, Steven R.Schmid, "Manufacturing Processes for Engineering Materials", 4/e, Pearson Education, Inc. 2007.
3. Taylon Altan, "Cold and Hot Forging, Fundamentals and Applications", ASM International, The Materials Information Society, Ohio, 2005.

10. Revised Bloom's based Assessment Pattern:

Revised Bloom's Category	Internal				University Examination %
	Unit Test 1 %	Mid Term Test 1 %	Unit Test 2 %	Mid Term Test 2 %	
Remember					
Understand	70	70	70	70	70
Apply	30	30	30	30	30
Analyse					
Evaluate					
Create					

Revised Bloom's Category	Assignments	
	1 (COs addressed CO1,CO2) (max marks in %)	2 (COs addressed CO3,CO4) (max marks in %)
Remember	**20**	**20**
Understand	**50**	**50**
Apply	**30**	**30**
Analyse		
Evaluate		
Create		

COURSE CODE	ADVANCED METAL JOINING	L	T	P	C
1152ME150		3	0	0	3

1. Preamble

This course provides an insight on metal joining processes made using conventional and non-conventional techniques. It also throws light on the essentials of metal joining that includes knowledge on welding symbols, types of joints, specifications, joint quality, equipment, accessories and safety precautions.

2. Pre-Requisite

1 Manufacturing Technology 1151ME104

3. Links to Other Courses

1 Project work

4. Course Educational Objectives

- To understand the various metal joining processes, characteristics of weldable metals, safety precaution and automation in metal joining.

5. Course Outcomes

The students would be benefitted with the following outcomes:

CO Nos.	Course Outcomes	Level of learning domain (Based on revised Bloom's)
CO1	Describe the fundamentals of metal joining such as equipment, accessories, treatment process and weld symbols	K2
CO2	Understand the principles, working and applications of various fusion joining techniques	K2
CO3	Understand the construction and working of various solid state joining techniques	K2
CO4	Explain the mechanical and metallurgical characteristics of metals, defects in joints, testing of joints and weld zones	K2
CO5	Understand the applications of robots in welding and safety measures during welding	K2

6. Correlation of COs with Programme Outcomes

CO s	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
CO1	L		H		L							M		
CO2	L		H									M	M	
CO3	L		H				L					M	M	
CO4	L					L						M	M	
CO5	L		L									M		M

H- High; M-Medium; L-Low

7. Course Content

UNIT I FUNDAMENTALS OF METAL JOINING L-9

History of metal joining – Classifications – Applications – Welding equipment and accessories – Pretreatment and post treatment for different types of joints – Welding symbols.

UNIT II FUSION JOINING PROCESSES L-9

Soldering: tools, types of tips, solderability, procedure, desoldering – Arc welding: principle, welding machine (AC vs DC), Significance of polarity – Electrodes: types, constituents, functions, specifications – Brazing: types, selection of fillers, fuels and flames, flux, atmosphere – Forge welding: principle, working, advantages, disadvantages, applications – Explosive welding: principle, working, advantages, disadvantages, applications.

UNIT III SOLID STATE JOINING PROCESSES L-9

Adhesive bonding – Riveting - Diffusion bonding – Friction Welding – Friction Stir Welding - Friction Stir Spot Welding – Linear Friction Welding - Magnetic Welding.

UNIT IV CHARACTERISTICS OF METAL, WELD ZONES AND JOINT QUALITY L- 9

Properties of metal: physical, chemical and mechanical – Selection of metals and alloys: functional, manufacturing and economical – Factors affecting weld quality – Testing of joint quality – Weld zones.

UNIT V WELDING AUTOMATION AND SAFETY L-9

Introduction to welding automation – Advantages and disadvantages – TANDEM MIG – Robotic welding – Narrow gap SAW – Laser arc hybrid welding.
Need for safety during metal joining – Safety standards – Precautions – Safety equipment for metal joining – Case study on welding accidents.

Total: 45 periods

8. Text Books

1. O.P. Khanna" A Text Book of Welding Technology", Dhanpat Rai Publishing Co. Pvt. Ltd. , New Delhi, India. 2018.
2. S.P. Tewari, S.A. Rizwi" Advanced Welding Technology", S.K. Kataria and Sons Publishers, 2013.

9. References

1. Mahmoud Kamel Semary, Ibrahiem Mausa" Principles of Applied Welding Technology", LAP Lambert Academic Publishing, 2011.
2. M.J.M Hermans" Welding Technology", ebook, Boeken Bestsellers.NL.
3. R.S. Mishraa,, Z.Y. Ma (2005) Friction stir welding and processing, Materials Science and Engineering R 50 pp.1–78

COURSE CODE	ARTIFICIAL INTELLIGENCE SYSTEM IN	L	T	P	C

1152ME146	MANUFACTURING	3	0	0	3

1. Preamble :

This course addresses practical experience with algorithms used in advanced manufacturing system (artificial intelligence - expert systems).

2. Prerequisite:

1 Manufacturing System

3. Links to other courses:

1 Computer Aided Design

4. Course Educational Objectives :

Students undergoing this course are expected to:

- Familiarize students with new modern methods and tools used for design and control of manufacturing systems with respect to automated manufacturing.
- The emphasis is placed on methods based on application of knowledge base systems in modern manufacturing.

5. Course Outcomes :

Upon the successful completion of the course, learners will be able to

CO Nos.	Course Outcomes	Level of learning domain (Based on revised Bloom's)
CO1	To explain the concept of Artificial intelligence in CAD.	K2
CO2	To apply the concept of knowledge representation and programming in an expert system.	K3
CO3	To discuss the basic knowledge of decision support systems	K2
CO4	To analyses performance of multilayer network	K2
CO5	To design an expert system through Fuzzy logic and neural networks	K3

(K3 – Apply)

6. Correlation of CO's with Programme Outcomes:

Cos	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
CO1		L											M	
CO2		M				L							M	
CO3		H				L							M	
CO4		H				L							M	
CO5		L				L					L		M	

H- High; M-Medium; L-Low

7. **Course Content:**

UNIT I-INTRODUCTION **L-9**

Artificial Intelligence in CAD, Applications of Artificial Intelligence in Design. Scope and History of AI. Structure of an Expert System, Building an Expert System. Strategies for Knowledge Acquisition, Components of Knowledge. Knowledge Representation, Production Systems, Decision Tables.

UNIT II- KNOWLEDGE REPRESENTATIONS **L-9**

Knowledge Representations Process, Purposes, Contexts and Agents, Knowledge Soup, Knowledge Acquisition and Sharing. Knowledge Representation Languages, Issues in Knowledge Representation. A Network Representation Language.

LISP: Introduction to LISP. Search Strategies in LISP

UNIT III- DECISION SUPPORT SYSTEMS **L-9**

Introduction. Basis of Decision Making. Typical Progressive Models. Intelligent Models, Life-Cycle Values. Total Life-Cycle Cost.

Learning Processes and AI Algorithms: The General Problem Solver and Difference Tables. Machine Learning, Perceptron Learning, Back Propagation Learning.

The Genetic Algorithm: The Genetic Programming.

UNIT IV-ARTIFICIAL NEURAL NETWORK **L-9**

Multi-layer Network: Back propagation, examples & applications, performance of multilayer feed forward Network.

UNIT V- DESIGN OF EXPERT SYSTEMS AND APPLICATIONS **L-9**

Benefits and Examples of Expert Systems. Design of Expert Systems, Introduction to CLIPS, Pattern Matching, Modular Design and Execution Control Fuzzy Logic, Typical Expert System MYCIN, DENDRAL, PROSPECTOR.

TOTAL : 45 PERIODS

9. **Text Books :**

1. A guide to Expert Systems – Donald A Waterman, Addison Wesley, 1st edition, 2002.
2. Principles of Artificial Intelligence – Springer-Verlag, Berlin, paperback edition, 1982.

9. References:

1. Understanding Decision Support System and Expert Systems – McGraw Hill, 2nd edition, 1993.
2. Artificial Intelligence – Elain Rich, McGraw Hill, 3rd edition, 2010.

10. Revised Bloom's based Assessment Pattern:

Revised Bloom's Category	Internal				University Examination %
	Unit Test 1 %	Mid Term Test 1 %	Unit Test 2 %	Mid Term Test 2 %	
Remember					
Understand	70	70	70	70	70
Apply	30	30	30	30	30
Analyse					
Evaluate					
Create					

Revised Bloom's Category	Assignments	
	1 (COs addressed CO1,CO2) (max marks in %)	2 (COs addressed CO3,CO4) (max marks in %)
Remember	**20**	**10**
Understand	**40**	**40**
Apply	**40**	**50**
Analyse		
Evaluate		
Create		

COURSE CODE	DESIGN OF ROTODYNAMIC PUMPS	L	T	P	C
1152ME139		3	0	0	3

1. Preamble

To enrich the knowledge about rotodynamic pumps and as well as to design the pump for specific requirements.

2. Pre-requisite

Fluid Mechanics and Machinery 1151ME103

3. Links to other courses

Project Work

4. Course Educational Objectives

- To familiarize with velocity triangles for pumps of various classification
- To familiarize with the design of radial flow, mixed flow, and axial flow pumps based on the various requirements.
- To emphasis the effects of cavitation in pumps and the effects of cavitation on performance of the pumps.

5. Course Outcomes

Upon the successful completion of the course, learners will be able to

CO Nos.	Course Outcomes	Level of learning domain (Based on revised Bloom's)
CO1	Identify the pumps based on specific requirements	K2
CO2	Construct the design of radial flow pump for a given application	K3
CO3	Examine the design and development of mixed flow pumps	K3
CO4	Design a heart pump (bio medical) as well as for high flow rate applications	K3
CO5	Describe how cavitation can be avoided	K2

(K1– Remember, K2-Understand, K3- Apply, K4- Analyze, K5 –Evaluate, K6- Create)

6. Correlation of COs with Programme Outcomes

COs	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
CO1	H	-	-	-	-	-	-	-	-	-	-	-	H	M
CO2	H	M	H	-	-	-	M	-	-	-	-	-	H	M
CO3	H	M	H	-	-	-	M	-	-	-	-	-	H	M
CO4	H	M	H	-	-	-	M	-	-	-	-	-	H	M
CO5	H	-	H	-	-	-	-	-	-	-	-	-	H	M

(H-High; M-Medium; L-Low)

7. Course Content

UNIT I - INTRODUCTION ON PUMPS 9

Fundamental definitions about pumps, classification of pumps, comparison between rotodynamic pumps and positive displacement pumps, pump theory, construction of inlet and outlet velocity triangles for the blades of pumps.

UNIT II - DESIGN OF RADIAL FLOW PUMP 9

Design of radial flow pump – calculation of the dimensions of the impeller, method of designing impeller, shaping the blade surface.

UNIT III – DESIGN OF MIXED FLOW PUMP 9

Design of mixed flow pump – Helical pump, diagonal pump, design calculation of a mixed flow pump.

UNIT IV – DESIGN OF AXIAL FLOW PUMP AND CASING 9

Design of axial flow pump, design of inlet and outlet elements, design calculation for casing.

UNIT V - CAVITATION 9

Cavitation in pumps – cavitation parameters, cavitation inception, types of impeller cavitation, effect of cavitation and application of cavitation. Trouble shooting in Pumps

Total: 45 Periods

8. Text Books

1. Karassik, I. *Centrifugal Pump Clinic*. 2nd Ed., New York, CRC Press, 2017.
2. Guelich, J.F. *Centrifugal Pumps*, Springer Verlag, New York, 2014.

9. References

1. Neumann, B. *The Interaction between Geometry and Performance of a Centrifugal Pump.* MEP, London, 2005.
2. Kumaraswamy, S. *Data Book for Design of Centrifugal Pumps*. *Hydroturbomacines Lab.*, Indian Institute of Technology Madras, 2001.
3. Li, S.C. *Cavitation of Hydraulic Machinery*, London Imperial College press, 2000.
4. Stepanoff, A.J. *Centrifugal and Axial Flow Pumps.* 2nd Ed., John Wiley, New York, 1991.
5. Lazarkiewicz, S. and Troskolanski, A, T. *Impeller Pumps.* Pergamon press, Oxford, 1965.
6. Kovats, A. *Design and Performance of Centrifugal and Axial Flow Pumps and Compressors.* Pergamon Press, New York, 1964.

10. Revised Bloom's based Assessment Pattern

Revised Bloom's Category	Internal				University Examination %
	Unit Test I %	Mid Term Test I %	Unit Test II %	Mid Term Test II %	
Remember	30	20	20	20	20
Understand	70	30	30	30	30
Apply	-	50	50	50	50
Analyze	-	-	-	-	-
Evaluate	-	-	-	-	-
Create	-	-	-	-	-

Revised Bloom's Category	Assignments	
	1 (CO1 & CO2) (max marks in %)	2 (CO3 & CO4) (max marks in %)
Remember	20	20
Understand	40	40
Apply	40	40
Analyze	-	-
Evaluate	-	-
Create	-	-

COURSE CODE	ENGINEERING APPLICATIONS OF PUMP	L	T	P	C
1152ME151		3	0	0	3

1. **Preamble**

To deepen the knowledge on selection, commissioning, and testing of pumps based on their performance characteristics for various applications.

2. **Pre-requisite**

Fluid Mechanics and Machinery 1151ME103

3. **Links to other courses**

Project Work

4. **Course Educational Objectives**

- To provide an overview of flow through pipes and the various losses.
- To familiarize the performance characteristics of different rotodynamic pumps under various operating conditions.
- To select the pumps according to the need of customers and suggesting a procedure for installation and commissioning.
- To disseminate the various testing procedures for pumps according to the purpose of usage.

5. **Course Outcomes**

Upon the successful completion of the course, learners will be able to

CO Nos.	Course Outcomes	Level of learning domain (Based on revised Bloom's)
CO1	Take a broad view on the importance of flow losses in piping system	K2
CO2	Understand the characteristics of pumps provided by pump manufacturer	K2
CO3	Illustrate the selection procedure and the installation of pumps	K3
CO4	Explain the various methods of pump testing	K2
CO5	Apply the knowledge for better utilization of pumps	K3

(K1– Remember, K2-Understand, K3- Apply, K4- Analyze, K5 –Evaluate, K6- Create)

6. Correlation of COs with Programme Outcomes

COs	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
CO1	H	-	-	-	-	-	-	-	-	-	-	-	H	-
CO2	H	M	-	-	-	L	-	-	-	-	-	-	H	-
CO3	H	-	M	-	-	L	L	-	-	-	-	-	H	-
CO4	H	-	-	-	-	L	-	-	-	-	-	-	H	-
CO5	H	-	-	-	-	-	-	-	-	-	-	-	H	-

(H-High; M-Medium; L-Low)

7. Course Content

UNIT I – MAJOR AND MINOR LOSSES 9

Flow through pipes, Reynolds number, major losses-Darcy Weisbach equation, minor losses, Moody's chart and its applications.

UNIT II – PUMP PERFORMANCE CHARACTERISTICS 9

Pump characteristics – pump operation under normal and abnormal conditions, plotting of head-discharge characteristics, affinity law of characteristics curves, system curve, series and parallel pump characteristics.

UNIT III – SELECTION, INSTALLATION, AND COMMISSIONING 9

Piping system sizing and analysis, construction of pumps, selecting and installing of pumps.

UNIT IV – PUMP TESTING 9

Pump testing – classification of tests, general principles of testing, measurement of characteristics quantities, test rig for rotodynamic pumps, acceptance test.

UNIT V – APPLICATIONS OF PUMPS 9

Application of pumps – power plant services, petroleum industries, chemical Industries, water supply, food processing and handling industries and sewage and sump services, jet pumps, and submersible pumps.

Total: 45 Periods

8. Text Books

1. Karassik, I. *Centrifugal Pump Clinic*. 2nd Ed., New York, CRC Press, 2017.
2. Guelich, J.F. *Centrifugal Pumps*, Springer Verlag, New York, 2014.

9. References

1. Neumann, B. *The Interaction between Geometry and Performance of a Centrifugal Pump.* MEP, London, 2005.
2. IS 9137:1978 (Reaffirmed 2002) Code for Acceptance Test for Centrifugal, Mixed Flow and Axial Pumps – Class C.
3. Stepanoff, A.J. *Centrifugal and Axial Flow Pumps.* 2nd Ed., John Wiley, New York, 1991.
4. Lazarkiewicz, S. and Troskolanski, A, T. *Impeller Pumps.* Pergamon press, Oxford, 1965.
5. Kovats, A. *Design and Performance of Centrifugal and Axial Flow Pumps and Compressors.* Pergamon Press, New York, 1964.

10. Revised Bloom's based Assessment Pattern

Revised Bloom's Category	Internal				University Examination %
	Unit Test I %	Mid Term Test I %	Unit Test II %	Mid Term Test II %	
Remember	**30**	**30**	**20**	**20**	**20**
Understand	**70**	**70**	**30**	**30**	**30**
Apply	-	-	**50**	**50**	**50**
Analyze	-	-	-	-	-
Evaluate	-	-	-	-	-
Create	-	-	-	-	-

Revised Bloom's Category	Assignments	
	1 (CO1 & CO2) (max marks in %)	2 (CO3 & CO4) (max marks in %)
Remember	**30**	**20**
Understand	**70**	**30**
Apply	-	**50**
Analyze	-	-
Evaluate	-	-
Create	-	-

COURSE CODE	INTEGRATED PRODUCT DESIGN AND PROCESS DEVELOPMENT	L	T	P	C
1152ME142		3	0	0	3

1. Preamble

This course is designed to provide the knowledge about the concepts of various tools and approaches available for product design and process development.

2. Prerequisite

Basic Mechanical Engineering.

3. Link to other Courses

Total Quality Management, Project works.

4. Course Educational Objectives

Students undergoing this course are expected to

- Understand the concepts of tools and techniques in the Integrated Product Development area of the Engineering Services industry.
- Relate the engineering topics into real world engineering applications.

5. Course Outcomes

Upon the successful completion of the course, learners will be able to

CO Nos.	Course Outcomes	Level of learning domain (Based on revised Bloom's)
CO1	Summarise the various trends affecting product decision	K2
CO2	Identify the requirements to create new product	K3
CO3	Compare different techniques involved in design creation and design testing	K2
CO4	Rephrase the methods of model creation, integration between software and hardware and confidentiality.	K2
CO5	Understand the various aspects of design such as design for manufacture and economic analysis.	K2

(K1 – Remember; K2 – Understand; K3 – Apply ;)

6. Correlation of COs with Programme Outcomes

COs	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
CO1	H	L				L	L	L	L			L	H	L
CO2	H	L				L	L	L	L			L	H	L
CO3	H	L				L	L	L	L			L	H	L
CO4	H	L				L	L	L	L			L	H	L
CO5	H	L				L	L	L	L		M	L	H	L

H- High; M-Medium; L-Low

7. Course Content

UNIT I: INTRODUCTION L-9

Global Trends Analysis and Product decision: Types of various trends affecting product decision - Social Trends-Technical Trends- Economic Trends- Environmental Trends- Political/ Policy Trends- PESTLE Analysis. Introduction to Product Development Methodologies and Management: Overview of Products and Services- Types of Product Development- Overview of Product Development methodologies - Product Life Cycle - Product Development Planning and Management.

UNIT II: REQUIREMENTS AND SYSTEM DESIGN L-9

Requirement Engineering: Types of Requirements- Requirement Engineering- Analysis -Traceability Matrix and Analysis- Requirement Management. System Design & Modeling: Introduction to System Modeling- introduction to System Optimization- System Specification-Sub-System Design- Interface Design.

UNIT III: DESIGN AND TESTING L-9

Conceptualization -Industrial Design and User Interface Design- Introduction to Concept generation Techniques-Concept Screening & Evaluation- Concept Design- S/W Architecture- Hardware Schematics and simulation-Detailed Design: Component Design and Verification- High Level Design/Low Level Design of S/W Programs- S/W Testing-Hardware Schematic- Component design- Layout and Hardware Testing.

UNIT IV: IMPLEMENTATION, INTEGRATION &BUSINESS DYNAMICS L-9

Prototyping: Types of Prototypes -Introduction to Rapid Prototyping and Rapid Manufacturing. System Integration- Testing- Certification and Documentation: Introduction to Manufacturing /Purchase and Assembly of Systems- Integration of Mechanical, Embedded and S/W systems- Introduction to Product verification and validation processes - Product Testing standards, Certification and Documentation, Intellectual Property Rights and Confidentiality- Security and configuration management

UNIT V: DESIGN FOR MANUFACTURING AND PRODUCT DEVELOPMENT L-9

Definition - Estimation of Manufacturing cost-reducing the component costs and assembly costs – Minimize system complexity-Economic Analysis - Understanding and representing tasks-baseline project planning - accelerating the project-project execution.

TOTAL=45 periods

8. Text Books

1. NASSCOM student Handbook "Foundation Skills in Integrated Product Development".
2. Product Design and Development, Karl T.Ulrich and Steven D.Eppinger, McGraw –Hill International Edns.1999
3. Anita Goyal, Karl T Ulrich, Steven D Eppinger, "Product Design and Development ", 4th Edition, 2009, Tata McGraw-Hill Education, ISBN-10-007-14679-9

9. References

1. George E.Dieter, Linda C.Schmidt, "Engineering Design", McGraw-Hill International Edition, 4th Edition, 2009, ISBN 978-007-127189-9
2. Kevin Otto, Kristin Wood, "Product Design", Indian Reprint 2004, Pearson Education,ISBN. 9788177588217
3. Yousef Haik, T. M. M. Shahin, "Engineering Design Process", 2nd Edition Reprint, Cengage Learning, 2010, ISBN 0495668141

4. Concurrent Engg./Integrated Product Development. Kemnneth Crow, DRM Associates, 6/3,ViaOlivera, Palos Verdes, CA 90274(310) 377-569,Workshop Book

5. Clive L.Dym, Patrick Little, "Engineering Design: A Project-based Introduction", 3rd Edition, John Wiley & Sons, 2009, ISBN 978-0-470-22596-7
6. Product Design Techniques in Reverse Engineering and New Product Development, KEVIN OTTO & KRISTIN WOOD, Pearson Education (LPE), 2001.
7. The Management and control of Quality-6th edition-James R. Evens, William M Lindsay Pub:son south-western(www.swlearning.com)

10. Revised Bloom's based Assessment Pattern

Revised Bloom's Category	Internal				University Examination %
	Unit Test-I %	Mid Term Test I %	Unit Test-II %	Mid Term Test II %	
Remember	40	20	20	10	10
Understand	60	40	20	20	20
Apply		40	40	30	30
Analyse			20	40	40
Evaluate					
Create					

Revised Bloom's Category	Assignments	
	1(CO1 &CO2) (max marks in %)	2(CO3&CO4) (max marks in %)
Remember		
Understand		
Apply	60	40
Analyse	40	60
Evaluate		
Create		

COURSE CODE	LASER PROCESSING OF MATERIALS	L	T	P	C
1152ME147		3	0	0	3

1. Preamble
The course provides insights into laser processing of materials.

2. Prerequisite
Manufacturing Technology 1151ME104

3. Links to other courses
Project Work

4. Course Educational Objectives
Students undergoing this course are expected to

- Understand background of laser systems, process parameters, material considerations and specific applications.
- Know about the principles of industrial lasers, laser generation, mode selection, beam mechanisms, modifications and characteristics, types of lasers.

5. Course Outcomes
The students would be benefitted with the following outcomes:

CO Nos.	Course Outcomes	Level of learning domain (Based on revised Bloom's)
CO1	Describe the principles of different types of industrial laser and its working mechanisms	K2
CO2	Explain the heat and fluid flow mechanism in the laser processing of materials	K2
CO3	Illustrate the microstructural changes and defects formed during the laser processing of materials	K2
CO4	Describe the principle and working mechanisms of welding and surface engineering using laser beam	K2
CO5	Explain the process of advanced machining using laser beam	K2

6. Correlation of COs with Programme Outcomes

COs	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
CO1	H	M			L							L	M	M
CO2	H	M			L							L	M	M
CO3	H	M			L							L	M	M
CO4	H	M			L							L	M	M
CO5	H	M			L							L	M	M

H-High; M-Medium; L-Low

7. Course Content

UNIT I PRINCIPLES OF INDUSTRIAL LASERS L - 9

Principle of laser generation, optical resonators, laser modes - mode selection, line - broadening mechanisms, laser beam modifications and types of industrials laser.

UNIT II HEAT AND FLUID FLOW L - 9

Heat flow in the work piece: thick plate with point heat source, thin plate with line heat source, peak temperature and cooling rates, Fluid flow in molten pool: continuity equation, Navier-Stokes equation and surface tension effects.

UNIT III LASER METALLURGY L - 9

Process microstructure - fusion zone, zone of partial melting, HAZ, discontinuities - porosity, cracking, lack of fusion, incomplete penetration and undercut.

UNIT IV LASER WELDING AND SURFACE MODIFICATIONS L - 9

Process mechanisms (Key hole and Plasmas) – operating characteristics – process variations – imperfections - industrial applications – recent developments. Laser surface heat treatment, Laser surface melting - Glazing, Laser direct metal deposition – Laser surface alloying, Laser surface cladding and hard coatings, Laser physical vapour deposition and Laser shock peening.

UNIT V LASER MACHINING L - 9

Laser instrumentation for cutting and drilling – cut quality and process characteristics – methods of cutting – practical performance – process variations – industrial applications of Laser cutting and drilling.

TOTAL: 45 PERIODS

8. Text Books

1. Elijah Kannatey - Asibu, Jr., "Principles of Laser Materials processing ", John Wiley & Sons, 2009.
2. Jacques Perrière, Eric Millon, Eric Fogarassy, "Recent advances in laser processing of materials" Elsevier, 2006.

9. Reference Books

1. Peter Schaaf., "Laser Processing of Materials - Fundamentals, Applications and Developments", Springer, 2010.
2. Dowden, John, Schulz, Wolfgang. "The Theory of Laser Materials Processing - Heat and Mass Transfer in Modern Technology", Springer, 2017.
3. John C. Ion., "Laser Processing of Engineering Materials - Principles, Procedure and Industrial Application" Elsevier, 2005.

10. Revised Bloom's based Assessment Pattern

Revised Bloom's Category	Internal				University Examination %
	Unit Test-I %	Mid Term Test I %	Unit Test-II %	Mid Term Test II %	
Remember	40	40	40	40	20
Understand	60	40	60	40	60
Apply		20		20	20
Analyse					
Evaluate					
Create					

Revised Bloom's Category	Assignments	
	1 (CO1 & CO2) (Max marks in %)	2 (CO3, CO4 & CO5) (Max marks in %)
Remember		
Understand	**50**	**50**
Apply	**50**	**50**
Analyze		
Evaluate		
Create		

COURSE CODE	MATERIALS CHARACTERIZATION AND TESTING OF METHODS	L	T	P	C
1152ME145		3	0	0	3

1. Preamble

This course imparts the knowledge on the on characterization tests, thermal and electrical properties, mechanical properties and flammability, optical properties and provide exposure to understand the testing of foam plastics and testing organizations so as to select the appropriate material for suitable applications.

2. Prerequisite

Engineering Materials and Metallurgy	1151ME117

3. Links to other courses:

1	Composite Materials	1152ME104
2	Corrosion and Surface Engineering	1152ME103

4. Course Educational Objectives

Students undergoing this course are expected to:

- Gain knowledge in properties of materials.
- Acquire the knowledge about various testing and standards of the materials.
- Attain knowledge in characterization and evaluate the mechanical properties of different materials.
- Impart the knowledge about the failure analysis of ductile and brittle materials.

5. Course Outcomes

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

CO Nos.	Course Outcomes	Level of learning domain (Based on revised Bloom's)
CO1	Explain the different characterization techniques and evaluation procedures.	K2
CO2	Explain the important thermal and electrical properties of materials and its evaluation.	K2
CO3	Describe different mechanical properties evaluation techniques for various materials.	K3
CO4	Describe different optical properties and analytical testing of materials.	K2
CO5	Describe the advanced diffraction and Spectroscopic Techniques	K3

(K3-Apply)

6. Correlation of COs with Programme Outcomes

COs	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
CO1	H	H		M			L						H	
CO2	H	H		M			L						H	
CO3	H	H		M			L						H	
CO4	H	H		M			L						H	
CO5	H	H		M			L						H	

H- High; M-Medium; L-Low

7. Course Content

UNIT I CHARACTERIZATION TESTS 9

TGA, DTA, DSC, TMA, XRD, SEM, AFM, TEM, IR, NMR, GC, GPC melt index and viscosity.

UNIT II THERMAL AND ELECTRICAL PROPERTIES 9

Heat deflection temperature, Vicat softening temperature, thermal conductivity thermal expansion, brittleness temperature – dielectric strength dielectric constant, dissipation factor, resistance.

UNIT III MECHANICAL PROPERTIES AND FLAMMABILITY 9

Tensile tests, compressive properties, impact properties, deformation, brittleness abrasion resistance hardness tests – incandescence resistance, ignition properties, oxygen index and surface burning characteristics.

UNIT IV OPTICAL PROPERTIES AND ANALYTICAL TESTS 9

Refractive index, luminous transmittance, haze, density, water absorption, moisture analysis, sieve analysis, crush and burst strength.

UNIT V ADVANCED CHARACTERIZATION TECHNIQUES 9

Advanced Diffraction Techniques: SAXS, SANS, LEED, RHEED, and EXAFS - Surface Characterization Techniques: XPS, AES, SIMS- Microscopic Techniques: TEM: HR, HAADF, STEM, In-situ; EBSD, AFM, STM, Laser Confocal Microscopy, Spectroscopic Techniques: Vis, UV, FTIR, Raman, STEM-EELS.

TOTAL: 45 periods

8. Text Books

3. S. K. Nayak, S. N. Yadav, S. Mohanty, Fundamentals of Plastic Testing, Springer, 2010.
4. Vishu Shah, Hand book of Plastics Testing and Failure Analysis, 3rd Edition, John-Willey &Sons, New York, 2007.

9. References

1. B. Sivasankar, Engineering Chemistry, Tata McGraw-Hill Publishing Company Ltd., New Delhi, 2012.
2. B. Mathur, I. S. Bharadwaj, Testing and Evaluation of Plastics, Allied Publishers Pvt. Ltd., New Delhi, 2003.
3. Ya. Malkin, A.A. AskaDsky, V.V. Koverica Experimental methods of polymers, MirPublishers, Moscow, 1998.
4. Iver, Mead and Riley, Hand book of Plastic test methods, Illith Publishers, New York, 1982.

10. Revised Bloom's based Assessment Pattern

Revised Bloom's Category	Internal				University Examination %
	Unit Test-I %	Mid Term Test I%	Unit Test-II%	Mid Term Test II %	
Remember	40	40	40	40	20
Understand	60	40	60	40	60
Apply		20		20	20
Analyse					
Evaluate					
Create					

Revised Bloom's Category	Assignments	
	1 (CO1 &CO2) (max marks in %)	2 (CO3&CO4) (max marks in %)
Remember		
Understand	**80**	**70**
Apply	**20**	**30**
Analyse		
Evaluate		
Create		

COURSE CODE	WELDING METALLURGY AND WELDABILITY OF STAINLESS STEELS	L	T	P	C
1152ME140		3	0	0	3

1. Preamble

This course imparts the knowledge on the fundamentals of metallurgy, weldability studies on types of stainless steel material so as to select the appropriate feasibility of better weldments and standard testing techniques

2. Pre-requisite

Engineering Materials and Metallurgy 1151ME117

3. Links to other courses

1 Advanced Welding Technology 1152ME125
2 Corrosion and Surface Engineering 1153ME103

4. Course Educational Objectives

To understand the physical metallurgy of weldability studies on different types of stainless steel grades and testing techniques in weldments

5. Course Outcomes

Upon the successful completion of the course, students would be benefitted with the following outcomes:

CO Nos.	Course Outcomes	Level of learning domain (Based on revised Bloom's)
CO1	Explain the basic phase diagrams for iron chromium based system and importance of alloying elements	K2
CO2	Understand the basic standards and welding metallurgy principles used in martensitic and ferritic stainless steel	K2
CO3	Understand the weldability of Austenitic stainless steels and guidelines after postweld heat treatment	K2
CO4	Explain the welding metallurgy principles and standards used in duplex and precipitation hardenable stainless steel	K2
CO5	Understand the importance and difficulties of joining dissimilar materials and different testing techniques	K2

(K1-Remember K2-Understand K3-Apply K4-Analyze K5-Evaluate K6-Create)

6. Correlation of COs with Programme Outcomes

Cos	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
CO1	H											M	M	L
CO2	H											M	M	L
CO3	H											M	M	L
CO4	H											M	M	L
CO5	H											M	M	L

H- High; M-Medium; L-Low

7. Course Content

UNIT I PHASE DIAGRAMS AND ALLOYING ELEMENTS 9 Hrs

History of Stainless steel – Types – Production of stainless steel, Iron-Chromium system, Iron –Chromium-Carbon system, Iron-Chromium-Nickel system, Alloying elements in stainless steels (Chromium, Nickel, Manganese, Silicon, Molybdenum, Carbide-forming elements, Precipitation-Hardening elements, other elements)

Constitution diagrams: Austenitic –Ferritic alloy system, Schaeffler diagram, Delong diagram, Austenitic-Martensitic Alloy system, Ferritic-Martensitic alloy systems

UNIT II MARTENSITIC AND FERRITIC STAINLESS STEELS 9 Hrs

Standard alloys and consumables – Welding metallurgy – Fusion zone, Heat –Affected Zone, Phase transformations, Post-weld heat treatment and Guidelines, Weldability – Solidification and Liquation cracking, Re-heat cracking, Hydrogen-Induced cracking, Case study

UNIT III AUSTENITIC STAINLESS STEEL 9 Hrs

Standard alloys and consumables – Welding metallurgy – Fusion zone Microstucture evolution, Solidification in grain and sub-grain boundaries – Heat affected zone, Post-weld heat treatment, Weldability - Weld solidification cracking, HAZ and weld metal liquation cracking, Ductility-Dip cracking, Reheat cracking, Corrosion Resistance – Inter-granular corrosion, Stress corrosion cracking, Pitting and crevice corrosion, Case study

UNIT IV DUPLEX AND PRECIPITATION-HARDENING STAINLESS STEEL 9 Hrs

Standard alloys and consumables, Physical Metallurgy, Welding Metallurgy – Microstructure Evolution, Post-weld Heat Treatment, Weldability – Hydrogen Induced cracking, Intermediate Temperature Embrittlement, Mechanical Properties of Weldments, Corrosion Resistance

UNIT V DISSIMILAR WELDING OF STAINLESS STEELS AND WELDABILITY TESTING 9 Hrs

Applications of Dissimilar welds, Carbon or Low-alloy Steel to Austenitic stainless steel, Weldability – Solidification cracking, Clap Disbonding, Creep Failure in HAZ of carbon steel, other dissimilar combinations

Weldability Testing – Weldability test approach and Techniques, Varestraint test, Hot ductility test, Fissure Bend test, Strain-to-Fracture test

TOTAL: 45 HOURS

8. Text Book

1. John C.Lippold, Damian J.Kotecki, Welding Metallurgy and Weldability of Stainless Steels, Wiley Publications, 2005
2. Sindo Kou, “Welding Metallurgy”, Second Edition, John Wiley & Sons, Inc., Hoboken, New Jersey, 2003.

9. References

1. John C.Lippold, Welding Metallurgy and Weldability, Wiley Publications, 2015
2. A Designers Handbook Series, Welding of Stainless Steels and Other Joining Methods, AISI
3. J.F. Lancaster, Metallurgy of Welding, 6th Edition, Woodhead Publishing Limited, 1999
4. Kenneth Easterling, Introduction to the Physical Metallurgy of Welding, Second Edition, Butterworth-Heinemann Ltd.

10. Revised Bloom’s based Assessment Pattern

Revised Bloom’s Category	Internal				University Examination %
	Unit Test 1 %	Mid Term Test 1 %	Unit Test 2 %	Mid Term Test 2 %	
Remember	**50**	**50**	**50**	**50**	**50**
Understand	**50**	**50**	**50**	**50**	**50**
Apply					

Revised Bloom’s Category	**Assignments**	
	I (CO1 & CO2 addressed) (Max marks in %)	**II (CO3 & CO4 addressed) (Max marks in %)**
Remember	**50**	**50**
Understand	**50**	**50**
Apply		
Analyse		
Evaluate		
Create		

COURSE CODE	PROCESS PLANNING AND COST ESTIMATION	L	T	P	C
1152ME138		3	0	0	3

1. **Preamble**
   This course provides an introduction about process planning and its activities. It introduces the procedure of cost estimation of products manufactured in different shops and also machine time evaluation.

2. **Pre-Requisite**
   NIL

3. **Links to other courses**
   NIL

4. **Course Educational Objectives**
   Students, after undergoing this course would
   - Introduce the process planning concepts to make cost estimation for various products after process planning.

5. **Course Outcomes**
   Upon the successful completion of the course, learners will be able to

CO Nos.	Course Outcomes	Level of learning domain (Based on revised Bloom's)
CO1	Discuss the steps involved in process planning	K2
CO2	Prepare the documents for process planning	K2
CO3	Predict the parameters to evolve the cost of any product	K3
CO4	Estimate the cost of a product based on manufacturing methods	K3
CO5	Estimate the machining time to manufacture a given product	K3

(K3 - Apply)

6. **Correlation of COs with Programme Outcomes**

COs	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
CO1	H	M									M	L	M	L
CO2	H	M									M	L	M	L
CO3	H	H									M	L	M	L
CO4	H	H									M	L	M	L
CO5	H	H									M	L	M	L

H- High; M-Medium; L-Low

7. Course Content

UNIT I INTRODUCTION TO PROCESS PLANNING L-9
Introduction- methods of process planning-Drawing interpretation-Material evaluation – steps in process selection-Production equipment and tooling selection

UNIT II PROCESS PLANNING ACTIVITIES L-9
Process parameters calculation for various production processes-Selection jigs and fixtures-Selection of quality assurance methods - Set of documents for process planning-Economics of process planning- case studies

UNIT III INTRODUCTION TO COST ESTIMATION L-9
Importance of costing and estimation –methods of costing-elements of cost estimation – Types of estimates – Estimating procedure- Estimation labor cost, material cost-allocation of overhead charges- Calculation of depreciation cost

UNIT IV PRODUCTION COST ESTIMATION L-9
Estimation of Different Types of Jobs - Estimation of Forging Shop, Estimation of Welding Shop, Estimation of Foundry Shop

UNIT V MACHINING TIME CALCULATION L-9
Estimation of Machining Time - Importance of Machine Time Calculation- Calculation of Machining Time for Different Lathe Operations ,Drilling and Boring - Machining Time Calculation for Milling, Shaping and Planning -Machining Time Calculation for Grinding

TOTAL: 45 Periods

8. Text Books

1. Peter scalon, “Process planning, Design/Manufacture Interface”, Elsevier science technology Books, 2003.
2. Sinha.B.P, "Mechanical Estimating and Costing", Tata McGraw-Hill Publishing Co., 1995.
3. Phillip.F Ostwalal and Jairo Munez, "Manufacturing Processes and systems", John Wiley, 9th Edition, 2008.
4. Chitale, A. K., and Gupta, R. C., “Product Design and manufacturing”, Prentice Hall of India, New Delhi, 6th Edition 2013.
5. Adithan, M. S., and Pabla, “Production Engineering Estimating and Costing”, Konark Publishers Pvt., Ltd. 1989.

9. References

1. Ostwalal P.F. and Munez J., “Manufacturing Processes and systems”, 9th Edition, John Wiley, 1998.
2. Russell R.S and Tailor B.W, “Operations Management”, 4th Edition, PHI, 2003.
3. Banga T.R and Sharma.S.C, “Estimating and costing”, Khanna Publishers, New Delhi, 16th
   Edition, 2011.
4. Nanua Singh, “System Approach to Computer Integrated Design and Manufacturing”, John Wiley & Sons, New York, 2011.

10. Revised Bloom's based Assessment Pattern

Revised Bloom's Category	Internal				University Examination (%)
	Unit Test 1 (%)	Mid Term Test 1 (%)	Unit Test 2 (%)	Mid Term Test 2 (%)	
Remember	40	40	40	40	20
Understand	60	40	60	40	60
Apply		20		20	20
Analyse					
Evaluate					
Create					

Revised Bloom's Category	Assignment	
	I (CO1 & CO2 addressed) (Max marks in %)	II (CO3 & CO4 addressed) (Max marks in %)
Remember		
Understand		
Apply	50	50
Analyse	50	50
Evaluate		
Create		

COURSE CODE	SYSTEM MODELING AND CONTROL ENGINEERING	L	T	P	C
1152ME143		3	0	0	3

1. Preamble:

This course provides an introduction to the basic concepts and techniques of control system representation, system modeling, response analysis & identification, and control system design with some real world applications.

2. Pre-Requisite:

1. Engineering Mathematics II

3. Links to Other Courses:

1. Mechatronics Systems

4. Course Educational Objectives:

To understand the various types of control system, their modeling & identification, to be able to represent a control system and to develop a control strategy for the system.

5. Course Outcomes:

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

CO Nos.	**Course Outcomes**	**Level of learning domain (Based on revised Bloom's)**
CO1	Describe a control system with the category and its components	K2
CO2	Represent a control system with transfer function, block diagram and signal flow graph	K3
CO3	Develop a mathematical model of a system using conventional control theory and modern control theory	K3
CO4	Analyze the characteristics of a system from the system's response	K3
CO5	Design control systems using suitable controllers	K3

(K3-apply)

6. Correlation of COs with Programme Outcomes:

COs	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
CO1	**H**											**L**	**L**	
CO2	**H**	**L**										**L**	**L**	
CO3	**H**				**L**							**L**	**L**	
CO4	**H**	**M**				**L**						**L**	**L**	
CO5	H		H		L	L						L	M	

H- High; M-Medium; L-Low

7. Course Content:

UNIT I INTRODUCTION 9

Introduction, Historical background, System definition, Basic components of control system, types of control system, open loop vs. closed loop control, examples of control system

UNIT II CONTROL SYSTEM REPRESENATION 9

Transfer function form, series, parallel and feedback connection of transfer functions, block diagram with illustrative examples, simplification of block diagrams, signal flow graphs and their simplification

UNIT III SYSTEM MODELING 9

Modeling of mechanical, electrical, hydraulic, thermal, rotational-translational system, electro-mechanical system, linearized model of nonlinear systems, state-space modeling

UNIT IV SYSTEM RESPONSE AND ANALYSIS 9

Test signals, measurement of system responses, transient and steady-state response, response of 1st order system & 2nd order system, Routh's stability criterion, Hurwitz's criterion, frequency Response.

UNIT V CONTROL SYSTEM DESIGN 9

Root locus plots & stability margins, preliminary design considerations, lead compensation, Lag compensation, lag-lead compensation, the proportional, derivative and integral actions, tuning principles of PID controllers, introduction to Fuzzy control method.

.

Total: 45 periods

8. Text Books:

1. Katsuhiko Ogata, 'Modern Control Engineering', Pearson Education Ltd., 5th Edition, 2011
2. Norman S. Nise, 'Control Systems Engineering', John Wiley and Sons, 6th Edition, 2010

9. References:

1. W. Bolton, 'Mechatronics: Electronic Control Systems in Mechanical and Electrical Engineering, Pearson Education Ltd., 6th Edition, 2015
2. S. Ghosh, 'Control Systems: Theory and Applications, Pearson Education India, 2nd Edition, 2012

11. Revised Bloom's based Assessment Pattern

Revised Bloom's Category	Internal				University Examination (%)
	Unit Test 1 (%)	Mid Term Test 1 (%)	Unit Test 2 (%)	Mid Term Test 2 (%)	
Remember	40	40	40	40	20
Understand	60	40	60	40	60
Apply		20		20	20
Analyse					
Evaluate					
Create					

Revised Bloom's Category	Assignment	
	I (CO1 & CO2 addressed) (Max marks in %)	II (CO3 & CO4 addressed) (Max marks in %)
Remember		
Understand		
Apply	50	50
Analyse	50	50
Evaluate		
Create		

COURSE CODE	FINITE ELEMENT MODELLING OF COMPOSITE STRUCTURES	L	T	P	C
1152ME141		2	2	0	3

1. **Preamble**
   The intention of this course is to bridge the two subjects such as finite element methods and composite materials as a single unified content and make the students to have a theoretical and practical understanding on the finite element modelling of composite structures.
2. **Pre-Requisite**
   Strength of Materials 1151ME116
3. **Links to other courses**
   Project work
4. **Course Educational Objectives**
   Students, after undergoing this course would
   - Possess the basic knowledge in finite element methods, liner elasticity, composite materials and mechanics in the areas of applied engineering.
   - Develop the skills in the areas of application of finite element techniques to solve lightweight engineering based product design problems.
5. **Course Outcomes**
   Upon the successful completion of the course, learners will be able to

CO Nos.	Course Outcomes	Level of learning domain (Based on revised Bloom's)
CO1	Explain important concepts in linear algebra and linear elasticity	K2
CO2	Describe the basics of mechanics of composite materials and solve problems	K2
CO3	Develop concepts on finite element methods and solve problems	K2
CO4	Develop theoretical understanding on FE modelling of composite structures	K2
CO5	Solve practical problems in composites structural analysis using FEA	K3

(K3 - Apply)

6. **Correlation of COs with Programme Outcomes**

COs	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
CO1	H	H										H	H	
CO2	H	H										H	H	
CO3	H	H										H	H	
CO4	H	H										H	H	
CO5	H	H			H	H						H	H	

H- High; M-Medium; L-Low

7. Course Contents

UNIT- I INTRODUCTION **5**

Linear algebra - vector and matrix operations - Introduction to indicial notations and tensors - Review of linear elasticity equations.

UNIT - II MECHANICS OF COMPOSITE MATERIALS **10**

Introduction to composite materials - General characteristics - Elastic behavior of composite lamina at micro and macro level - Strength of unidirectional lamina at micro and macro level - Elastic behavior of multi-directional laminates - Failure prediction.

UNIT - III FINITE ELEMENT METHODS **10**

Introduction - Concepts of FEM – Energy principles – Rayleigh –Ritz method of functional approximation - Stiffness matrix and shape functions for simple 1D and 2D elements - Convergent and compatibility requirement - Isoparametric formulation - Numerical integration - Finite element solution procedures for static and dynamic problems.

UNIT - IV FE MODELLING OF COMPOSITE STRUCTURES **10**

Elements used for composite laminate analysis - Effect of change in mesh density - Accuracy of finite element solution - Modelling of composite materials - Other modelling methodologies applicable to composite materials - Composite structural optimization - effect of ply lay up on the structural response.

UNIT - V CASE STUDIES **10**

Case studies and practical examples in composite structural analysis using CATIA, HyperMesh and LSDYNA.

45 periods

8. Text books

1. J.N. Reddy, "Mechanics of Laminated Composite Plates and Shells: Theory and Analysis", CRC Press, 1997
2. F.L. Mathews, G.A.O. Davies, D. Hitchings, C. Soutis, "Finite Element Modelling of Composite Materials and Structures", Woodhead Publishing and CRC Press, 2003.

9. Reference books

1. S.P. Timoshenko, J.N. Goodier, "Theory of Elasticity", McGraw Hill Education Pvt Ltd, 2013.
2. Roman Solecki, R, Jay Conat, "Advanced Mechanics of Materials", Oxford University Press, 2003.
3. R.M. Jones, "Mechanics of Composite Materials", Taylor and Francis, 1999.
4. I. Daniel, O. Ishai, "Engineering Mechanics of Composite Materials", Oxford University Press, 2006.
5. K.J. Bathe, "Finite Element Procedures", Eastern Economy Edition, PHI, 1996.

10. Revised Bloom's based Assessment Pattern

Revised Bloom's Category	Internal				University Examination (%)
	Unit Test 1 (%)	Mid Term Test 1 (%)	Unit Test 2 (%)	Mid Term Test 2 (%)	
Remember	20	20	20	20	20
Understand	80	80	80	80	80
Apply					
Analyse					
Evaluate					
Create					

COURSE CODE	SURFACE MODELLING AND ASSEMBLY	L	T	P	C
1152ME201		1	0	4	3

1. Preamble

This course imparts the knowledge to understand fundamental concepts of surface modelling and its tools in a generic framework and provide clear understanding of CAD systems for 3D modeling and assembly.

2. Prerequisite

Engineering Graphics	1150ME202

3. Links to other courses:

Project Work	1154ME701

4. Course Educational Objectives

Students undergoing this course are expected to:

- Understand the various stages in the design process and the role of computer graphic communication process.
- Understand the concepts of Part Design and Surface design for modeling of mechanical components.
- Familiarize with the computer applications in design and preparing drawings for various mechanical components.

5. Course Outcomes

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

CO Nos.	Course Outcomes	Level of learning domain (Based on revised Bloom's)
CO1	Describe the basics of Surface Modelling, Parametric technology	K2, S3
CO2	Describe the use of Part modelling and Editing Modules	K2, S3
CO3	Demonstrate the applications of Surface Design	K3, S3
CO4	Analyze the Assembly Design by CAD modules	K4, S3
CO5	Utilize the CAD Modules in 3D modelling & Assembly	K3, S3

(K3-Apply)

6. Correlation of COs with Programme Outcomes

COs	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
CO1	H	H	M		M							M	M	H
CO2	H	H	M		M							M	M	H
CO3	H	H	M		M							M	M	H
CO4	H	H	M		M							M	M	H
CO5	H	H	M		M							M	M	H

H- High; M-Medium; L-Low

7. Course Content

UNIT I Introduction to Surface Modelling 3 + 12

CAD/CAM/CAE Product cycle, Parametric Technology, Introduction to CAD Environment & Menu bar and Use of Mouse.

Sketcher Workbench creating 2D Geometry, Working on Profile Toolbar Dimensioning the Sketches, Modifying and Constructing using Operation & Transformation Toolbar.

Experiments: Applying Constraints & Constraint Definition, Animating constraint & Checking Various Mechanisms.

UNIT II Part Design 3 + 12

Understanding Part Design Environment, Creating Solid Models using Sketch-Based Features, Working with Dress-Up Features, View Toolbar, Creating & Working efficiently on Reference Elements Planes and lines & points.

Editing Updating Features, Transformation Features e.g. Patterning, Rotating, Advanced Modeling Techniques

Experiments: Boolean Operations, Annotations, Assigning Materials & Measuring Properties.

UNIT III Surface Design 3 + 12

Creating Wireframe elements - helix, splines, Curves, etc. Creating Surfaces like blended, lofted surfaces, etc. Operations on Shape Geometry

Experiments: Joining, splitting & trimming

UNIT IV Assembly Design 3 + 12

Creating Bottom-up Assemblies, Inserting Components, Using Smart Move tool, Applying Constraints, Creating Top-down Assemblies, Working with Subassemblies, Editing Assemblies, Simplifying Assembly, Interference Detection, Sectioning & exploding assembly

Experiments: Shaft couplings – Plummer block – Screw jack- Lathe Tailstock – Universal Joint – Machine Vice – Stuffing box- safety Valves - Non-return valves.

UNIT V Drafting Workbench 3 + 12

Generating Drawing View with 1st angle or 3rd angle, Using Wizard, Generating Projected, Auxiliary, Section, Detailed views, etc. Using Control knob, Editing Views, Generating Dimensions, Inserting Sheets, Adding Datum, Geometric Tolerances & symbols and Generating BOM table.

Experiments: Connecting rod –Piston and crank shaft- Multi plate clutch- Preparation of Bill of materials and tolerance data sheet.

TOTAL: 75 periods

8. Text Books

1. Ibrahim Zeid "CAD/CAM -- Theory and Practice" 2nd Edition- McGraw Hill , International Edition, 2012.
2. Sham Tickoo, ,CATIA V5R20 for Designers, Tickoo CADCIM Series, 2017.

9. References

1. Chris McMahon and Jimmie Browne "CAD/CAM Principles, practice and manufacturing management "Pearson education Asia, 2001.

10. Revised Bloom's based Assessment Pattern

Revised Bloom's Category	Internal		University Examination %
	Model Test- I %	Model Test II%	
Remember			10
Understand	15	15	15
Apply	85	85	75
Analyse			
Evaluate			
Create			

COURSE CODE	ANALYSIS OF MECHANICAL SYSTEMS	L	T	P	C
1152ME202		1	0	4	3

1. Preamble

This course imparts the knowledge to understand fundamental concepts of finite element analysis and its tools in a generic framework and provide clear understanding of FEA Analysis for Engineering Applications.

2. Prerequisite

Finite Element Analysis

3. Links to other courses:

Project Work	1154ME701

4. Course Educational Objectives

Students undergoing this course are expected to:

- Prepare drawings for various mechanical components using any commercially available 3D modeling software's
- Develop a thorough understanding of the Computer Aided Finite Element Analysis packages with an ability to effectively use the tools of the analysis for solving practical problems arising in engineering design

5. Course Outcomes

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

CO Nos.	Course Outcomes	Level of learning domain (Based on revised Bloom's)
CO1	Describe the basics of FEA, Discretization Techniques	K2, S3
CO2	Prepare the Part models	K2, S3
CO3	Utilize the FEA for Geometric modelling and Importing	K3, S3
CO4	Apply the FEA modules in 1D and 2D Analysis	K4, S3
CO5	Apply the FEA modules in 3D Analysis	K4, S3

(K3-Apply)

6. Correlation of COs with Programme Outcomes

COs	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
CO1	H	H	M		M							M	M	H
CO2	H	H	M		M							M	M	H
CO3	H	H	M		M							M	M	H
CO4	H	H	M		M							M	M	H
CO5	H	H	M		M							M	M	H

H- High; M-Medium; L-Low

7. Course Content

UNIT I Introduction to FEA 3 + 6

Basics of various engineering topics like Static, Quasi Static, Dynamic, Linear & Non-Linear Engineering Problems, Types of Non Linearities, Rigid Body Dynamics, Multi Body Dynamics Basics, Finite Element Methods (FEM) & Finite Element Analysis (FEA)

Experiments: Common Steps to solve engineering problems using FEA.

UNIT II Finite Element Analysis Work Bench 3 + 6

Fundamentals of FEA Software Package, Design Modeller in Workbench.

Experiments: Key points, Lines, Surfaces and Solids.

UNIT III Geometric Modeling 3 + 6

Geometry Import from any CAD software, File Management, Geometric Modeling Tools using work bench

Experiments: Importing CAD Drawings

UNIT IV Meshing 3 + 6

1D & 2D Meshing using Work Bench with ALL Element Types, 3D Meshing using Work Bench with ALL Element Types, Element Quality Check against set criteria and Refining Mesh Quality, Auto meshing and Manual Meshing Tools Lab Exercises, Assigning Material Properties, Constraints, Loads

Experiments: 2D and 3D Analysis of Structural Components.

UNIT V Solver 3 + 6

Structural Static Linear & Non-Linear Analysis using Work Bench, Structural Dynamics Analysis (Modal Analysis & Transient),

Experiments: Thermal Analysis, Results review & preparation of Analysis Reports. (Post Processing), Analysis Report Preparation.

TOTAL: 45 periods

8. Text Books

1. David V.Hutton, "Fundamentals of Finite Element Analysis", Tata McGraw-Hill Edition, 2014

9. References

1. Huei-Huang Lee "Finite Element Simulations with ANSYS Workbench 17 "SDC Publications, 2018.

10. Revised Bloom's based Assessment Pattern

Revised Bloom's Category	Internal		University Examination %
	Model Test- I %	Model Test II%	
Remember			10
Understand	15	15	15
Apply	85	85	75
Analyse			
Evaluate			
Create			

Allied Electives

Allied Electives						
Sl. No.	**Code**	**Course**	**L**	**T**	**P**	**C**
1	1153ME101	Industrial Management	3	0	0	3
2	1153ME102	MEMS and Nano Technology	3	0	0	3
3	1153ME103	Corrosion and Surface Engineering	3	0	0	3
4	1153ME104	Composites and Polymers	3	0	0	3
5	1153ME105	Facility Layout and Material Handling	3	0	0	3
6	1153ME106	Maintenance Engineering and Condition Monitoring	3	0	0	3
7	1153ME108	3D Printing and Tooling	3	0	0	3
8	1153ME201	Project Based 3D Printing	3	2	4	6

COURSE CODE	INDUSTRIAL MANAGEMENT	L	T	P	C
1153ME101		3	0	0	3

1. Preamble

This course makes an attempt to bring students in direct contact with the working environment of an industry. It empowers the students to amalgamate their knowledge of production, process planning & control, maintenance and system analysis.

2. Prerequisite

Nil

3. Links to other courses

Operation Planning & control

4. Course Educational Objectives

Students undergoing this course are expected to

- Be familiar with fundamentals of various science and technological subjects and thus acquire the capability to applying them.
- Equip knowledge and skills necessary for entry-level placement in MNC's.
- Develop capacity to understand professional and ethical responsibility and to display skills
- Required for continuous and lifelong learning and up- gradation.

5. Course Outcomes

The students would be benefitted with the following outcomes:

CO Nos.	Course Outcomes	Level of learning domain (Based on revised Bloom's)
CO1	Understand about various production system and various layouts	K2
CO2	Describe about Process Planning and Control.	K2
CO3	Discuss on various types of method study and work measurement.	K2
CO4	Solve inventory control problems using various models	K2
CO5	Explain the concept of system analysis and maintenance.	K2

(K2 – Comprehend)

6. Correlation of COs with Programme Outcomes

Cos	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
CO1	M											L	M	
CO2	M											L	M	
CO3	M				L							L	M	
CO4	M											L	M	
CO5	M						L					L	M	

H- High; M-Medium; L-Low

7. Course Content

UNIT- I PRODUCTION SYSTEM L–9

Industrial engineering - Concept, History and development, Applications, Roles of Industrial engineer.Production management, Industrial engineering versus production management, Operations Management.Production system – Analysis, Input output model, Productivity, Factors affecting productivity. Plant layout, Process layout, Product layout, Combination layout, fixed position layout, Flow pattern, and Workstation design

UNIT- II PROCESS PLANNING AND CONTROL L-9

Process planning – definition, procedure, Process selection, Machine capacity, process sheet, process analysis, process chart – symbols, outline process chart, flow process chart. Group technology – functional and group layout, classification and coding system, formation of component family.Production planning, economic batch quantity, loading, scheduling. Production control – dispatching, routing. Progress control – bar, curve, gantt chart, route & schedule chart, line of balance

UNIT III WORK STUDY L-9

Work study – definition, need, advantages, objectives of method study and work measurement, method study procedure, flow diagram, string diagram, multiple activity chart, operation analysis, analysis of motion, principles of motion economy, design of work place layout & ergonomics, therbligs, SIMO chart, stop watch procedure, micro & macro motion study. Predetermined motion time system, work sampling – principle, procedure.

UNIT –IV INVENTORY MANAGEMENT L-9

Inventory – control, classification, management, objectives, functions. Economic order quantity, Inventory models, ABC analysis, Material Requirement Planning(MRPI), Manufacturing Resource Planning(MRP II), Operating cycle, Just in Time manufacturing system, KANBAN technique, lean manufacturing, Supply chain management. Material handling – functions, principles, Engineering and economic factors, Material handling equipment – selection, maintenance, types.

UNIT- V SYSTEM ANALYSIS AND MAINTENANCE L-9

System concept - system analysis, systems engineering, techniques, applications.Value analysis – aim, technique, procedure, advantages, value engineering, value control, types of values.Re-engineering, Business process re-engineering.Plant maintenance – objectives, importance, maintenance engineer – duties, functions and responsibilities. Types – breakdown, scheduled, preventive, predictive - seminar

TOTAL : 45 periods

8. Text Books

1. O. P. Khanna, *Industrial Engineering and Management*, Dhanpat Rai and Sons, New Delhi, 2008
2. Hamdy M. Taha, *Operations Research, an Introduction*, McMillan Co.,2008

9. References

1. J. A. Tompkins and J. A. White, Facilities planning, John Wiley, 2010.
2. Benjamin W. Neibel, Motion and time study, Richard .D .Irwin Inc., 2006.
3. Lee J. Krajewski, Larry P.Ritaman, Operations Management , Addison Wesley,2007.
4. Ravi Shankar, Industrial Engineering and Management, Golgotia Publications Pvt Ltd, New Delhi, 2009.

10. Revised Bloom's based Assessment Pattern

Revised Bloom's Category	Internal				University Examination %
	Unit Test- I %	Mid Term Test I %	Unit Test- II %	Mid Term Test II %	
Remember	30	20	30	20	20
Understand	70	50	70	50	50
Apply		30		30	30
Analyse					
Evaluate					
Create					

Revised Bloom's Category	Assignments	
	1 (CO1 &CO2) (Max marks in %)	2 (CO3&CO4) (Max marks in %)
Remember	**30**	**20**
Understand	**70**	**80**
Apply		
Analyze		
Evaluate		
Create		

COURSE CODE	MEMS AND NANO TECHNOLOGY	L	T	P	C
1153ME102		3	0	0	3

1. Course Content

UNIT I INTRODUCTION TO MEMS **9**

Overview - Definition, scaling laws, multi disciplinary nature of MEMS; working principle - actuation techniques, types of microactuators; fabrication - substrates, lithography, CVD, PVD, ion implantation, diffusion; application of MEMS in various industries.

UNIT II INTRODUCTION TO NANOMATERIALS **9**

Amorphous, Crystalline, microcrystalline, quasicrystalline and nanocrystalline materials- historical development of nanomaterials – Nanomaterials classification (Gleiter's Classification) – properly changes done to size effects, Hall – petch, inverse Hall- petch effects - polymeric nanostructures.

UNIT III ZERO DIMENSIONAL NANOMATERIALS **9**

Nanoparticles – Properties – Processing – Liquid state processing - Sol-gel process, wet chemical synthesis – Vapour state processing , Aerosol processing, solid state processing – mechanical, mechanochemical synthesis – Application of nanoparticle. Quantum Dots – Quantum confinement – Pauli's Exclusion Principle – Processing – Optical lithography – MOCVD – Droplet epitaxy - Applications.

UNIT IV ONE DIMENSIONAL NANOMATERIALS **9**

Carbon nanotubes – Old and new forms of carbon – Structure of CNT and classification – Processing – Solid carbon based production techniques – Gaseous carbon based production technique - growth mechanisms – Applications. Nanowire – processing – Laser ablation – Oxide assisted growth – carbo thermal reactions – Thermal evaporation – Temperature based synthesis – Electro spinning – Vapour–Solid growth (VS growth) - vapour – liquid – solid growth (VLS technique) – Applications.

UNIT V CHARACTERIZATION OF NANOMATERIALS **9**

Nano indentation – Types of nanoindenter – Force actuation-Displacement measurement- factors affectingnanoindentation- Atomic Force Microscope (AFM) – Scanning Tunneling Microscope (STM) – Electrostatic Force Mode (EFM) – Magnetic Force Mode (MFM) – Scanning Electron Microscope (SEM) – Transmission Electron Microscope (TEM).

TOTAL: 45 periods

2.TEXT BOOKS:

1. Carl C. Koch (ed.), "Nanostructured Materials", Processing, Properties and Potential Applications, Noyes Publications, Norwich, New York, U.S.A.
2. Bhusan, Bharat (Ed), "Springer Handbook of Nanotechnology", 2nd Edition, 2007.

3.REFERENCES:

1. Mark Ratner and Daniel Ratner, "Nano Technology", Pearson Education, New Delhi, 2003.
2. Charles P. Poole Jr., Frank J. Ownes, 'Introduction to Nanotechnology", Wiley Interscience, 2003.
3. G. Wilde, "Nanostructured Materials', Elsevier, 2008.
4. Bamberg, D., Grundman, M. and Ledentsov, N.N., "Quantum Dot Heterostructures", Wiley, 1999.
5. G Timp (ed), "Nanotechnology", AIP press/Springer, 1999.

6. K.A. Padmanabhan and S. BalasivanandhaPrabu, 'On the Origins of Conflict in the Experimental Results Concerning the Mechanical Properties of Ultra-Fine Grained and Nanostructured Materials: Effects of Processing Routes and Experimental Conditions', Adv.Mech.Properties and Deform. Mechanism of Bulk Nanostr.Mat, Trans Tech Publication,

4. Correlation Of COs With Programme Outcomes

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
CO	H				L		L						M	
CO	H				L		L						M	
CO	H				L		L						M	
CO	H				L		L						M	
CO	H				L		L						M	

5. Revised Bloom's based Assessment Pattern:

Revised Bloom's Category	Internal				University Examination %
	Unit Test- I %	Mid Term Test I %	Unit Test- II %	Mid Term Test II %	
Remember	40	40	20	20	20
Understand	60	40	20	20	50
Apply		20	40	40	20
Analyse			20	20	10
Evaluate					
Create					

Revised Bloom's Category	**Assignments**	
	1 (CO1 &CO2) (Max marks in %)	**2 (CO3&CO4) (Max marks in %)**
Remember		
Understand	**10**	
Apply	**70**	**70**
Analyze	**20**	**30**
Evaluate		
Create		

COURSE CODE	CORROSION AND SURFACE ENGINEERING	L	T	P	C
1153ME103		3	0	0	3

1. Preamble
This course provides general issues relating to Corrosion and Prevention of corrosion.

2. Pre-Requisites
Engineering Materials and Metallurgy

3. Links to Other Courses
Engineering Materials and Metallurgy

4. Course Educational Objectives
Students undergoing this course will be able to understand

- Different types of corrosion on engineering structures and their impacts.
- Correlate materials theory with practical applications.
- About design and selection of materials to prevent different types of corrosion.
- Behavior of materials
- Surface coating process

5. Course Outcomes
Upon the successful completion of the course, students will be able to

CO Nos.	Course Outcomes	Level of learning domain (Based on revised Bloom's)
CO1	Explaining various mechanisms and corrosion types	K2
CO2	Explain the various testing and corrosion prevention.	K2
CO3	Describe about plastics	K2
CO4	Explain about the characteristics of super alloys.	K2
CO5	Describe the concept about ceramics.	K2

(K2 –Understand)

6. Correlation Of COs With Programme Outcomes

COs	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
CO1	H						L					L	M	
CO2	H						L					L	M	
CO3	H						L					L	M	
CO4	H				L		L					L	M	
CO5	H				L		L					L	M	

H- High; M-Medium; L-Low

7. Course Content

UNIT 1 MECHANISMS AND TYPES OF CORROSION L - 9
Principles of direct and Electro chemical corrosion, Hydrogen evolution and oxygen absorption mechanisms - Galvanic corrosion, Galvanic series -Specific types of corrosion such as, Uniform, pitting, Intergranular, Cavitations, Crevice, Fretting, Erosion and Stress corrosion - Factors influencing corrosion.

UNIT 2 TESTING AND PREVENTION OF CORROSION L - 9
Corrosion testing techniques and procedures - Prevention of corrosion -Design against corrosion – Modification of corrosive environment - Inhibitors - Catholic protection - Protective surface coatings.

UNIT 3 CORROSION BEHAVIOUR OF MATERIALS L - 9
Corrosion of Steels, Stainless steels, Aluminum alloys, Copper alloys, Nickel and Titanium alloys - Corrosion of polymers, Ceramics and composite materials

UNIT 4 SURFACE ENGINEERING FOR WEAR AND CORROSION RESISTANCE L - 9
Diffusion coatings - Electro and Electro less plating - Hot dip coating - Hard facing - Metal spraying, Flame and Arc processes - Conversion coatings -Selection of coating for wear and corrosion resistance.

UNIT 5 THIN LAYER ENGINEERING PROCESSES L - 9
Laser and Electron Beam hardening - Effect of process variables such as power and scan speed – Physical vapour deposition, Thermal evaporation, Arc vaporisation, Sputtering, Ion plating - Chemical vapour deposition -Coating of tools, TiC, TiN, Al_2O_3 and Diamond coating properties and applications of thin coatings.

TOTAL: 45 PERIODS

8. Text Books

1. Fontana, G., " Corrosion Engineering ", McGraw-Hill, 1985.
2. Schweitzer P.A., " Corrosion Engineering Hand Book ", 3rd Edition, Marcel Decker, 1996.

9. References

1. Winston Revie, R,Uhlig's " corrosion, Hand Book ", 2nd Edition, JohnWiley, 2000.
2. Kammeth G. Budinski, " Surface Engineering for Wear resistance ", Prentice Hall, 1988.
3. Metals Handbook, Vol.5, " Surface Engineering ", ASM International, 1996.

10. Revised Bloom's based Assessment Pattern

Revised Bloom's Category	Internal				University Examination %
	Unit Test- I %	Mid Term Test I %	Unit Test- II %	Mid Term Test II %	
Remember	40	40	20	20	20
Understand	60	40	20	20	50
Apply		20	40	40	20
Analyse			20	20	10
Evaluate					
Create					

Revised Bloom's Category	Assignments	
	1 (CO1 &CO2) (Max marks in %)	2 (CO3&CO4) (Max marks in %)
Remember		
Understand	**10**	
Apply	**70**	**70**
Analyze	**20**	**30**
Evaluate		
Create		

COURSE CODE	COMPOSITE MATERIALS AND POLYMERS	L	T	P	C
1153ME104		**3**	**0**	**0**	**3**

1. Preamble

The course provides an introduction to the need, properties, application, and manufacturing processes of various composite materials.

2. Prerequisite

Engineering Materials and Metallurgy

3. Links to other courses

Composites & Nano Materials
Composite Materials and Mechanics

4. Course Educational Objectives

Students undergoing this course are expected to

- Understand the need of composites in structural and non-stuctural applications
- Know the, properties and application of different types of reinforcements and matrices
- Understand the fabrication techniques involved in the polymer, metal, and ceramic matrix composites

5. Course Outcomes

The students would be benefitted with the following outcomes:

CO Nos.	Course Outcomes	Level of learning domain (Based on revised Bloom's)
CO1	Describes various types of composite materials and their applications.	K2
CO2	Describe various manufacturing processes of Polymer Matrix Composite	K2
CO3	Apply the principles of mechanics for Metal Matrix Composites	K3
CO4	Explain the need of Ceramic Matrix Composites and their practical applications	K2
CO5	Describe the advances in composite materials	K2

(K2 – Comprehend, K3 – Apply)

6. Correlation of COs with Programme Outcomes

COs	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
CO1	H	L	L										M	L
CO2	H	L	L										M	L
CO3	H	L	L										M	L
CO4	H	L	L										M	L
CO5	H	L	L										M	L

H- High; M-Medium; L-Low

7. Course Content

UNIT I- INTRODUCTION TO COMPOSITES **L-9**

Fundamentals of composites, characteristics, need for composites, Enhancement of properties, Reinforcements - glass fibers, boron fibers, carbon fibers, organic fibers, aramid fibers, ceramic fibers, oxide and nonoxide fibers, Forms of reinforcements - Roving , Woven fabrics Non woven, random mats, whiskers, Matrix materials – Polymers - Thermosetting resins, thermoplastic resins , Metals, Ceramic materials

UNIT II- POLYMER MATRIX COMPOSITES **L-9**

Processing of polymer matrix composites- hand lay-up, Spray lay-up processes, Compression molding- SMC Reinforced reaction injection molding, Resin transfer molding, Pultrusion, Filament winding, Applications of polymer matrix composites.

UNIT III-METAL MATRIX COMPOSITES **L-9**

Characteristics of MMCs, Various types of Metal matrix composites, Advantages and limitations of MMCs, Effect of reinforcements on properties – Volume fraction – Rule of mixtures, Processing of MMCs - Liquid state processing- stir casting, squeeze casting, infiltration, solid state processing - Powder metallurgy, diffusion bonding, In situ processes, applications of MMCs

UNIT IV- CERAMIC MATRIX COMPOSITES **L-9**

Need for CMCs, Processing of CMCs- cold pressing and sintering, hot pressing, infiltration, chemical vapor deposition and chemical vapor impregnation, sol-gel and polymer pyrolysis, high temperature synthesis properties and applications of CMC.

UNIT V- ADVANCES IN COMPOSITES **L-9**

Carbon fiber composites – properties, chemical vapor deposition– oxidative etching, liquid phase oxidation carbon/carbon composites - properties and applications of C/C Composites, multifilament superconducting composites

TOTAL = 45 periods

8. Text Books

1. Ronald Gibson, Principles of Composite Material Mechanics, Tata McGraw Hill, 2013.
2. P.K.Mallicak, Fiber-reinforced composites, Monal Deklar Inc., New York, 2013.

9. References

1. F.L.Matthews & R.D.Rawlings, Composite Materials, Engneering & Sciences, Chapman & Hall, London, 2001.
2. Micael hyer, Stress Analysis of Fiber - Reinforced Composite Materials, Tata McGraw Hill, 2006.
3. Ronald Gibson, Principles of Composite Material Mechanics, Tata McGraw Hill, 2001.
4. Sanjay.K.Majumdar, Composites Manufacturing, Kindle edition, CRC press, 2001.

10. Revised Bloom's based Assessment Pattern

Revised Bloom's Category	**Internal**				**University Examination %**
	Unit Test- I %	**Mid Term Test I %**	**Unit Test- II %**	**Mid Term Test II %**	
Remember	40	40	10	20	30
Understand	60	60	60	60	60
Apply			30	20	10
Analyse					
Evaluate					
Create					

Revised Bloom's Category	**Assignments**	
	1 (CO1 &CO2) (Max marks in %)	**2 (CO3&CO4) (Max marks in %)**
Remember	30	10
Understand	70	80
Apply		10
Analyze		
Evaluate		
Create		

COURSE CODE	FACILITY LAYOUT AND MATERIAL HANDLING	L	T	P	C
1153ME105		3	0	0	3

1. Preamble
To understand basic layout for industries, the usage of material handling equipments for industrial layout and gain knowledge on industrial buildings and utilities

2. Pre-Requisite
NIL

3. Link to Other Courses
Project work

4. Course Educational Objectives
Students undergoing this course are expected to
- Understand the concept of facility location and design
- Understand the concept of computerized layout planning.
- Know about the various material handling equipment and utilities of the industries.

5. Course Outcomes
Upon the successful completion of the course, learners will be able to

CO Nos.	Course Outcomes	Level of learning domain (Based on revised Bloom's)
CO1	Demonstrate the knowledge about types of facility location problems and various models.	K2
CO2	Design the plant layout	K3
CO3	Demonstrate the knowledge about computerized layout planning and line balancing techniques.	K2
CO4	Know the different types of material handling equipment and packing systems.	K2
CO5	Know the effective selection and contribution of utilities for buildings.	K2

(K2- Understand, K3-Apply)

6. Correlation of Cos with Programme Outcomes

COs	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
CO1	H						L				L	L	M	L
CO2	H						L				L	L	M	L
CO3	H				M		L				L	L	M	L
CO4	H						L				L	L	M	L
CO5	H						L				L	L	M	L

H -High; M-Medium: L-Low

7. Course Content

UNIT I FACILITY LOCATION L - 9
Introduction , Factors affecting location decisions , Location theory , Qualitative models , Semi-Quantitative models -Composite measure , Brown & Gibbs model , Break-Even analysis model, Single facility location problems – Median model, Gravity location model, Mini-Max model, Multi-facility location problems, Network and warehouse location problems.

UNIT II FACILITY LAYOUT DESIGN L - 9
Need for layout study , Factors influencing plant layout ,Objectives of a good facility layout, Classification of layout , Layout procedure – Nadler's ideal system approach, Immer's basic steps, Apple's layout procedure, Reed's layout procedure –Layout planning – Systematic layout planning – Information gathering, flow analysis and activity analysis, relationship diagram, space requirements and availability, designing the layout.

UNIT III COMPUTERISED LAYOUT PLANNING L - 9
Concepts, Designing process layout –CRAFT, ALDEP, CORELAP – Trends in computerized layout, Algorithms and models for Group Technology - ROC and Bond Energy Algorithms.
Line balancing - Objectives, Line balancing techniques – Largest Candidate rule Kilbridge and Wester method- RPW method- COMSOAL.

UNIT IV MATERIAL HANDLING AND PACKAGING L - 9
Objectives and benefits of material handling, Relationship between layout and material handling, Principles of material handling, Unit load concept, Classification of material handling equipments, Equipment selection, Packing and storage of materials - layout for packaging - packaging machinery - wrapping and packing of materials, cushion materials.

UNIT IV: UTILITIES L - 9
Industrial buildings and utilities - Centralized electrical pneumatic water line systems.Types of building, lighting heating, air- conditioning and ventilation utilities. Planning and maintenance, waste handling statutory requirements. Utilities planning

TOTAL: 45 PERIODS

8. Text Books

1. James, M. Apple., „Plant Layout and Material Handling‟, John Wiley & Sons, INC, 1977.
2. Rudenko. N., "Materials handling equipment", ELnvee Publishers, 1970.
3. Francis, R.L., and White, J.A. Facilities layout and Location, Prentice Hall of India, 2002.

9. References

1. James, M. Moore, „Plant Layout and Design‟, Macmillan Company, NY, 1963
2. Muther, R., „Practical Plant Layout‟, Mc Graw Hill Book Company, NY, 1955
3. Tompkins, White et al., Facilities planning, John Wiley & Sons, inc. 2003.
4. James, Apple, Material Handling System design, Ronald Press, 1980.
5. Krajewski, J. and Ritzman, Operations Management – Strategy and Analysis, Addison – Wesley
publishing company inc. 5th Edition, 1999.
6.Pannerselvam,R. Production & operations Management, PHI, 2nd Edition, 2005

10. Revised Bloom's based Assessment Pattern

Revised Bloom's Category	Internal				University Examination %
	Unit Test – I %	Mid Term Test - I %	Unit Test – II %	Mid Term Test - II %	
Remember	30	20	30	20	20
Understand	70	40	70	40	40
Apply		40		40	40
Analyse					
Evaluate					
Create					

Revised Bloom's Category	Assignments	
	1 (COs addressed) (max marks in %)	2 (COs addressed) (max marks in %)
Remember		
Understand	**20**	**10**
Apply	**40**	**40**
Analyze	**40**	**50**
Evaluate		
Create		

COURSE CODE 1153ME106	MAINTENANCE ENGINEERING AND CONDITION MONITORING	L	T	P	C
		3	0	0	3

1. Preamble

To provide knowledge and understanding of maintenance functions in Industries and also to introduce various concepts for condition monitoring of machineries for effective use of resources.

2. Prerequisite

Basic Mechanical Engineering

3. Links to other courses

Project Work

4. Course Educational Objectives

Students completing this course are expected

- To understand the importance of maintenance function, costs involved and benefits.
- To impart knowledge on wear and its effects
- To assess condition monitoring techniques and their advantages for effective usage

5. Course Outcomes

Upon the successful completion of this course, the learners will be able to

CO Nos.	Course Outcomes	Level of learning domain (Based on revised Bloom's)
CO1	Understand and remember various types of maintenance functions.	K2
CO2	Understand and recall causes of wear and their effects.	K2
CO3	Use various networking models for the given distance network.	K2
CO4	Understand and recall principles of condition monitoring.	K2
CO5	Work with the condition monitoring equipments.	K2

(K3-Apply)

6. Correlation of Cos with Programme Outcomes

COs	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
CO1	H						L					L	M	
CO2	H						L					L	M	
CO3	H						L					L	M	
CO4	H						L					L	M	
CO5	H						L					L	M	

H-High; M-Medium: L-Low

7. Course Content

UNIT I FUNDAMENTALS OF MAINTENANCE FUNCTION L- 9
Introduction – Maintenance function and its importance in material and energy conservation – inventory control, productivity, safety , pollution control etc. Safety regulations , pollution problems ,human reliability , Total productive maintenance (TPM) – environmental issues in maintenance – ISO 9000.

UNIT II MAINTANENCE MANAGEMENT L- 9
Types of maintenance strategies , planned and unplanned maintenance, breakdown, preventive and predictive maintenance their comparison , Advantages and disadvantages.Limitation , computer aided maintenance , maintenance scheduling , spare parts management , inventory control, organization of maintenance department .

UNIT III TRIBOLOGY IN MAINTANENCE L- 9
Meaning – friction wear and lubrication, friction and wear mechanisms, prevention of wear, types of lubrication mechanism, lubrication process. Lubricants – types, general and special purpose, additives, testing of lubricants , degradation of lubricants ,seal and packaging.

UNIT IV CONDITION MONITORING L- 9
Condition based maintenance, Signature analysis, oil analysis, vibration ,noise and thermal signatures, online and offline techniques , instrumentation and equipment used in machine health monitoring , instrumentation in maintenance signal processing , data acquisition ,analysis and application of intelligent systems , database design .

UNIT V CONDITION MONITORING EQUIPMENTS L- 9
General equipment's and tools, special equipment's to monitor conditions of general machineries such as IC engines, compressors , High torque motors , generators , and other machineries. Automated condition monitoring for automobile systems , aero engines, Boilers , buildings and structural systems.

TOTAL: 45 Periods

8. Text Books

1. Gopalakrishnan , "Maintenance and spare parts Management ", 9th Edition, Prentice Hall of India, New Delhi, 2013
2. Kiran , "Maintenance Management ", PHI, , 2014.

9. References

1. Higgins , Maintenance Engineering , 8th Edition, McGraw Hill, 2010.
2. S.K.Shrivastav, Industrial Maintenance Management , S.K Chand Publishers , 2013
3. CNR Rao, "Handbook of condition monitoring ", Prentice hall India Publishers , 2012

10. Revised Bloom's based Assessment Pattern

Revised Bloom's Category	Internal				University Examination %
	Unit Test – I %	Mid Term Test - I %	Unit Test – II %	Mid Term Test - II %	
Remember	30	20	30	20	20
Understand	70	40	70	40	40
Apply		40		40	40
Analyse					
Evaluate					
Create					

Revised Bloom's Category	Assignments	
	1 (COs addressed) (max marks in %)	2 (COs addressed) (max marks in %)
Remember		
Understand	**20**	**10**
Apply	**40**	**40**
Analyze	**40**	**50**
Evaluate		
Create		

COURSE CODE	3D PRINTING AND TOOLING	L	T	P	C
1153ME108		3	0	0	3

1. Preamble
This course addresses additive manufacturing principles, variety and its concept, scope of additive manufacturing and areas of application.

2. Prerequisite
NIL

3. Links to other courses
Project Work

4. Course Educational Objectives
Students undergoing this course are expected to
- Know the principles, methods, areas of usage, possibilities and limitations as well as environmental effects of the additive manufacturing technologies
- Be familiar with the characteristics of various materials that are used in additive manufacturing.

5. Course Outcomes
Upon the successful completion of the course, learners will be able to

CO Nos.	Course Outcomes	Level of learning domain (Based on revised Bloom's)
CO1	Describe the differences and of the application of a range of additive manufacturing processes	K2
CO2	Select and use correct CAD formats in the manufacture of a 3D printed part.	K2
CO3	Understand the operating principles, capabilities, and limitations of liquid and solid based additive manufacturing system, including fused deposition modeling and stereolithography.	K2
CO4	Appreciate the operating principles, capabilities and limitations of powder based additive manufacturing system, including 3D printing and laser sintering.	K2
CO5	Describe the important process parameters for bio-manufacturing and determine the suitable additive technique for bio-manufacturing.	K2

(K2 – Understand)

6. Correlation of CO's with Programme Outcomes

Cos	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
CO1	M				M		M					L	L	
CO2	M				M		M					L	L	
CO3	M				M		M					L	L	
CO4	M				M		M					L	L	
CO5	M				M		M					L	L	

H- High; M-Medium; L-Low

7. Course Content

UNIT I-INTRODUCTION L-9

Overview – History – Need-Classification –Additive manufacturing Technology in product development–Additive manufacturing - Materials for Additive Manufacturing.

UNIT II-CAD & REVERSE ENGINEERING L-9

Basic Concept –3D scanning- Digitization techniques – Model Reconstruction – Data Processing for Reverse Engineering- Additive Manufacturing Technology: CAD model preparation – Part Orientation and support generation – Model Slicing –Tool path Generation.

UNIT III-LIQUID BASED AND SOLID BASED ADDITIVE MANUFACTURING SYSTEMS L-9

Classification – Liquid based system – Stereo lithography Apparatus (SLA)- Principle, process, advantages and applications – Solid based system –Fused Deposition Modeling – Principle, process, advantages.

UNIT IV-LASER BASED ADDITIVE MANUFACTURING SYSTEMS L-9

Selective Laser Sintering – Principles of SLS process – Process, advantages and applications, Three Dimensional Printing – Principle, process, advantages - Laser Engineered Net Shaping (LENS)

UNIT V- RAPID TOOLING AND APPLICATIONS OF ADDITIVE MANUFACTURING. L-9

Principles and typical process for quick batch production of plastic and metal parts through quick tooling —Applications of Additive manufacturing in Aerospace, Automotive, Manufacturing and Architectural Engineering.

TOTAL: 45 PERIODS

8. Text Books

1. Chua C.K., Leong K.F., and Lim C.S., "Rapid prototyping: Principles and applications", Third Edition, World Scientific Publishers, 2010.
2. Gebhardt A., "Rapid prototyping", Hanser Gardener Publications, 2003.

9. References

1. Liou L.W. and Liou F.W., "Rapid Prototyping and Engineering applications: A tool box for prototype development", CRC Press, 2007.
   Kamrani A.K. and Nasr E.A., "Rapid Prototyping: Theory and practice", Springer, 2006.
2. Hilton P.D. and Jacobs P.F., "Rapid Tooling: Technologies and Industrial Applications", CRC press, 2000.
3. Dougles Bryden, "CAD and Prototyping for Product Design", 2014

10. Revised Bloom's based Assessment Pattern

Revised Bloom's Category	**Internal**				**University Examination %**
	Unit Test 1 %	**Mid Term Test 1 %**	**Unit Test 2 %**	**Mid Term Test 2 %**	
Remember					
Understand	70	70	70	70	70
Apply	30	30	30	30	30
Analyse					
Evaluate					
Create					

Revised Bloom's Category	**Assignments**	
	1 (COs addressed CO1,CO2) (max marks in %)	**2 (COs addressed CO3,CO4) (max marks in %)**
Remember	**20**	**10**
Understand	**40**	**40**
Apply	**40**	**50**
Analyse		
Evaluate		
Create		

COURSE CODE	PROJECT BASED 3D PRINITING	L	T	P	C
1153ME201		3	0	6	6

1. Preamble

This course addresses the principles behind additive manufacturing techniques, varieties and its concept, scope and potential areas of application. This course will demonstrate how to use 3D printing software to create digital design that can be turned into physical objects. This course is hands on in nature and will provide step-by-step instruction to guide the students through two softwares cero and flash print.

2. Prerequisite

NIL

3. Links to other courses:

Project Work

4. Course Educational Objectives

Students undergoing this course are expected to:

- Know the principles, methods, areas of usage, possibilities and limitations and environmental effects of the additive manufacturing technologies.
- Be familiar with the characteristics of various materials used in additive manufacturing.
- Use 3D software to design a wide variety of objects for both personal and professional use.

5. Course Outcomes

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

CO Nos.	Course Outcomes	Level of learning domain (Based on revised Bloom's)
CO1	Describe the differences and the application of a range of additive manufacturing processes	K2
CO2	Summarize the operating principles, capabilities, and limitations of additive manufacturing system.	K2
CO3	Choose the use of correct CAD model, processing technique and its use in 3D printing.	K3
CO4	Judge the effect of 3D Printing parameters on the quality of the printed part.	K3
CO5	Integrate the techniques learnt, skills obtained and prepare the report of their learning.	K3

(K3-Apply)

6. Correlation of COs with Programme Outcomes

COs	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
CO1	M	M										L	M	M
CO2	H	H										L	H	H
CO3	H	H	L		L		L					L	H	H
CO4	H	H	H	M	M		L		M	M		L	H	H
CO5	H	H	H	M	M	M	L		M	H	H	H	H	H

H- High; M-Medium; L-Low

7. Course Content

UNIT I INTRODUCTION TO 3D PRINTING L-15

Overview-History-Need-Additive Manufacturing (AM) in product development-Generalized AM process Chain-Design for AM-Materials for AM Technology- Applications of AM in aerospace, automotive & medical- Business opportunities & future directions.

UNIT II CLASSIFICATION OF AM PROCESS L-15

Classification of AM as per ASTM F42-Principle, process, advantages, application - Vat Photo polymerisation (Stereo lithography), Powder bed fusion processes (Selective Laser Sintering), Extrusion based system (Fused Deposition Modeling), Material Jetting (Inkjet Printing), Binder Jetting, Sheet Lamination Process (Laminated Object Manufacturing), Directed Energy Deposition Process (Laser Engineered Net Shaping)- Guidelines for Process selection.

UNIT III CAD MODELLING AND DATA PROCESSING FOR 3D PRINTING L-15

Basic concept- Digitization techniques – Model Reconstruction – Data Processing: CAD model preparation, Data Requirements – Geometric modeling techniques: Wire frame, surface and solid modeling – Data formats - Data interfacing, Part orientation and support generation, Support structure, Model Slicing, Direct and Adaptive slicing, Tool path generation.

UNIT IV DESIGN AND PRINTING OF OBJECTS P-30

Introduction to modelling software, flash print software & FDM printer- Design & Printing of Solid features (Eg: Circle, Rectangle, Pyramid)- Design & Printing of a moderately complex geometry, 3D Scanning & Printing of Human hand.

UNIT V DESIGN PROJECT/VALIDATION P-60

Students will be given a design challenge during which they will come out with a valid design and 3D Print of a functional component. Students are expected to record a report about their work as well as the deliverables of the design challenge.

TOTAL: 45+90 periods

8. Text Books

1. Gibson, Rosen, Stucker, Additive Manufacturing Technologies: Rapid Prototyping to Direct Digital Manufacturing. Springer, 2015.
2. Chua C.K., Leong K.F., and Lim C.S., “Rapid prototyping: Principles and applications”, Third Edition, World Scientific Publishers, 2010.
3. Gebhardt A., “Rapid prototyping”, Hanser Gardener Publications, 2003.

9. References

1. Liou L.W. and Liou F.W., "Rapid Prototyping and Engineering applications: A tool box for prototype development", CRC Press, 2007.
2. Kamrani A.K. and Nasr E.A., "Rapid Prototyping: Theory and practice", Springer, 2006. 3. Hilton P.D. and Jacobs P.F., "Rapid Tooling: Technologies and Industrial Applications", CRC press, 2000.
3. DouglesBryden, "CAD and Protyping for Product Design", 2014

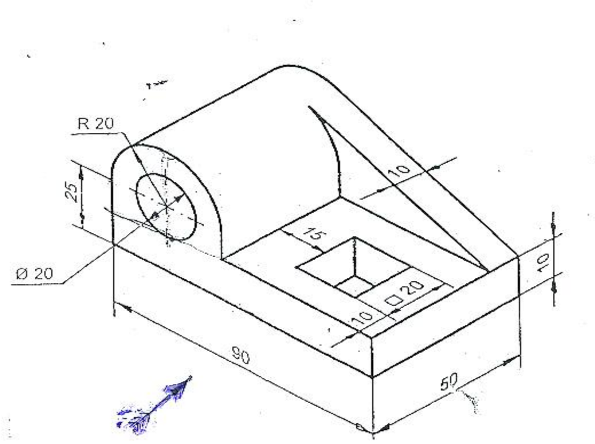
10. Revised Bloom's based Assessment Pattern

Revised Bloom's Category	Internal		University Examination %
	Model Test- I %	Model Test II%	
Remember			10
Understand	15	15	15
Apply	85	85	75
Analyse			
Evaluate			
Create			

Sample Assessment Questions:

UNIT-1	**Theory:** 1. Explain the role of additive manufacturing technology in product development. 2. Discus the various materials used in additive manufacturing. 3. Explain the application of additive manufacturing in aerospace, automotive, medical.
UNIT-2	**Theory:** 1. List out the classification of AM process as per ASTM F42. 2. Explain the principle & process of extrusion based system. 3. Discuss the guidelines to be followed while selecting an AM process.
UNIT-3	**Theory:** 1. Explain the various digitization techniques. 2. Write a short note on: a. Tool Path Generation b. Support structure c. Model slicing d. Path orientation & support generation 3. Discuss in detail about direct & adaptive slicing.
UNIT-4	**Theory:** 1. Explain the steps involved in design of bearing block.

BEARING BLOCK



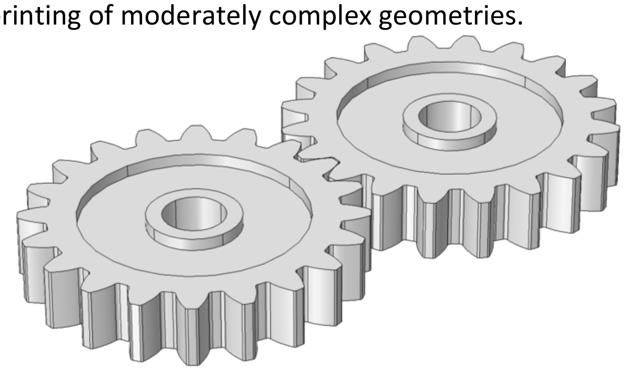
2. Discuss bout the factors influencing the quality of the printed part.
3. Explain the steps involved in 3D Printing.

Practical:

1. Introduction to cad modelling software. (creation of part using creo)
2. Introduction to FDM & Flash print.
3. Design & printing of simple geometric also verify effect of parameters.

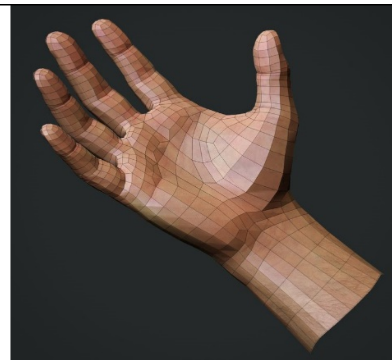
Input Parameters				**Output**		
Layer Thickness in “mm”	**Fill Density in %**	**Angle of Orientation in deg**	**Print Speed “mm/s”**	**Build Time**	**Materials Consumed in “m”**	**Surface roughness /strength**

4. Design & printing of moderately complex geometries.



Spur Gear

5. 3D Scanning & printing of human hand

<table>
<tr><td></td><td>
Scanned Human Hand</td></tr>
<tr><td>UNIT-5</td><td>Sample Project Titles
1. Design & Development of slider crank mechanism
2. Design & Development of prosthetic arm
3. Design & Development of biomimetic structure
4. Design & Development of drone/glider.</td></tr>
<tr><td colspan="2">Step 1: Identify a problem or an innovative idea.
Step 2: Designing the component as defined in the problem
Step 3: Printing of designed component
Step 4 : Assemble and test the component developed</td></tr>
</table>

Institute Electives

Institute Electives						
S.NO	**COURSE CODE**	**Course**	**L**	**T**	**P**	**C**
THEORY						
1	1154ME101	Integrated Product Development	3	0	0	3
2	1154ME102	IPR and Patent Rights	3	0	0	3
3	1154ME103	Product Design and Entrepreneurship	3	0	0	3
4	1154ME104	Optimization Technique	3	0	0	3
5	1154ME105	Industrial Safety, Health and Hazards	3	0	0	3
6	1154ME106	Industrial Robotics	3	0	0	3
7	1154ME107	Energy Conservation and Audit	3	0	0	3
8	1154ME108	Engineering Economics and Financial Accounting	3	0	0	3
9	1154ME109	Green Engineering and Sustainability	3	0	0	3
10	1154ME111	3D Printing	3	0	0	3
11	1154ME112	Energy Management	3	0	0	3
12	1154ME113	Solar Thermal Technology	3	0	0	3
13	1154ME301	Computer Aided Drawing Laboratory	0	0	2	1
14	1154ME114	Industrial Nanotechnology	3	0	0	3
15	1154ME201	Project Based Product Development	3	2	4	6

COURSECODE 1154ME101	INTEGRATED PRODUCT DEVELOPMENT	L	T	P	C
		3	0	0	3

1. Preamble
This course is designed to provide the knowledge about the concepts of various tools and approaches available for product development.

2. Prerequisite
Basic Mechanical Engineering.

3. Link to other Courses
Project Work

4. Course Educational Objectives
Students undergoing this course are expected to
- Understand the concepts of tools and techniques in the Integrated Product Development area of the Engineering Services industry.
- Relate the engineering topics into real world engineering applications.

5. Course Outcomes
Upon the successful completion of the course, learners will be able to

CO Nos.	Course Outcomes	Level of learning domain (Based on revised Bloom's)
CO1	Summarise the various trends affecting product decision	K2
CO2	Identify the requirements to create new product	K3
CO3	Compare different techniques involved in design creation and design testing	K2
CO4	Rephrase the methods of model creation and integration between software and hardware.	K2
CO5	Illustrate the need of end of life and patenting.	K2

(K1 – Remember; K2 – Understand; K3 – Apply ;)

6. Correlation of COs with Programme Outcomes

COs	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
CO1	H	L				L	L	L	L			L	H	L
CO2	H	L				L	L	L	L			L	H	L
CO3	H	L				L	L	L	L			L	H	L
CO4	H	L				L	L	L	L			L	H	L
CO5	H	L				L	L	L	L			L	H	L

H- High; M-Medium; L-Low

7. Course Content

UNIT I: FUNDAMENTALS OF PRODUCT DEVELOPMENT L-9

Global Trends Analysis and Product decision: Types of various trends affecting product decision - Social Trends-Technical Trends- Economic Trends- Environmental Trends- Political/ Policy Trends- PESTLE Analysis. Introduction to Product Development Methodologies and Management: Overview of Products and Services- Types of Product Development- Overview of Product Development methodologies - Product Life Cycle - Product Development Planning and Management.

UNIT II: REQUIREMENTS AND SYSTEM DESIGN L-9

Requirement Engineering: Types of Requirements- Requirement Engineering- Analysis -Traceability Matrix and Analysis- Requirement Management. System Design & Modeling: Introduction to System Modeling- introduction to System Optimization- System Specification-Sub-System Design- Interface Design.

UNIT III: DESIGN AND TESTING L-9

Conceptualization -Industrial Design and User Interface Design- Introduction to Concept generation Techniques-Concept Screening & Evaluation- Concept Design- S/W Architecture- Hardware Schematics and simulation-Detailed Design: Component Design and Verification- High Level Design/Low Level Design of S/W Programs- S/W Testing-Hardware Schematic- Component design- Layout and Hardware Testing.

UNIT IV: IMPLEMENTATION & INTEGRATION L-9

Prototyping: Types of Prototypes -Introduction to Rapid Prototyping and Rapid Manufacturing. System Integration- Testing- Certification and Documentation: Introduction to Manufacturing /Purchase and Assembly of Systems- Integration of Mechanical, Embedded and S/W systems- Introduction to Product verification and validation processes - Product Testing standards, Certification and Documentation.

UNIT V: SUSTENANCE ENGINEERING AND BUSINESS DYNAMICS L-9

Sustenance -Maintenance and Repair- Enhancements Product End of Life (EoL): Obsolescence Management-Configuration Management- EoL Disposal.

The Industry - Engineering Services Industry overview- Product development in Industry versus Academia The IPD Essentials- Introduction to vertical specific product development processes- Product development Trade-offs- Intellectual Property Rights and Confidentiality- Security and configuration management

TOTAL=45 periods

8. Text Books

1. NASSCOM student Handbook "Foundation Skills in Integrated Product Development".
2. Anita Goyal, Karl T Ulrich, Steven D Eppinger, “Product Design and Development “, 4th Edition, 2009, Tata McGraw-Hill Education, ISBN-10-007-14679-9

9. References

1. George E.Dieter, Linda C.Schmidt, "Engineering Design", McGraw-Hill International Edition, 4th Edition, 2009, ISBN 978-007-127189-9
2. Kevin Otto, Kristin Wood, "Product Design", Indian Reprint 2004, Pearson Education,ISBN. 9788177588217
3. Yousef Haik, T. M. M. Shahin, "Engineering Design Process", 2nd Edition Reprint, Cengage Learning, 2010, ISBN 0495668141
4. Clive L.Dym, Patrick Little, "Engineering Design: A Project-based Introduction", 3rd Edition, John Wiley & Sons, 2009, ISBN 978-0-470-22596-7
5. Product Design Techniques in Reverse Engineering and New Product Development, KEVIN OTTO & KRISTIN WOOD, Pearson Education (LPE), 2001.
6. The Management and control of Quality-6th edition-James R. Evens, William M Lindsay Pub:son south-western(www.swlearning.com)

10. Revised Bloom's based Assessment Pattern

Revised Bloom's Category	**Internal**				**University Examination %**
	Unit Test-I %	**Mid Term Test I %**	**Unit Test-II %**	**Mid Term Test II %**	
Remember	40	20	20	10	10
Understand	60	40	20	20	20
Apply		40	40	30	30
Analyse			20	40	40
Evaluate					
Create					

Revised Bloom's Category	**Assignments**	
	1(CO1 &CO2) (max marks in %)	**2(CO3&CO4) (max marks in %)**
Remember		
Understand		
Apply	60	40
Analyse	40	60
Evaluate		
Create		

COURSECODE 1154ME102	IPR AND PATENT RIGHTS	L	T	P	C
		3	0	0	3

1. Preamble

The course is designed to introduce fundamental aspects of Intellectual property Rights to students who are going to play a major role in development and management of innovative projects in industries.

2. Prerequisite

NIL

3. Link to other Courses:

Project Work

4. Course Educational Objectives

Students undergoing this course are expected to:

- Understand the concepts of all aspects of the IPR Acts.
- Relate the application of the legal concepts in Science, Engineering, Technology and Creative Design.

5. Course Outcomes

Upon the successful completion of the course, learners will be able to

CO Nos.	Course Outcomes	Level of learning domain (Based on revised Bloom's)
CO1	Understand the important of intellectual property rights	K2
CO2	Apply for the patents	K3
CO3	Understand and apply for the copyrights	K2
CO4	Understand the important of trademarks	K3
CO5	Appreciate the importance of IPR and its related issues	K2

(K3– APPLY)

6. Correlation of COs with Programme Outcomes

COs	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
CO1	L					L		L		L		L	L	L
CO2	L					L		L		L		L	L	L
CO3	L					L		L		L		L	L	L
CO4	L					L		L		L		L	L	L
CO5	L					L		L		L		L	L	L

H- High; M-Medium; L-Low

7. Course Content

UNIT I: INTRODUCTION TO IPR **L-9**
Introduction – Invention and Creativity – Intellectual Property (IP) – Importance – IPR in India and IPR abroad Protection of IPR – Basic types of property - Movable Property - Immovable Property - Intellectual Property.

UNIT II: PATENTS **L-9**
Patents - their definition – granting - infringement - searching & filing - Utility Models an introduction

UNIT III: COPYRIGHTS **L-9**
Copyrights - their definition - granting - infringement - searching & filing - distinction between related and copy rights

UNIT IV: TRADEMARKS AND GEOGRAPHICAL INDICATIONS **L-9**
Trademarks - role in commerce -importance – protection- registration - domain names - Industrial Designs - Design Patents – scope – protection - filing infringement - difference between Designs & Patents - Geographical indications - international protection

UNIT V: **CASE STUDIES IN IPR**. **L-9**

Case Studies on – Patents (Basmati rice, Turmeric, Neem, etc.) – Copyright and related rights – Trade Marks – Industrial design and Integrated circuits – Geographic indications – Protection against unfair competition.

TOTAL: 45 periods

8. Text Books

1. Subbaram N.R. "Handbook of Indian Patent Law and Practice ", S. Viswanathan Printers and Publishers Pvt. Ltd., 1998

9. References

1. Eli Whitney, United States Patent Number: 72X, Cotton Gin, March 14, 1794.
2. Intellectual Property Today: Volume 8, No. 5, May 2001, [www.iptoday.com].
3. Using the Internet for non-patent prior art searches, Derwent IP Matters, July 2000.
Web Resources www.ipmatters.net/features/000707_gibbs.html.

10. Revised Bloom's based Assessment Pattern

Revised Bloom's Category	**Internal**				**University Examination %**
	Unit test – I %	**Mid Term -I %**	**Unit test – II %**	**Mid Term -II %**	
Remember	30	20	30	20	20
Understand	70	40	70	40	40
Apply		40		40	40
Analyse					
Evaluate					
Create					

Revised Bloom's Category	**Assignments**	
	1 (COs addressed) (max marks in %)	**2 (COs addressed) (max marks in %)**
Remember		
Understand	20	10
Apply	40	40
Analyze	40	50
Evaluate		
Create		

COURSECODE 1154ME103	PRODUCT DESIGN AND ENTREPRENEURSHIP DEVELOPMENT	L	T	P	C
		3	0	0	3

1. Preamble

The course is designed to provide the basic concepts of product design, product features and its architecture so that student can have a basic knowledge in the common features a product has and how to incorporate them suitably in product. The course also aim to provide an understanding of the scope of an entrepreneur, key areas of development, financial assistance by the institutions, methods of taxation and tax benefits, etc.

2. Prerequisite

NIL

3. Link to other Courses

Project Work

4. Course Educational Objectives

Students undergoing this course are expected to:

- Understand the basic concepts of product design, product features and its architecture.
- Understand the scope of an entrepreneur, financial assistance by the institutions, taxations
- and tax benefit.

5. Course Outcomes:

On completion of the course the student will be able to

CO Nos.	Course Outcomes	Level of learning domain (Based on revised Bloom's)
CO1	Understand the integration of customer requirements in product design	K2
CO2	Apply structural approach to concept generation, selection and testing	K3
CO3	Understand various aspects of design such as industrial design, design for manufacture, economic analysis and product architecture	K2
CO4	Understand the various aspects of innovation and methods of fostering Innovation	K2
CO5	Apply knowledge and skills needed to run a business	K3

6. Correlation of COs with Programme Outcomes

Cos	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
CO1	H	M	L			L	L				L	L	H	H
CO2	H	M	L			L	L				L	L	H	H
CO3	H	M	L			L	L				L	L	H	H
CO4	H	M	L			L	L		L		L	L	H	H
CO5	H	M	L			L	L		L		L	L	H	H

H- High; M-Medium; L-Low

7. Course Content

UNITI INTRODUCTION L-9
Need for IPPD-Strategic importance of Product development-integration of customer, designer, material supplier and process planner, Competitor and customer - behavior analysis. Understanding customer-promoting customer understanding-involve customer in development and managing requirements- Organization process management and improvement

UNITII CONCEPTGENERATION, SELECTIONAND TESTING L-9
Plan and establish product specifications. Task-Structured approaches -clarification-search-externally and internally-Explore systematically-reflecton the solutions and processes-concept selection-methodology-benefits. Implications-Product change-variety -component standardization-product performance - manufacturability –Concept Testing Methodologies.

UNITIII INDUSTRIAL DESIGN L-9
Integrateprocessdesign-Managingcosts-Robustdesign-IntegratingCAE, CAD, CAM tools– Simulating product performance and manufacturing processes electronically-Need for industrial design-impact–designprocess-investigationofcustomerneeds-conceptualization-refinement - management of the industrial design process –technology driven products - user- driven products - assessing the quality of industrial design.

UNITIV ENTREPRENEURSHIP AND ENTREPRENEURIAL MOTIVATION L-9
Definition, Requirements to be an entrepreneur, Entrepreneur and Entrepreneur, Entrepreneur and Manager, Growth of entrepreneurship in India, Women Entrepreneurship, Rural and Urban Entrepreneurship. Motivating factors, Motivation Theories-Maslow’s Need Hierarchy Theory, McClelland’s Acquired Need Theory, Government’s Policy actions towards Entrepreneurial motivation, Entrepreneurship development Programmes.

UNITV PROJECTS, TYPES OF ENTERPRISES AND OWNERSHIP STRUCTURE L-9
Identification and selection of projects; project report: contents and formulation, concept of project evaluation, methods of project evaluation: internal rate of return method and net present value method. Small scale, medium scale and large scale enterprises, role of small enterprises in economic development; proprietorship, partnership, Ltd. companies and co-operatives: their formation, capital structure and source of finance.

TOTAL:

45PERIODS

8. Text book

1. Product Design and Development, Karl T.Ulrich and Steven D.Eppinger, McGraw –Hill International Edns.1999
2. S.S.Khanka “Entrepreneurial Development” S.Chand & Co. Ltd. Ram Nagar New Delhi, 1999.

9. References

1. Effective Product Design and Development, Stephen Rosenthal, Business One Orwin,
2. Homewood, 1992,ISBN, 1-55623-603-4
3. Tool Design – Integrated Methods for successful Product Engineering, Stuart Pugh, Addison
4. Wesley Publishing,Neyourk,NY,1991, ISBN 0-202-41639-5
5. Hisrich R D and Peters M P, “Entrepreneurship” 5th Edition Tata McGraw-Hill, 2002.

10. Revised Bloom's based Assessment Pattern

Revised Bloom's Category	Internal				University Examination %
	Unit test – I %	Mid Term -I %	Unit test – II %	Mid Term -II %	
Remember	30	20	30	20	20
Understand	70	40	70	40	40
Apply		40		40	40
Analyse					
Evaluate					
Create					

Revised Bloom's Category	Assignments	
	1 (COs addressed) (max marks in %)	2 (COs addressed) (max marks in %)
Remember		
Understand	20	10
Apply	40	40
Analyze	40	50
Evaluate		
Create		

COURSECODE 1154ME104	OPTIMIZATION TECHNIQUES	L	T	P	C
		3	0	0	3

1. Preamble

To provide knowledge and training in using optimization techniques under limited resources for the engineering and business problems.

2. Pre-Requisite

NIL

3. Links to Other Courses

Advanced Operations Research,
Total Quality Management and Reliability Engineering,
Project work

4. Course Educational Objectives

Students undergoing this course are expected to

- Understand the nonlinear problem and multi-objective problem
- Effectively use Optimization Techniques for solving complex Mechanical engineering Problems.
- Prepare base for understanding engineering analysis software.
- Develop logical sequencing for solution procedure and skills in soft computing.
- Optimize the solution for different real life problems with available constraints.
- Build the foundation for engineering research
- Serve as a prerequisite for post graduate and specialized studies in research.

5. Course Outcomes

Upon the successful completion of the course, learners will be able to

CO Nos.	Course Outcomes	Level of learning domain (Based on revised Bloom's)
CO1	Demonstrate the knowledge about types of optimization problems. Solve problems by MCDM AHP, Markov Decision processes.	K3
CO2	Solve Nonlinear programming problems.	K3
CO3	Solve convex and non-convex set of problems.	K3
CO4	Solve problems by Genetic Algorithms, Simulated annealing, Tabu search, Ant Colony Optimization Techniques	K3
CO5	Apply the techniques of Neural networks and Fuzzy system in the real-world applications.	K3

6. Correlation of Cos with Programme Outcomes:

COs	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
CO1	H	M	L	L	L	L						L	M	L
CO2	H	M	L	L	L	L						L	M	L
CO3	H	M	L	L	L	L						L	M	L
CO4	H	M	L	L	L	L			L		L	L	M	L
CO5	H	M	L	L	L	L						L	M	L

H-High; M-Medium: L-Low

7. COURSE CONTENT

UNIT I INTRODUCTION AND DECISION ANALYSIS L - 9
Classification of optimization problems, concepts of design vector, Design constraints, constrains surface, objective function surface and multi-level optimization, parametric linear programming, Decision Trees, MCDM –, AHP and Markov Decision processes

UNIT II NON-LINEAR OPTIMIZATION – I L - 9
Types of Non-linear programming problems, unconstrained optimization, KKT conditions for constrained optimization, Quadratic programming- Dichotomous search – Fibonacci method - Golden section - Interpolation methods. Quadratic and cubic interpolation

UNIT III NON-LINEAR OPTIMIZATION- II L - 9
Separable programming, convex programming, Non-convex programming, Geometric programming, Stochastic programming- - Direct search methods: Random search – Hooke and Jeeve's – Simplex method Descent methods – Cauchy method- Newtons method

UNIT IV NON-TRADITIONAL OPTIMIZATION- I L - 9
Evolutionary Optimization Techniques Genetic algorithms, Simulated Annealing techniques, Particle swarm optimization, Ant colony algorithm, Differential evolution - Implementation of algorithm using Software- MATLAB –GA, SA Program.

UNIT V NON-TRADITIONAL OPTIMIZATION- II L - 9
Neural network based optimization, Optimization of Fuzzy systems

TOTAL: 45

PERIODS

8. Text Books

1. Singiresu S Rao, "Engineering Optimization", Wiley, 1998.
2. Kalyanmoy Deb, "Optimization for Engineering Design", PHI, 2000.

9. References

1. Johnson Ray, C., "Optimum Design of Mechanical Elements", Wiley, John & Sons, 1990.
2. Goldberg, D.E., "Genetic Algorithms in Search, Optimization and Machine", Barnen, Addison -Wesley, New York, 1989.
3. Chong, E.K.P.and Zak, S. H.."An Introduction to Optimization", John Wiley & Sons, N.Y.
4. Peressimi A.L., Sullivan F.E., Vhl, J.J. "Mathematics of Non-linear Programming", Springer – Verlag.
5. Christos H. Papadimitriou, Kenneth Steiglitz, "Combinatorial Optimization", PHI 2006

10. Revised Bloom's based Assessment Pattern

Revised Bloom's Category	Internal				University Examination %
	Unit test – I %	Mid Term -I %	Unit test – II %	Mid Term -II %	
Remember	30	20	30	20	20
Understand	70	40	70	40	40
Apply		40		40	40
Analyse					
Evaluate					
Create					

Revised Bloom's Category	Assignments	
	1 (COs addressed) (Max marks in %)	2 (COs addressed) (Max marks in %)
Remember		
Understand	20	10
Apply	40	40
Analyze	40	50
Evaluate		
Create		

COURSECODE 1154ME105	INDUSTRIAL SAFETY, HEALTH AND HAZARDS	L	T	P	C
		3	0	0	3

1. Preamble

This course provides an introduction about industrial safety, health and hazards where an engineer is going to be employed in his professional life. It also enhances his ability to deal with various situations during his stay in industry.

2. Pre-Requisite

NIL

3. Links to Other Courses

Project Work

4. Course Educational Objectives

Students undergoing this course are expected to

- Understand about Industrial Safety
- Possess knowledge of Industrial Safety Legislations
- Interpret Occupational Safety, Health and Environment Legislations
- Understand about Hazard Identification
- Possess knowledge of Occupational Health

5. Course Outcomes

Upon the successful completion of the course, learners will be able to

CO Nos.	Course Outcomes	Level of learning domain (Based on revised Bloom's)
CO1	Understand about Industrial Safety	K2
CO2	Possess knowledge of Industrial Safety Legislations	K2
CO3	Interpret Occupational Safety, Health and Environment Legislations	K2
CO4	Understand about Hazard Identification	K2
CO5	Possess knowledge of Occupational Health	K2

6. Correlation of Cos with Programme Outcomes

COs	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
CO1	H					L	L	L					M	L
CO2	H					L	L	L					M	L
CO3	H					L	L	L					M	L
CO4	H					L	L	L					M	L
CO5	H					L	L	L					M	L

H-High; M-Medium: L-Low

7. Course Content

Unit I: Introduction to Industrial Safety **L-9**
History and development of safety movement Need for safety, Safety legislation: Acts and rules. Safety standards and codes, Safety policy: safety organization and responsibilities and authorities of different levels. Accident sequence theory, Causes of accidents, Accident prevention and control techniques

Unit II : Industrial Safety Legislations **L-9**

Legislative measures in industrial safety -Factories Act, Workman's Compensation Act, Employees State Insurance Act, Mines Act , Air (Prevention and control) Pollution Act, Water (Prevention and Control) Pollution Act, ,Boiler Vessels Act. Child Labour and Women Employee Act. The factories rules, History, Provisions under the factories Act and rules made there under with amendments, Functions of safety management. ILO Convention and Recommendations in the furtherance of safety, health and welfare.

Unit III Occupational Safety, Health and Environment Legislations **L-9**
Bureau of Indian standards on safety and health 14489 - 1998 and 15001 – 2000 OSHA, Process Safety Management (PSM) as per OSHA, PSM principles, OHSAS – 18001, EPA Standards, Performance measurements to determine effectiveness of PSM

Unit IV: Hazard Identification **L-9**
Identification of hazard, Categorization methods for elimination of hazard, Mechanical hazards; machine guarding, safety with hand tools/ portable power tools, Pressure vessel hazards and their control, Safety in material handling: hazards and safe Practices, safety with storage of materials,
Electrical hazards: classification, safe work practices, Chemical hazards: laboratory safety, bulk handling of chemicals, Fire and explosion hazards, Fire detection, Prevention ,control, and extinguishments, Industrial layout, Industrial waste management.

Unit V: Occupational Health **L-9**
Concept of health and occupational health, Spectrum of health, Occupational and work related diseases, Levels of prevention, History of occupational health, Characteristics of occupational diseases, Essentials of occupational health service, personal protective equipment's.

8. Text Book

1. R.K.Jain and Sunil S.Rao , Industrial Safety, Health and Environment Management Systems,
2. Khanna publishers , New Delhi (2006)
3. Slote.L.Handbook of Occupational Safety and Health, John Willey and Sons, NewYork .

9. Reference Books

1. Grimaldi and Simonds , Safety Management, AITBS Publishers , New Delhi (2001)
2. "Industrial Safety and Pollution Control Handbook" National Safety Council and Associate Publishers Pvt. Ltd, Hyderabad (1993).
3. "Handbook of Environmental Health and Safety" Herman Koren and Michel Bisesi, Jaico Publishing House, Delhi (1999).
4. Handbook of Environmental Risk Assessment and Management: Peter Calow, Blackwell Science Ltd. USA (1998).

5. Risk Assessment and Environmental Management: D. Kofi Asvite-Dualy, John Willey & Sons, West Sussex, England (1998).
6. The Factories Act with amendments 1987, Govt. of India Publications DGFASLI, Mumbai

10. Revised Bloom's based Assessment Pattern

Revised Bloom's Category	Internal				University Examination %
	Unit test – I %	Mid Term -I %	Unit test – II %	Mid Term -II %	
Remember					
Understand	30	30	30	30	30
Apply	70	70	70	70	70
Analyse					
Evaluate					
Create					

Revised Bloom's Category	Assignments	
	1 (COs addressed) (Max marks in %)	2 (COs addressed) (Max marks in %)
Remember		
Understand		
Apply	50	50
Analyze	50	50
Evaluate		
Create		

COURSE CODE 1154ME106	INDUSTRIAL ROBOTICS	L	T	P	C
		3	0	0	3

1. Preamble

This course provides an introduction to the robots types, Laws, configurations and application; Co-ordinate frames and types, Transformations and types; Forward and Inverse Kinematics of manipulator's; all types of robotic sensors; Open loop and closed loop control systems with examples

2. Pre-requisite

Basic Electronics Engineering

3. Links to other Courses

Project Work

4. Course Educational Objectives

To understand an overview of robotics in practice and research with topics including control systems, motion planning, mobile mechanisms, kinematics, inverse kinematics, and sensors.

5. Course Outcomes

On successful completion of this course students will be able to:

CO Nos.	Course Outcomes	Level of learning domain (Based on revised Bloom's)
CO1	Demonstrate knowledge of robot configurations and motions.	K3
CO2	Describe the operations of robot components	K3
CO3	Describe the sensing and visioning operations of robot	K3
CO4	Describe methods for programming robot	K3
CO5	Describe industrial applications of robot.	K3

(K3 – APPLY)

6. Correlation of COs with Programme Outcomes

Cos	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
CO1	H				L							L	L	
CO2	H				L							L	L	
CO3	H				L							L	L	
CO4	H				L							L	L	
CO5	H				L							L	L	

H- High; M-Medium; L-Low

7. Course Content

UNIT I: INTRODUCTION **L-9**

Definition of a Robot - Basic Concepts - Robot configurations - Types of Robot drives - Basic robot motions -Point to point control - Continuous path control.

UNIT II: COMPONENTS AND OPERATIONS **L-9**

Basic control system concepts - control system analysis - robot actuation and fed back, Manipulators – director and inverse kinematics, Coordinate transformation - Brief Robot dynamics. Types of Robot and effectors -Grippers - Tools as end effectors - Robot/End - effort interface.

UNIT III: SENSING AND MACHINE VISION **L-9**

Range sensing - Proximity sensing - Touch sensing - Force and Torque sensing. Introduction to Machine vision - Sensing and digitizing - Image processing and analysis.

UNIT IV: ROBOT PROGRAMMING **L-9**

methods - languages - Capabilities and limitation - Artificial intelligence - Knowledge representation – Search techniques - A1 and Robotics.

UNIT V: INDUSTRIAL APPLICATIONS **L-9**

Application of robots in machining - Welding - Assembly - Material handling - Loading and unloading – CIM - Hostile and remote environments.

TOTAL : 45 PERIODS

8. Text Books

1. John J. Craig, Introduction to Robotics Mechanics and Control, Prentice Hall, 3rd Edition, 2004.
2. M.W. Spong, S. Hutchinson and M. Vidyasagar, “Robot modeling and control,” John Wiley and Sons, First Edition, 2005.
3. Norman S.Nise, " Control Systems Engineering", John Wiley and Sons, 6th Edition, 2010.

9. References

1. Richard D. Klafter, Thomas. A, Chri Elewski, Michael Negin, Robotics Engineering an Integrated Approach, Prentice Hall, 1989.
2. Frank L. Lewis , Chaouki T. Abdallah , D. M. Dawson, "Robot manipulator control: theory and practice", CRC press, 2nd Edition, 2003.

10. Revised Bloom's based Assessment Pattern

Revised Bloom's Category	Internal				University Examination %
	Unit test – I %	Mid Term -I %	Unit test – II %	Mid Term -II %	
Remember	30	20	30	20	20
Understand	70	40	70	40	40
Apply		40		40	40
Analyse					
Evaluate					
Create					

Revised Bloom's Category	Assignments	
	1 (COs addressed) (max marks in %)	2 (COs addressed) (max marks in %)
Remember		
Understand	20	10
Apply	40	40
Analyze	40	50
Evaluate		
Create		

COURSECODE 1154ME107	ENERGY CONSERVATION AND AUDIT	L	T	P	C
		3	0	0	3

1. Preamble

To enable the students to acquire the knowledge of energy conservation measures in thermal and electrical energy systems. To familiarize the students about energy conservation and energy audit. To familiarize the students with the concept of energy conservation and management.

2. Prerequisite

Basic Electrical Engineering

3. Links to other courses

Project work

4. Course Educational Objectives

Students undergoing this course are expected to:

- Understand the energy management concepts
- Energy conservation principles and measures
- Learn the methods of energy audit and usage of instruments
- Analyse and report the outcome of energy audit

5. Course Outcomes

Upon the successful completion of this course, the learners will be able to

CO Nos.	Course Outcomes	Level of learning domain (Based on revised Bloom's)
CO1	Identify the energy demand supply gap in the World & India and understand energy conservation opportunities available	K2
CO2	Quantify the energy conservation opportunities in different thermal systems	K3
CO3	Quantify the energy conservation opportunities in different electrical systems	K3
CO4	Identify and evaluate the common energy conservation opportunities in different energy intensive industrial equipments	K3
CO5	Understand the need for energy audit and examine the economic evaluation of energy conservation solutions adopted	K3

(K3 – APPLY)

6. Correlation of Course Outcomes with Programme Outcomes

COs	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
CO1	M					L	L				L	L	L	
CO2	M					L	L				L	L	L	
CO3	M					L	L				L	L	L	
CO4	M					L	L				L	L	L	
CO5	M					L	L				L	L	L	

H-High; M-Medium: L-Low

7. Course Content

UNIT I INTRODUCTION TO ENERGY CONSERVATION L- 9

Principles - Past and present energy scenario of world – Energy consumption in India – resource availability – Demand supply gap - Environmental aspects–Energy Conservation act – Standards and labeling – designated consumers

UNIT II ENERGY CONSERVATION IN THERMAL SYSTEMS L- 9

Steam systems – Boilers - blow down control – furnaces – thermic fluid heaters – steam traps – insulators and refractories –cooling tower – air pressure control – waste heat recovery – cogeneration

UNIT III ENERGY CONSERVATION IN ELECTRICAL SYSTEMS L- 9

Components of EB billing - types of tariff – HT and LT supply – Transformers – cable selection – power factor improvement – capacitors – harmonics – electric motors – efficiency – energy efficient motors – variable speed drives - lighting – types- efficacy – LED

UNIT IV ENERGY CONSERVATION IN INDUSTRIES L- 9

Pumps – fans – blowers – compressed air systems – refrigeration and air conditioning systems – cooling towers – DG sets

UNIT V ENERGY AUIDT AND ENERGY ECONOMICS L-9

Energy audit -need – types - benefits - methodology and barriers – role of energy managers – instruments for energy auditing; Energy economics – discount rate – depreciation cost - payback period – internal rate of return – net present value – life cycle costing – case study.

TOTAL: 45 Periods

8. Text Books

1. Kennedy, William J., Turner, Wayne C., &Capehart, Barney L., Guide to Energy Management, The Fairmount Press
2. Callaghan, P.W., Design and Management for Energy Conservation", Pergamon Press, Oxford

9. References

1. Dryden, I.G.C., The Efficient Use of Energy, Butterworths, London
2. Turner, W.C., Energy Management Handbook, Wiley, New York (1982)
3. Energy Manager Training Manual (www.energymanagertraining.com)

10. Revised Bloom's based Assessment Pattern

Revised Bloom's Category	Internal				University Examination %
	Unit test – I %	Mid Term -I %	Unit test – II %	Mid Term -II %	
Remember	50				20
Understand	50	60	70	20	40
Apply		40	30	40	20
Analyse				40	20
Evaluate					
Create					

Revised Bloom's Category	Assignments	
	1 (COs addressedco1,co2) (max marks in %)	2 (COs addressedco3,co4) (max marks in %)
Remember	**30**	
Understand	**30**	**30**
Apply	**40**	**30**
Analyse		**40**
Evaluate		
Create		

COURSECODE 1154ME108	ENGINEERING ECONOMICS AND FINANCIAL ACCOUNTING	L	T	P	C
		3	0	0	3

1. Preamble

This course makes an attempt to bring students in direct contact with the principles of engineering economics and financial management.

2. Pre requisite

NIL

3. Links to other courses:

Operation Planning & Control

4. Course Educational Objectives

Students undergoing this course are expected to

- Be familiar WITH the concepts of engineering economics, its impact in the very engineering principles and the issues related to financial management

5. Course Outcomes

The students would be benefitted with the following outcomes. They will be enable to

CO Nos.	Course Outcomes	Level of learning domain (Based on revised Bloom's)
CO1	Understand the basics of engineering economics and financial accounting	K2
CO2	Identify the issues underlying the supply and demand issues	K3
CO3	Calculate the production and cost analysis	K3
CO4	Understand the concepts of financial accounting	K2
CO5	Understand the concepts of capital budget accounting	K3

(K3 – APPLY)

6. Correlation of COs with Programme Outcomes

Cos	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
CO1	M										M	L	L	
CO2	M										M	L	L	
CO3	M										M	L	L	
CO4	M										M	L	L	
CO5	M										M	L	L	

H- High; M-Medium; L-Low

7. Course Content

UNIT I INTRODUCTION **L -9**

Managerial Economics - Relationship with other disciplines - Firms: Types, objectives and goals - Managerial decisions - Decision analysis.

UNIT II DEMAND & SUPPLY ANALYSIS **L-9**

Demand - Types of demand - Determinants of demand - Demand function – Demand elasticity - Demand forecasting - Supply - Determinants of supply - Supply function - Supply elasticity.

UNIT III PRODUCTION AND COST ANALYSIS **L-9**

Production function - Returns to scale - Production optimization - Least cost input - Isoquants - managerial uses of production function.

Cost Concepts - Cost function - Determinants of cost - Short run and Long run cost curves - Cost Output Decision - Estimation of Cost, Determinants of Price - Pricing under different objectives and different market structures - Price discrimination - Pricing methods in practice.

UNIT IV FINANCIAL ACCOUNTING (ELEMENTARY TREATMENT) **L-9**

Balance sheet and related concepts - Profit & Loss Statement and related concepts - Financial Ratio Analysis - Cash flow analysis - Funds flow analysis – Comparative financial statements - Analysis & Interpretation of financial statements.

UNIT V CAPITAL BUDGETING (ELEMENTARY TREATMENT) **L-9**

Investments - Risks and return evaluation of investment decision - Average rate of return - Payback Period - Net Present Value - Internal rate of return.

Total: 45 Periods

8. Text Books

1. Samuelson. Paul A and Nordhaus W.D., 'Economics', Tata Mcgraw Hill Publishing Company
2. Limited, New Delhi, 2004.
3. McGuigan, Moyer and Harris, 'Managerial Economics; Applications, Strategy and Tactics',
4. Thomson South Western, 10th Edition, 2005.

9. References

1. Paresh Shah, 'Basic Financial Accounting for Management', Oxford University Press, New Delhi, 2007.
2. Salvatore Dominick, 'Managerial Economics in a global economy'.Thomson South Western, 4th Edition, 2001.
3. Prasanna Chandra. 'Fundamentals of Financial Management', Tata Mcgraw Hill Publishing Ltd., 4th edition, 2005.

10. Revised Bloom's based Assessment Pattern

Revised Bloom's Category	Internal				University Examination %
	Unit test – I %	Mid Term -I %	Unit test – II %	Mid Term -II %	
Remember	30	20	30	20	20
Understand	70	40	70	40	40
Apply		40		40	40
Analyse					
Evaluate					
Create					

Revised Bloom's Category	Assignments	
	1 (COs addressed) (Max marks in %)	2 (COs addressed) (Max marks in %)
Remember		
Understand	20	10
Apply	40	40
Analyze	40	50
Evaluate		
Create		

COURSECODE 1154ME109	GREEN ENGINEERING AND SUSTAINABILITY	L	T	P	C
		3	0	0	3

1. Preamble

The course is designed to provide the an increased awareness among students about various renewable energy sources and issues in areas of sustainability and to establish a clear understanding of the role and impact of various aspects of engineering and engineering decisions on environmental, societal, and economic issues.

2. Prerequisite

NIL

3. Link to other Courses

Project Work

4. Course Educational Objectives

Students undergoing this course are expected to:

- Understand the various sources of renewable energy.
- Get an understanding of the engineering decisions and its impacts on environmental, societal, and economic problems.

5. Course Outcomes

On completion of the course the student will be able to

CO Nos.	Course Outcomes	Level of learning domain (Based on revised Bloom's)
CO1	Understand the concepts of green energy and sustainability	K2
CO2	Identify the uses of solar and wind energy sources with respect to sustainability	K3
CO3	Identify the uses of biomass, ocean & geothermal energy sources	K2
CO4	Undetstand the underlying principles of environmental sustainability	K2
CO5	Understand about pollution and waste management	K3

6. Correlation of COs with Programme Outcomes

Cos	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
CO1	M					L	L	L			L	L	L	
CO2	M					L	L	L			L	L	L	
CO3	M					L	L	L			L	L	L	
CO4	M					L	L	L			L	L	L	
CO5	M					L	L	L			L	L	L	

H- High; M-Medium; L-Low

7. Course Content

UNIT 1: GREEN ENERGY AND SUSTAINABILITY L-9

Introduction to Green Energy – Basic concepts - Green Energy Potential of India. Energy Scenario in India. Energy & Environment, Non-renewable energy sources.

Sustainability – Definition - Need and Concept – Environmental and Economic Sustainability Concepts – Sustainable Energy Development – Sustainability issues in Engineering – Challenges and Solutions.

UNIT 2:SOLAR AND WIND ENERGY SOURCES L-9

Solar Energy – Sun and its energy, Basics of solar energy, Solar Thermal Energy, Solar Photovoltaic. Wind Energy – Historical Background, Wind Resources, Wind Turbines. Environmental Impact.

UNIT 3: BIOMASS, OCEAN & GEOTHERMAL ENERGY SOURCES L-9

Biomass – Types of biogas plants, biofuels. Ocean Energy – Ocean Energy potential against Wind & Solar, Wave Characteristics and Statistics, Wave Energy Devices, Tide Characteristics and Statistics, Tide Energy Technologies, Ocean Thermal Energy, Osmotic Power. Geothermal Energy – Geothermal Resources, Geothermal Technologies.

UNIT 4: ENVIRONMENTAL SUSTAINABILITY L-9

Tools for sustainability, Life Cycle Assessment (LCA) – ISO 14000, bio-mimicking. Environment Impact Assessment (EIA) – Environmental Auditing. Environmental legislations in India – Water act, Air act. Environmental Ethics, Environmental Education, Multilateral Environmental Agreements and Protocols.

UNIT 5: POLLUTION AND WASTE MANAGEMENT L-9

Air Pollution – Sources of air pollution, vehicular and industrial, types of air pollutants, Effects of air pollutants. Global Environmental Issues.

Water pollutants – sources, persistent pollutants, rain water harvesting, water quality standards, sustainable wastewater treatment methods, energy from wastewater.

Waste Management: Solid waste – sources, effects of solid waste pollutants, zero waste concept, 3R concept, and waste to energy concept.

Total: 45 Periods

8. Text books

1. Godfrey Boyle, "Renewable Energy – Power for a Sustainable Future", 2nd Edition, Oxford University Press.
2. Atul Sharma (Editor), Sanjay Kumar Kar (Editor), "Energy Sustainability Through Green Energy", Springer, May 2015

9. References

1. Aldo V. da Rosa, "Fundamentals of Renewable Energy Processes", 2005, Academic Press.
2. John W Twidell and Anthony D Weir, Renewable Energy Resources, English Language Book Society (ELBS) 1996.
3. D P Kothari, K C Singal, Rakesh Ranjan, Renewable Energy Sources and Emerging Technologies, Prentice Hall of India
4. S.S Purohit , Green Technology-An approach for sustainable environment, Agrobios publication
5. Mihelcic, J. R. and Zimmerman, J. B., Environmental Engineering, Wiley Publishers.
6. Brennen, D. Sustainable Process Engineering, Pan Stanford Publishers.

10. Revised Bloom's based Assessment Pattern

Revised Bloom's Category	Internal				University Examination %
	Unit test – I %	Mid Term -I %	Unit test – II %	Mid Term -II %	
Remember					
Understand	30	**30**	**30**	**30**	**30**
Apply	70	**70**	**70**	**70**	**70**
Analyse					
Evaluate					
Create					

Revised Bloom's Category	Assignments	
	1 (COs addressed) (Max marks in %)	2 (COs addressed) (Max marks in %)
Remember		
Understand		
Apply	50	50
Analyze	50	50
Evaluate		
Create		

COURSE CODE	3D PRINTING	L	T	P	C
1154ME111		3	0	0	3

1. Preamble

This course addresses the principle behind rapid prototyping techniques, variety and its concept, scope and areas of application.

2. Prerequisite

NIL

3. Links to other courses:

Project Work

4. Course Educational Objectives

Students undergoing this course are expected to:

- Know the principles, methods, areas of usage, possibilities and limitations as well as environmental effects of the additive manufacturing technologies
- Be familiar with the characteristics of various materials that are used in additive manufacturing.

5. Course Outcomes

Upon the successful completion of the course, learners will be able to

CO Nos.	Course Outcomes	Level of learning domain (Based on revised Bloom's)
CO1	Describe the differences and of the application of a range of additive manufacturing processes	K2
CO2	Select and use correct CAD formats in the manufacture of a 3D printed part.	K2
CO3	Understand the operating principles, capabilities, and limitations of liquid and solid based additive manufacturing system, including fused deposition modeling and stereolithography.	K2
CO4	Appreciate the operating principles, capabilities and limitations of powder based additive manufacturing system, including 3D printing and laser sintering.	K2
CO5	Describe the important process parameters for bio-manufacturing and determine the suitable additive technique for bio-manufacturing.	K2

(K2 – Understand)

6. Correlation of CO's with Programme Outcomes

Cos	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
CO1	H	L										L	H	
CO2	H	L										L	H	
CO3	H	L										L	H	
CO4	H	L										L	H	
CO5	H	L										L	H	

H- High; M-Medium; L-Low

7. Course Content

UNIT I-INTRODUCTION **L-9**
Overview – History – Need-Classification -Additive Manufacturing Technology in product development-Materials for Additive Manufacturing Technology –

UNIT II- REVERSE ENGINEERING **L-9**
Basic Concept –3D Scanning Digitization techniques – Model Reconstruction – Data Processing for Additive Manufacturing Technology – Part Orientation and support generation – Model Slicing –Tool path Generation.

UNIT III-LIQUID BASED AND SOLID BASED ADDITIVE MANUFACTURING SYSTEMS **L-9**
Classification – Stereo lithography Apparatus (SLA)- Principle, process, advantages –Fused Deposition Modeling – Principle, process, advantages.

UNIT IV-LASER BASED ADDITIVE MANUFACTURING SYSTEMS **L-9**
Selective Laser Sintering – Principle, Process, advantages, Three Dimensional Printing – Principle, process, advantages - Laser Engineered Net Shaping (LENS)

UNIT V- APPLICATIONS OF 3D PRINTING. **L-9**

Customized implants and prosthesis: Design and development, Bio-Additive Manufacturing-Computer Aided Tissue Engineering (CATE) – Applications of 3D Printing in Aerospace, Automotive, Manufacturing and Architectural Engineering.

Total: 45 Periods

8. Text Books

1. Chua C.K., Leong K.F., and Lim C.S., "Rapid prototyping: Principles and applications", Third Edition, World Scientific Publishers, 2010.
2. Gebhardt A., "Rapid prototyping", Hanser Gardener Publications, 2003.

9. References

1. Liou L.W. and Liou F.W., "Rapid Prototyping and Engineering applications: A tool box for prototype development", CRC Press, 2007.
2. Kamrani A.K. and Nasr E.A., "Rapid Prototyping: Theory and practice", Springer, 2006. 3. Hilton P.D. and Jacobs P.F., "Rapid Tooling: Technologies and Industrial Applications", CRC press, 2000.
3. DouglesBryden, "CAD and Protyping for Product Design", 2014

10. Revised Bloom's based Assessment Pattern

Revised Bloom's Category	Internal				University Examination %
	Unit Test 1 %	Mid Term Test 1 %	Unit Test 2 %	Mid Term Test 2 %	
Remember					
Understand	70	70	70	70	70
Apply	30	30	30	30	30
Analyse					
Evaluate					
Create					

Revised Bloom's Category	Assignments	
	1 (COs addressed CO1,CO2) (max marks in %)	2 (COs addressed CO3,CO4) (max marks in %)
Remember	**20**	**10**
Understand	**40**	**40**
Apply	**40**	**50**
Analyse		
Evaluate		
Create		

COURSE CODE	ENERGY MANAGEMENT	L	T	P	C
1154ME112		3	0	0	3

1. Preamble

This course provides an update, to the knowledge base of the students, in essential Energy Management. Students may gain knowledge on Energy Auditing, Waste Heat Recovery, HVAC, Lighting systems and Maintenance of Energy Systems.

2. Prerequisite

Not Required

3. Links to other courses:

Project work

4. Course Educational Objectives :

Students undergoing this course are expected to:

- Understand the basic principles of Energy Auditing and its types involved in Energy Sector.
- Understand the Energy Management Concepts in Waste Heat Recovery Systems, HVAC Systems, Lighting Systems etc. and to gain knowledge about the maintenance of Energy Systems.

5. Course Outcomes :

Upon the successful completion of the course, learners will be able to

CO Nos.	Course Outcomes	Level of learning domain (Based on revised Bloom's)
CO1	Understand the meaning and types of Energy Consuming Devices and concept of Energy Management	K2
CO2	Understand the principle of Energy Auditing and Economic aspects of investments	K2
CO3	Understand the Waste Heat Recovery Concepts and Energy Conservation methods in HVAC Systems	K2
CO4	Understand the Energy Conservation options in Lighting	K2
CO5	Understand the importance of Maintenance of Energy Consuming Devices	K2

(K1-Remember K2-Understand K3-Apply K4-Analyze K5-Evaluate K6-Create)

6. Correlation of CO's with Programme Outcomes:

Cos	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
CO1									H		M	L	M	L
CO2									H		M	L	M	L
CO3									H		M	L	H	L
CO4									H		M	L	M	L
CO5									H		M	L	M	L

H- High; M-Medium; L-Low

7. **Course Content:**

Unit I **Introduction to Energy Management** **L - 9**

Introduction to Energy Consuming Devices – Energy Management – Effective Energy Management – Structure – Energy Policy – Planning – Audit Planning – Educational Planning – Strategic Planning – Reporting.

Unit II **Energy Auditing and Economic Analysis** **L - 9**

Energy Auditing Services – Basic Components of Energy Audit – Specialized Audit Tools – Industrial Audits – Commercial Audits – Residential audits – Simple Payback – Return on Investment – Net Present Value method – Time Value of Money Concepts.

Unit III **Waste Heat Recovery and HVAC Systems** **L - 9**

Waste Heat Survey – Waste Heat Exchangers – Commercial Options in Waste Heat Recovery Equipment – Economics of Waste Heat Recovery – Surveying Existing Conditions – Human Thermal Comfort – HVAC System Types – Energy Conservation Opportunities – Cooling Equipment – Domestic Hot Water – Estimating HVAC Energy Consumption.

Unit IV **Lighting** **L - 9**

Lighting Fundamentals – Lighting Energy Management Steps – Maintenance – New Technologies & Products – Special Considerations – Day Lighting – Common Retrofits – Schematics – Use of Alternative Energy – Solar Energy – Wind Energy – Refuse-Derived Fuel – Fuel Cells

Unit V **Energy Systems Maintenance** **L - 9**

Developing the Maintenance Program – Detailed Maintenance Procedure – Material Handling Maintenance – Truck Operation and Maintenance – Measuring Instruments – Saving Energy in Material Handling and Storage – Recent Developments

45 Hours

8. Text Book

1. Energy Management Handbook, Wayne C. Turner, Marcel Dekker, Inc., New York and Basel.

9. References

1. Handbook of Energy Audit, Sonal Desai, Mc Graw Hill Education.
2. Energy Engineering and Management, Amlan Chakrabarti, PHI.
3. Energy Management Handbook, Jonathan H Turner.
4. Study Materials from e-Sources, related to Energy Management.

10.Revised Bloom's based Assessment Pattern:

Revised Bloom's Category	Internal				University Examination %
	Unit Test 1 %	Mid Term Test 1 %	Unit Test 2 %	Mid Term Test 2 %	
Remember	**50**	**50**	**50**	**50**	**50**
Understand	**50**	**50**	**50**	**50**	**50**
Apply					
Analyse					
Evaluate					
Create					

Revised Bloom's Category	Assignments	
	I (CO1 & CO2 addressed) (Max marks in %)	II (CO3 & CO4 addressed) (Max marks in %)
Remember	**50**	**50**
Understand	**50**	**50**
Apply		
Analyse		
Evaluate		
Create		

COURSE CODE	SOLAR THERMAL TECHNOLOGY	L	T	P	C
1154ME113		**3**	**0**	**0**	**3**

1. Preamble

This course delivers a knowledge of thermal systems in the solar energy domain. Students may gain knowledge on various applications of solar energy such as solar panel cooling, water heating, space heating and cost and estimation of solar system economics.

2. Prerequisite

NIL

3. Links to other courses

1	Solar energy engineering	1152ME123
2	Renewable sources of energy	UEMEA46
3	Power plant engineering	U6MEA34
4	Engineering Chemistry	GEA004
5	Engineering Thermodynamics	1151ME102

4. Course Educational Objectives

Students undergoing this course are expected to:

- Understand the basic principles of thermal technology in various solar thermal systems.
- Understand the solar applications of various systems such as Hot water generation, space heating, distillation and other applications related to solar energy.

5. Course Outcomes

Upon the successful completion of the course, learners will be able to

CO Nos.	Course Outcomes	Level of learning domain (Based on revised Bloom's)
CO1	Understand the meaning and kinds of solar collectors, storage tank and collector heat exchange factor	K2
CO2	Understand the working principle of various solar water heating systems	K2
CO3	Understand the solar space conditioning systems, heat storage configurations and refrigeration systems	K2
CO4	Understand the other solar applications such as solar cooking, chimney and pumping systems and etc	K2
CO5	Understand the importance of cost and estimation of solar systems and its power generation	K2

(K2 - Understand)

6. Correlation of CO's with Programme Outcomes:

Cos	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
CO1	M						L					L	L	
CO2	M						L					L	L	
CO3	M						L					L	L	
CO4	M						L					L	L	
CO5	M						L					L	L	

H- High; M-Medium; L-Low

7. Course Content

UNIT I SOLAR COLLECTORS L - 9

Introduction to Solar energy - Flat plate - Evacuated tube – Concentrated - Pool and Air collectors Construction – Function - Suitability – Comparison - Storage Tank - Solar Fluids – Collector Heat Exchanger Factor.

UNIT II SOLAR WATER HEATING SYSTEMS L - 9

Natural, Forced circulation systems, Integral Collector Storage System - Thermosyphon System - Open Loop, Drain Down, Drain Back, Antifreeze Systems - Refrigerant Solar Water Heaters - Solar Heated Pools.

UNIT III SOLAR SPACE CONDITIONING SYSTEMS L - 9

Liquid Type Solar Heating System With / Without Storage - Heat Storage Configurations – Heat Delivery Methods - Air-Type Solar Heating Systems - Solar Refrigeration and Air Conditioning

UNIT IV OTHER SOLAR APPLICATIONS L - 9

Solar Cooking – Distillation - Desalination - Solar Ponds – Solar Passive Architecture – Solar Drying – Solar Chimney – Swimming Pool Heating – Retrofit Water Heaters – Low Flow Pumped systems – Solar vehicles

UNIT V SOLAR ECONOMICS L - 9

Application of economic methods to analyse the feasibility of solar systems to decide project / policy alternatives - Net energy analysis - cost requirements for active and passive heating and cooling - for electric power generation - and for industrial process-heating.

TOTAL: 45 PERIODS

8. Text Book

1. J.A. Duffie, W.A. Beckman, Solar Engineering of Thermal Processes, John Wiley Interscience, New York, 2013.

9. Reference Book

1. H P Garg, M Dayal, G Furlan, Physics and Technology of Solar Energy- Volume I: Solar Thermal Applications, Springer, 2007.
2. Sukhatme and Nayak, Solar Energy: Principles Of Thermal Collection And Storage, Tata McGraw.Hill, 2008.
3. Bob Ramlow & Benjamin Nusz, Solar Water Heating, New Society Publishing, 2006.
4. John Canivan, Solar Thermal Energy, Sunny Future Press - 2003.
5. Charles Christopher Newton - Concentrated Solar Thermal Energy- Published by VDM Verlag, 2008.
6. H.P.Garg, S.C.Mullick, A.K.Bhargava, D.Reidal, Solar Thermal Energy Storage Springer, 2005.
7. Anne Grete Hestnes, Robert Hastings, Bjarne Saxhof, Solar Energy Houses: Strategies, Technologies Examples, Earthscan Publications, 2003.

10. Revised Bloom's based Assessment Pattern

Revised Bloom's Category	Internal				University Examination %
	Unit Test 1 %	Mid Term Test 1 %	Unit Test 2 %	Mid Term Test 2 %	
Remember	**50**	**50**	**50**	**50**	**50**
Understand	**50**	**50**	**50**	**50**	**50**
Apply					
Analyse					
Evaluate					
Create					

Revised Bloom's Category	Assignments	
	I (CO1 & CO2 addressed) (Max marks in %)	II (CO3 & CO4 addressed) (Max marks in %)
Remember	50	50
Understand	50	50
Apply		
Analyse		
Evaluate		
Create		

COURSE CODE	COMPUTER AIDED DRAWING LABORATORY	L	T	P	C
1154ME301		0	0	2	1

1. Preamble:

To introduce the basic design & drafting concepts of mechanical components by using modeling software package.

2. Prerequisite:

- Engineering Graphics - 1150ME202

3. Link to Other Courses:

- CAD & Applied FEA Laboratory – 1151ME310

4. Course Educational Objectives:

Students undergoing this course will be provided with:

- Drafting practice using computer in assembly and modelling.

5. Course Outcomes:

Students undergoing this course are able to

CO Nos.	Course Outcomes	Level of learning domain (Based on revised Bloom's)
CO1	Create drawings of various components and structures using Auto cad software.	K3,S3
CO2	Create 2D and 3D models of components.	K3,S3
CO3	Create assembly drawing of components.	K3,S3
CO4	Demonstrate knowledge of CAD software.	K3, S3

6. Correlation of Course Outcomes with Programme Outcomes :

COs	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
CO1	H				H					M		L	H	M
CO2	H				H					M		L	H	M
CO3	H				H					M		L	H	M
CO4	H				H					M		L	H	M

H- High; M-Medium; L-Low

7.List of Experiments:

1. Drawing of simple objects using the options offset, mirroring, arrays.
2. Drawing of a title block with necessary text and projection symbols.
3. Drawing of front view, top view and side view of simple solids.
4. Assembly of Plummer Block.
5. Assembly of Screw Jack.
6. Assembly of Tail Stock.
7. Assembly drawing of Connecting Rod.
8. Isometric View of simple prisms. **Total = 30 periods**

8.Assessment Pattern - Rubrics for Internal Assessment

Performance	Excellent (5)	Very good (4)	Good (3)	Average (2)	Low (1)
Observation (5)	On Time Submission with neat presentation	Submission before next lab with presentation	Submission on next lab hour	Submission within two weeks time	Submission after two weeks time
Record (5)	On Time Submission with neat presentation	Submission before next lab with presentation	Submission on next lab hour	Submission within two weeks time	Submission after two weeks time
Attendance(5)	Above 95%	95%-90%	85%-90%	80%-85%	75%- 80%

9. Rubrics for Model/ University Examination:

Performance	Excellent (100 %)	Very good (80 %)	Good (60 %)	Average (40%)	Low (20%)
Interpretation of drawing (20)	Interpret the drawing with exact scale and with proper dimensioning by using the shortcuts or using proper commands	Interpret the drawing with exact scale and with proper dimensioning	Interpret the drawing with relevant scale and without proper dimensioning	Not able to interpret the drawing but able to use some basic tools like line, circle.	Blank screen
Execution of the drawing in software (40)	Able to complete the drawing in proper scale and able to take print out	Completeness of drawing without title block	Completeness of drawing without dimensioning and title block	Completeness of partial drawing	Incomplete drawing.
Dimensioning (10)	Proper dimensioning with appropriate arrow mark	Some critical dimensioning missing	Missing of tolerance limits in dimensioning	Majority of dimensioning missing	No dimensions
Oral (10)	Good Course knowledge in subject	Reasonably Answered	Partially answer	Attempt to answer	Little answer
Print out with Title block & Viva voce (20)	Able to take print out in A4 format.	Title block missing	Drawing out of the A4 format	Not able to fit in the A4 format but drawing available	Not able to take print out

COURSE CODE	INDUSTRIAL NANOTECHNOLOGY	L	T	P	C
1154ME114		3	0	0	3

1. Preamble:
To provide knowledge of various industrial applications of nanotechnology.

2. Pre requisite:
NIL

3. Links to other courses:
Project work

4. Course Educational Objectives:
Students undergoing this course are expected to:

1. Elucidate on advantages of nanotechnology based applications in each industry.
2. Provide instances of contemporary industrial applications of nanotechnology.
3. Provide an overview of future technological advancements and increasing role of nanotechnology in each industry

5. Course Outcomes:
Upon the successful completion of the course, learners will be able to know

CO Nos.	Course Outcomes	Level of learning domain (Based on revised Bloom's)
CO1	The application of Nanotechnology in Electrical and Electronics Industry	K2
CO2	The application of Nanotechnology in Textiles and Cosmetics	K2
CO3	The application of Nanotechnology in Agriculture and Food Technology	K2
CO4	The application of Nanotechnology in Renewable and Nonrenewable Energy Technology	K2
CO5	The application of Nanotechnology in Environmental and Health Effects	K2

(K3-Apply)

6. Correlation of COs with Programme Outcomes:

COs	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
CO1	L								L			L		L
CO2	L						L					L		L
CO3	L						M		L			L		L
CO4	L						L					L		L
CO5	L						M					L		L

H- High; M-Medium; L-Low

7. Course Content:

UNIT-I (9 hrs)

Nanotechnology in Electrical and Electronics Industry

Advantages of nano electrical and electronic devices – Data storage and memory- Micro and nanoelectromechanical systems - Lighting and displays – Batteries- Fuel cells- Photovoltaic cells- Electric double layer capacitors- Nanoparticle coatings for electrical products.

UNIT-II (9 hrs)

Nanotechnology in Textiles and Cosmetics

Textiles: Nanofibre production - Electrospinning - Controlling morphologies of nanofibers- Nano - fillers embedded polypropylene fibers - Bionics - Swim-suits with shark-skin effect, Soil repellence, Lotus effect - Nano finishing in textiles - Modern textiles Nanopolymers in medical textiles. Cosmetics: Formulation of Gels, Shampoos, Hair-conditioners (Micellar self-assembly and its manipulation) - Sun-screen dispersions for UV protection using titanium oxide - Colour cosmetics.

UNIT- III (9 hrs)

Nanotechnology in Agriculture and Food Technology

Nanotechnology in Agriculture - Precision farming, Smart delivery system - Nanofertilizers: Nanourea and mixed fertilizers, Nanofertigation - Nanopesticides, Nano-seed Science. Nanotechnology in Food industry - Nanopackaging for enhanced shelf life - Smart/Intelligent packaging - Food processing and food safety and bio-security - Electrochemical sensors for food analysis and contaminant detection.

UNIT- IV (9 hrs)

Nanotechnology in Renewable and Nonrenewable Energy Technology

Energy Challenge in the 21st Century- Nanotechnology in energy research- Conventional fossil fuels- Unconventional fossil fuels- Nanotechnology in fuel production- Renewable energy sources- photovoltaics- Hydrogen production - fuel cells- thermoelectricity- Advantages of renewable energy technologies- Implementation of renewable energy technologies.

UNIT-V (9 hrs)

Nanotechnology in Environmental and Health Effects

Environmental pollutants in air, water, soil, hazardous and toxic wastes - Application of Nanotechnology in remediation of pollution in Industrial and waste water treatment – Drinking water and Air/Gas purifications. The challenge to occupational health and hygiene, toxicity of nanoparticles, effects of inhaled nanosized particles, skin exposure to nanoparticles, impact of CNTs on respiratory systems, hazards and risks of exposure to nanoparticles, monitoring nanoparticles in work place

8. TEXTBOOK

1. P. Brown and K. Stevens, Nanofibers and Nanotechnology in Textiles, Woodhead publication, London, 2006.
2. J. Altmann, Routledge, Military Nanotechnology: Potential Applications and Preventive Arms Control, Taylor and Francis Group, 2006.
3. Jennifer Kuzma and Peter VerHage, Nanotechnology in agriculture and food production, Woodrow Wilson International Center, (2006).
4. Q. Chaudry, L.Castle and R. Watkins Nanotechnologies in Food, RSC Publications, 2010.

9. REFERENCE BOOK

1. Y-W. Mai,Polymer Nano composites, Woodhead publishing, (2006).
2. Udo H. Brinker, Jean-Luc Mieusset (Eds.), Molecular Encapsulation: Organic Reactions in Constrained Systems,Wiley Publishers (2010).

Revised Bloom's based Assessment Pattern

Revised Bloom's Category	Internal				University Examination %
	Unit Test-I %	Mid Term Test I %	Unit Test-II %	Mid Term Test II %	
Remember	40	40	40	40	40
Understand	60	60	60	60	60
Apply					
Analyse					
Evaluate					
Create					

Revised Bloom's Category	Assignments	
	1 (COs addressed CO1,CO2) (max marks in %)	2 (COs addressed CO3,CO4) (max marks in %)
Remember	**10**	**10**
Understand	**40**	**40**
Apply		
Analyse		
Evaluate		
Create		

COURSECODE 1154ME201	PROJECT BASED PRODUCT DEVELOPMENT	L	T	P	C
		3	0	6	6

1. Preamble

This course is designed to provide the knowledge about the concepts of product features and its architecture so that student can have a sound knowledge in the common features a product has.

2. Prerequisite

Nil

3. Link to other Courses

Project work

4. Course Educational Objectives

Students undergoing this course are expected to acquire knowledge in:

- product management process
- Product lifecycle management stages
- The DFx concepts from the conception to recovery or disposal
- And to apply the knowledge suitably in the fabrication of a product so as to meet a specific purpose in a better way.

5. Course Outcomes

Upon the successful completion of the course, learners will be able to

CO Nos.	Course Outcomes	Level of learning domain (Based on revised Bloom's)
CO1	Summarise the various trends affecting product decision	K2
CO2	Apply the requirements to create a new product	K3
CO3	Analyse different techniques involved in design creation and design testing	K4
CO4	Apply the new concept of a product to make a prototype and test it	K3
CO5	Explain the need of maintenance, IPR and Product disposal.	K3

(K1 – Remember; K2 – Understand; K3 – Apply ; K4-Analyse)

6. Correlation of COs with Programme Outcomes

COs	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO 10	PO 11	PO 12	PSO1	PSO2
CO1	H	L				L	L	L	L		M	L	H	L
CO2	H	L				L	L	L	L		M	L	H	L
CO3	H	L				L	L	L	L		M	L	H	L
CO4	H	L	M			L	H	L	L		M	L	H	L
CO5	H	L	M			L	H	L	L		M	L	H	L

H- High; M-Medium; L-Low

7. Course Content

UNIT I: FUNDAMENTALS OF PRODUCT DEVELOPMENT L-9
Global Trends Analysis and Product decision: Types of various trends affecting product decision - Social Trends-Technical Trends- Economic Trends- Environmental Trends-Political/ Policy Trends- PESTLE Analysis. Product Life Cycle

UNIT II: REQUIREMENTS AND SYSTEM DESIGN L-9
Requirement Engineering: Types of Requirements- Requirement Engineering- Analysis -Traceability Matrix and Analysis- Requirement Management. System Design & Modeling: Introduction to System Modeling.

UNIT III: CONCEPT GENERATION AND EVALUATION L-9
Conceptualization -Industrial Design and User Interface Design- Introduction to Concept generation Techniques-Concept Screening & Evaluation- Concept Design

UNIT IV: PROTOTYPING, TESTING AND CERTIFICATION L-9
Prototyping: Types of Prototypes -Introduction to Rapid Prototyping and Rapid Manufacturing. System Integration- Testing- Certification and Documentation: Introduction to Manufacturing /Purchase and Assembly of Systems.

UNIT V: SUSTENANCE ENGINEERING, IPR AND CONFIDENTIALITY L-9
Sustenance -Maintenance and Repair- Enhancements Product End of Life (EoL): Obsolescence Management-Configuration Management- EoL Disposal. Intellectual Property Rights and Confidentiality

8. Lab Assessment:

Students belonging to circuit branch can get trained in PCB design using softwares like CATIA and the details are as follows:

- Circuit board geometry is designed within the global assembly product definition, taking into account the mechanical context.
- CATIA PCB communicates with the ECAD software using IDF File.
- Also CATIA Routing and schema design might be useful for circuit branch students.
- CATIA does have separate licenses for Electrical engineering such as wiring harness and Conduit design which has applications in automobiles.
- For computer science students as a lab practice coding in python can be assigned to carryout computational mechanics related work in developing numerical algorithms.

9. Sample Projects:

1. Design and fabricate an adjustable Chair so as to avoid back pain, neck pain, shoulder pain etc while working on a laptop/desktop.

2. Design and fabricate the rear side of the front seat of the passenger car to provide more utility and legroom for the rear seat passenger of a car.

3. Design and fabricate a single product to single punching, double punching and stapling of papers accurately.

4. Design and fabricate a mobile holder at a convenient place in a two wheeler to view google map safely while riding.

5. Design and fabricate a mechanism with sensors or by any means to guide the driver of a car to negotiate a turn in a narrow passage with ease.

TOTAL=45+30+60 periods

10. Text Books

1. NASSCOM student Handbook "Foundation Skills in Integrated Product Development".
2. Anita Goyal, Karl T Ulrich, Steven D Eppinger, "Product Design and Development ", 4th Edition, 2009, Tata McGraw-Hill Education, ISBN-10-007-14679-9

11. References

1. George E.Dieter, Linda C.Schmidt, "Engineering Design", McGraw-Hill International Edition, 4th Edition, 2009, ISBN 978-007-127189-9
2. Kevin Otto, Kristin Wood, "Product Design", Indian Reprint 2004, Pearson Education,ISBN. 9788177588217
3. Yousef Haik, T. M. M. Shahin, "Engineering Design Process", 2nd Edition Reprint, Cengage Learning, 2010, ISBN 0495668141
4. Clive L.Dym, Patrick Little, "Engineering Design: A Project-based Introduction", 3rd Edition, John Wiley & Sons, 2009, ISBN 978-0-470-22596-7
5. Product Design Techniques in Reverse Engineering and New Product Development, KEVIN OTTO & KRISTIN WOOD, Pearson Education (LPE), 2001.
6. The Management and control of Quality-6th edition-James R. Evens, William M Lindsay Pub:son south-western(www.swlearning.com)

12. Revised Bloom's based Assessment Pattern

Revised Bloom's Category	Internal				University Examination %
	Unit Test- I %	Mid Term Test I %	Unit Test- II %	Mid Term Test II %	
Remember	40	20	20	10	10
Understand	60	40	20	20	20
Apply		40	40	30	30
Analyse			20	40	40
Evaluate					
Create					

Revised Bloom's Category	Assignments	
	1(CO1 &CO2) (max marks in %)	2(CO3&CO4) (max marks in %)
Remember		
Understand		
Apply	60	40
Analyse	40	60
Evaluate		
Create		

SELF LEARNING COURSES

Sl. No.	Course Code	Course Name	L	T	P	C
1	1154ME601	Minor Project	0	0	8	4
2	1154ME701	Major Project	0	0	24	12
3	1157ME801	Internship	0	0	2	1
4	1156ME501	Seminar I	0	0	2	1
5	1156ME502	Seminar II	0	0	2	1
6		Online Courses	0	0	2	1

COURSE CODE	MINOR PROJECT	L	T	P	C
1154ME601		0	0	8	4

Course Category: Independent Learning

1. Preamble

This course imparts the knowledge to familiarize with scientific literature, to assimilate, synthesize and integrate information for solving the problem in a group.

2. Prerequisite

Program Core and Electives 115XMEXXX

3. Links to other courses:

Major Project 1156ME701

4. Course Educational Objectives

Students undergoing this course are expected:

- To acquaint with the process of undertaking literature survey/industrial visit and identifying the problem
- To familiarize the process of solving the problem in a group
- To acquaint with the process of applying basic engineering fundamental in the domain of practical applications
- To inculcate the process of research

5. Course Outcomes

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

CO Nos.	Course Outcomes	Level of learning domain (Based on revised Bloom's)
CO1	Identify a topic in advanced areas of Mechanical Engineering	K5, S3
CO2	Review literature to identify gaps and define objectives & scope of the work	K5, S3
CO3	Generate and implement innovative ideas for social benefit	K5, S3

(K5-Evaluate, S3-Skill Level)

6. Correlation of COs with Programme Outcomes

COs	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
CO1			H	M	M	M	H	M	H	M	H		H	M
CO2			H	M	M	M	H	M	H	M	H		H	M
CO3			H	M	M	M	H	M	H	M	H		H	M

H- High; M-Medium; L-Low

7. Course Description

Students should conduct literature survey/visit industry/analyze current trends and identify the problem for Project and finalize in consultation with Guide. Students should use multiple literatures and understand the problem. The minor project may address societal problems/issues related to the Programme.

8. Revised Bloom's based Assessment Pattern

As per PRC guidelines; refer VTUR 15 regulations

COURSE CODE	MAJOR PROJECT	L	T	P	C
1154ME701		0	0	24	12

Course outcomes and K levels for the self-learning course - Major Project:

Course Category: Independent Learning

1. Preamble

This course imparts the knowledge to implement the principles of engineering learnt by them in practical applications with innovative ideas and thus enable them to have a practical exposure.

2. Prerequisite

Program Core and Electives 115XMEXXX

3. Links to other courses:

Nil

4. Course Educational Objectives

Students undergoing this course are expected:

- To provide an opportunity to work in group on a topic / problem / experimentation
- To encourage creative thinking process
- To provide an opportunity to analyze and discuss the results to draw conclusions
- To acquire and apply fundamental principles of planning and carrying out the work plan of the project through observations, discussions and decision-making process.

5. Course Outcomes

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

CO Nos.	Course Outcomes	Level of learning domain (Based on revised Bloom's)
CO1	Identify problem through literature survey / field work	K6, S3
CO2	Identify problem solving methodology and enumerate social, ethical, economic and business aspects	K6, S3
CO3	Design the experiment / process / product and selection of tools / techniques	K6, S3
CO4	Perform a team work and interpret the results / process	K6, S3
CO5	Practice engineering report preparation and lifelong learning	K6, S3

(K6-create, S3-Skill Level)

6. Correlation of COs with Programme Outcomes

COs	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
CO1	L	M	H	H	H	M		H		L	H		H	H
CO2	L	M	H	H	H	M		H		L	H		H	H
CO3	H	H	H	H	H	H		H		L	H		H	H
CO4			H	H	H	L		H	H	L	M		H	M
CO5				H	H		H	H	H	L	M		H	M

H- High; M-Medium; L-Low

7. Course Description

Students should conduct literature survey/visit industry/analyze current trends and identify the problem for Project and finalize in consultation with Guide. Students should use multiple literatures and understand the problem. Students should attempt solution to the problem by experimental/simulation methods. The solution to be validated with proper justification and report to be compiled in standard format.

8. Revised Bloom's based Assessment Pattern

As per PRC guidelines; refer VTUR 15 regulations

COURSE CODE	INTERNSHIP	L	T	P	C
1157ME801		0	0	2	1

Course outcomes and K levels for the self-learning course - Internship:

Course Category: Independent Learning

1. Preamble

This course provides the opportunity to gain the actual industrial working experience.

2. Prerequisite

NIL

3. Links to other courses:

Major Project 1156ME701

4. Course Educational Objectives

Students undergoing this course are expected:

- To experience the 'real' industrial working environment.
- To acquire the knowledge about various manufacturing processes and metal forming operations.
- To familiarize the principles of design, manufacturing, marketing and customer service.
- To gain the knowledge and skills required for research and development activities.

5. Course Outcomes

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

CO Nos.	Course Outcomes	Level of learning domain (Based on revised Bloom's)
CO1	Explain the process of manufacturing a mechanical component.	K5, S3
CO2	Suggest the techniques for assembling a mechanism.	K5, S3
CO3	Identify the reasons for malfunctioning of a component and provide suitable remedial actions.	K5, S3

(K5-Evaluate, S3-Skill Level)

6. Correlation of COs with Programme Outcomes

COs	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
CO1			M		M	M	M	M	M	M		M	M	M
CO2			M		M	M	M	M	M	M		M	M	M
CO3			M		M	M	M	M	M	M		M	M	M

H- High; M-Medium; L-Low

7. Course Description

Students should undergo in-plant training at any one of the industries related to Mechanical Engineering, for a period of minimum five days or 40 working hours to earn one credit and ten days or 80 working hours to earn two credits. They are expected to observe the plant activities in all aspects from procurement of raw materials, design aspects of engineering components, material grades, tools used, various operations carried out, quality checking, material movement, customer service etc. All the observations are to be noted and after successful completion of training students have prepare a consolidated report. This report will be evaluated by a three-member review committee constituted by Head of the Department.

8. Revised Bloom's based Assessment Pattern

As per RC guidelines; refer VTUR 15 regulations, Section 8.3.8.

COURSE CODE	SEMINAR I	L	T	P	C
1156ME501		0	0	2	1

Course outcomes and K levels for the self-learning course - Seminar:

Course Category: Independent Learning

1. Preamble

This course provides the opportunity to gain the confidence of oral communication among the team members and others by preparing and presenting the technical and non-technical contents related to Mechanical Engineering.

2. Prerequisite

NIL

3. Links to other courses:

Major Project 1156ME701

4. Course Educational Objectives

Students undergoing this course are expected:

- To read and understand the contents of a journal article.
- To acquire the knowledge of extracting main contents from the article.
- To prepare a power point presentation based on the contents.
- To deliver the contents infront of the seminar review committee.

5. Course Outcomes

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

CO Nos.	Course Outcomes	Level of learning domain (Based on revised Bloom's)
CO1	Excerpt the essential contents from a technical article.	K2
CO2	Prepare an informative power point presentation.	K2
CO3	Deliver the oral presentation to a group/team.	K2

(K5-Evaluate, S3-Skill Level)

6. Correlation of COs with Programme Outcomes

Cos	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
CO1					M	M	H	L	H		M	M	M	M
CO2					M	M	H	L	H		M	M	M	M
CO3					M	M	H	L	H		M	M	M	M

H- High; M-Medium; L-Low

7. Course Description

Students should select a literature from Science indexed journals and carefully read, understand and analyze the contents of the article. They have to summarize the work explored in the article sequential manner. A well-arranged power point presentation should be prepared. The students should deliver the seminar infront of the seminar review committee members. This presentation will be evaluated by a three-member review committee constituted by Head of the Department.

8. Revised Bloom's based Assessment Pattern

As per VTUR 15 regulations.

COURSE CODE	SEMINAR II	L	T	P	C
1156ME502		0	0	2	1

Course outcomes and K levels for the self-learning course - Seminar:

Course Category: Independent Learning

1. Preamble

This course provides the opportunity to gain the confidence of oral communication among the team members and others by preparing and presenting the technical and non-technical contents related to Mechanical Engineering.

2. Prerequisite

NIL

3. Links to other courses:

Major Project 1156ME701

4. Course Educational Objectives

Students undergoing this course are expected:

- To read and understand the contents of a journal article.
- To acquire the knowledge of extracting main contents from the article.
- To prepare a power point presentation based on the contents.
- To deliver the contents infront of the seminar review committee.

5. Course Outcomes

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

CO Nos.	Course Outcomes	Level of learning domain (Based on revised Bloom's)
CO1	Excerpt the essential contents from a technical article.	K2
CO2	Prepare an informative power point presentation.	K2
CO3	Deliver the oral presentation to a group/team.	K2

(K5-Evaluate, S3-Skill Level)

6. Correlation of COs with Programme Outcomes

Cos	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
CO1					M	M	H	L	H		M	M	M	M
CO2					M	M	H	L	H		M	M	M	M
CO3					M	M	H	L	H		M	M	M	M

H- High; M-Medium; L-Low

7. Course Description

Students should select a literature from Science indexed journals and carefully read, understand and analyze the contents of the article. They have to summarize the work explored in the article sequential manner. A well-arranged power point presentation should be prepared. The students should deliver the seminar infront of the seminar review committee members. This presentation will be evaluated by a three-member review committee constituted by Head of the Department.

8. Revised Bloom's based Assessment Pattern

As per VTUR 15 regulations.

COURSE CODE	ONLINE COURSES	L	T	P	C
		0	0		1

Course outcomes and K levels for the self-learning course – Online Courses:

Course Category: Independent Learning

1. Preamble

This course provides the opportunity to gain the knowledge on specialized topics of technical and non-technical contents related to Mechanical Engineering.

2. Prerequisite

NIL

3. Links to other courses:

Major Project 1156ME701

4. Course Educational Objectives

Students undergoing this course are expected:

- To register an online course, follow the instructions and get certified to earn a credit.

5. Course Outcomes

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

CO Nos.	Course Outcomes	Level of learning domain (Based on revised Bloom's)
CO1	Explain the information about the specialized topic, learned.	K2
CO2	Apply the techniques on carrying out the Major Project.	K3

(K5-Evaluate, S3-Skill Level)

6. Correlation of COs with Programme Outcomes

COs	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
CO1					M	M	H	M	M	M	M	M	H	M
CO2					M	M	H	M	M	M	M	M	H	M

H- High; M-Medium; L-Low

7. Course Description

Students should select and register for any of the courses offered by NPTEL, SWAYAM etc. as recommended by the BoS online courses. They have to learn the study materials supplied by the course provider and submit the assignments as per the requirements. Students have to appear for the online exam conducted by the course provider and should score pass mark. The certificate issued by the course provider must be submitted to the Department for the approval of credit. Students have to re-register at the institution for writing the exam and earn credit, in case of unable to appear for online examinations due to genuine reasons.

8. Revised Bloom's based Assessment Pattern

As per RC guidelines; refer VTUR 15 regulations.