Kavayitri Bahinabai Chaudhari

NORTH MAHARASHTRA UNIVERSITY,

JALGAON (M.S.)

Third Year Engineering

(Mechanical Engineering)

Faculty of Science and Technology

कवयित्री बहिणाबाई चौधरी उत्तर महाराष्ट्र विद्यापीठ

अंतरी पेटवू ज्ञानज्योत

1990

'A' Grade
NAAC Re-Accredited
3rd Cycle

SYLLABUS STRUCTURE

Semester – V&VI

W.E.F. 2020 – 21

Subject Group Code and Subject Groups

Sr. No.	GROUP	Category	Breakup of Credits (Total 160)
1	A	Humanities and Social Sciences including Management Courses (HSMC)	10
2	B	Basic Science Courses (BSC)	26
3	C	Engineering Science Courses including workshop, drawing, basics of electrical/mechanical/computer etc. (ESC)	26
4	D	Professional Core Courses (PCC)	53
5	E	Professional Elective Courses relevant to chosen specialization/branch (PEC)	18
6	F	Open subjects – Electives from other technical and /or emerging subjects (OEC)	12
7	G	Project work, seminar and internship in industry or appropriate work place/ academic and research institutions in India/abroad (PROJ)	15
8	H	Mandatory Courses (MC) [Environmental Sciences, Induction program, Indian Constitution, Essence of Indian Traditional Knowledge]	(non-credit)
		Total	160

Kavayatri Bahinabai Chaudhari NORTH MAHARASHTRA UNIVERSITY, JALGAON (M.S.)

Bachelor of Engineering (Mechanical Engineering)

Faculty of Science and Technology

'A' Grade
NAAC Re-Accredited
3rd Cycle

Syllabus Structure & Contents of Third Year of Engineering

Semester-V

w.e.f. 2020 – 2021

Syllabus Structure for Third Year Engineering (Semester – V) (Mechanical Engineering) (w.e.f. 2020 – 21) AICTE

Name of the Course	Group	Teaching Scheme				Evaluation Scheme					Credits
						Theory		Practical		Total	
		Theory Hrs / week	Tutorial Hrs / week	Practical Hrs / week	Total	ISE	ESE	ICA	ESE		
Heat Transfer	**D**	**3**	**--**	**--**	**3**	40	60	--	--	100	**3**
Manufacturing Processes	**D**	**3**	**--**	**--**	**3**	40	60	--	--	100	**3**
Strength of Materials	**D**	**3**	**--**	**--**	**3**	40	60	--	--	100	**3**
Professional Elective Course – I	**E**	**3**	**--**	**--**	**3**	40	60	-	-	100	**3**
Open Elective Course – I	**F**	**3**	**--**	**--**	**3**	40	60	-	-	100	**3**
Heat Transfer Lab	**D**	**--**	**--**	**2**	**2**	--	--	25	25 (PR)	50	**1**
Manufacturing Processes Lab	**D**	**--**	**--**	**2**	**2**	--	--	25	25 (OR)	50	**1**
Machine Drawing Lab	**D**	**--**	**--**	**2**	**2**	-	-	25	25 (OR)	50	**1**
Minor Project – I (Stage –I)	**G**	**--**	**--**	**6**	**6**	-	-	50	-	50	**3**
Constitution of India	**H**	**--**	**--**	**--**	**--**	--	--	--	--		**0**
		15	**--**	**12**	**27**	**200**	**300**	**125**	**75**	**700**	**21**

ISE: Internal Sessional Examination ESE: End Semester Examination ICA: Internal Continuous Assessment

Professional Elective Course – I	Open Elective Course – I
1) Instrumentation and Control	**1) Electronic Devices**
2) Process Planning and Tool Design	**2) Object Oriented Programming**
3) Energy Conservation & Management	**3) Introduction to Plastic Engineering**
4) Tribology	**4) Industrial Safety Engineering**

Syllabus Structure for Third Year Engineering (Semester – VI) (Mechanical Engineering) (w.e.f. 2020 – 21) AICTE

Name of the Course	Group	Teaching Scheme				Evaluation Scheme					Credits
						Theory		Practical		Total	
		Theory Hrs / week	Tutorial Hrs / week	Practical Hrs / week	Total	ISE	ESE	ICA	ESE		
Kinematics and Theory of Machines	**D**	3	--	--	3	40	60	--	--	100	**3**
Manufacturing Technology	**D**	3	--	--	3	40	60	--	--	100	**3**
Material Engineering	**D**	3	--	--	3	40	60	--	--	100	**3**
Professional Elective Course – II	**E**	3	--	--	3	40	60	-	-	100	**3**
Open Elective Course – II	**F**	3	--	--	3	40	60	-	-	100	**3**
Kinematics and Theory of Machines Lab	**D**	--	--	2	2	--	--	25	25 (OR)	50	**1**
Manufacturing Technology Lab	**D**	--	--	2	2	--	--	25	25 (OR)	50	**1**
Material Engineering Lab	**D**	--	--	2	2	--	--	25	-	25	**1**
Minor Project	**G**	--	--	6	6	-	-	50	25 (OR)	75	**3**
Internship*	**H**	-	-	-	-	-	-	-	-	-	-
		15	**--**	**12**	**27**	**200**	**300**	**125**	**75**	**700**	**21**

ISE: Internal Sessional Examination **ESE: End Semester Examination** **ICA: Internal Continuous Assessment**

Professional Elective Course – II	Open Elective Course – II
1**) Mechanical Transmission Systems**	**1) Software Engineering**
2) Mechanical Estimation and Costing	**2) Introduction to Data Structure**
3) Internal Combustion Engine	**3) Introduction to Micro-Electro-Mechanical Systems (MEMS)**
4) Solid Mechanics	**4) Piping Engineering**

NOTE: * Internship is a mandatory and non-credit course. It shall be during summer vacation after Semester – VI. The satisfactory completion of Internship should be submitted to University at the end of Semester – VIII.

HEAT TRANSFER					
COURSE OUTLINE					
Course Title:	**HEAT TRANSFER**	**Short Title:**	**HT**	**Course Code:**	

Course description:

This course introduces undergraduate students to Heat Transfer. The background required includes a sound knowledge of Mathematics (Calculus), Engineering Thermodynamics, Applied Thermodynamics and Fluid Mechanics of second year Level. The course aims at imparting knowledge of Heat Transfer and modes of Heat Transfer.

Lecture	Hours/week	No. of weeks	Total hours	Semester credits
	03	14	42	3

Prerequisite course(s):

Mathematics (Calculus) at first year level and Engineering
Thermodynamics, Applied Thermodynamics and Fluid Mechanics at Second Year Level.

Course objectives:

(1) The aim of the course is to build a solid foundation in heat transfer exposing students to the three basic modes namely conduction, convection and radiation.
(2) Rigorous treatment of governing equations and solution procedures for the three modes will be provided, along with solution of practical problems using empirical correlations.
(3) The course will also briefly cover boiling and condensation heat transfer, and the analysis and design of heat exchangers.

Course outcomes:

Upon Successful completion of this course, students will be able to:

1. formulate and analyze the steady state heat transfer in conduction
2. design, analyze and interpret the data for fins and transient heat conduction
3. obtain exact solution by analysing the correlation for natural and force convection in heat transfer model
4. apply knowledge of radiation law, analyze problems and find shape factor for various bodies.
5. design, analyze, performance evaluation of heat exchanger.

COURSE CONTENT

HEAT TRANSFER		Semester:	V
Teaching Scheme:		**Examination scheme**	
Lectures:	**3 hours/week**	**End semester exam (ESE):**	**60 marks**
		Duration of ESE:	**03 hours**
		Internal Sessional Exams (ISE):	**40 marks**

Unit–I:	No. of Lectures: 09 Hours	Marks: 12

Steady State Conductive Heat transfer:

Concepts and Mechanism of heat flow: Steady and unsteady state heat transfer, Modes of heat transfer, their physical mechanism.

Laws of heat transfer, thermal conductivity, heat transfer coefficient, radiation heat transfer coefficient. Isotropic and an-isotropic materials, Insulation materials, Thermal resistance and thermal conductance.
One dimensional heat conduction Boundary conditions, Steady state heat conduction without heat generation in plane wall, cylinder and sphere, Thermal contact resistance, critical thickness of insulation on cylindrical bodies.

Unit–II:	No. of Lectures: 09 Hours	Marks: 12

Steady and Unsteady State Conductive Heat transfer:
One dimension Steady state heat conduction with heat generation in plane wall, cylinder and sphere
Heat transfer from extended surface.: Types of fins, governing equation for pin fin for infinite long fin and fin with negligible heat loss, Fin performance, fin efficiency, fin effectiveness, overall fin effectiveness
Unsteady state heat conduction, Introduction to lumped system approximation and Biot number. Importance and use of Heissler charts.

Unit–III:	No. of Lectures: 08 Hours	Marks: 12

Convection Heat Transfer:
Natural and forced convection; Dimensional analysis; Thermal boundary layer.
Convection boundary layers: laminar, turbulent, Laminar flow over bodies, turbulent flow inside circular and non- circular ducts, Reynolds Colburn analogy for flow over flat plate and flow inside tube.
Heat transfer in fully developed flow, Natural convection over vertical planes, use of empirical correlation for convection
Principle of condensation and boiling, Pool boiling curve (No numerical treatment). Introduction mass transfer, Similarity between heat and mass transfer (No numerical treatment).

Unit–IV:	No. of Lectures: 08 Hours	Marks: 12

Radiation Heat Transfer:
Thermal radiation: Concept, Black body radiation, Spectral and total emissive power, Stefan Boltzmann law, Radiation laws. Irradiation and radiosity, Surface absorption, reflection and transmission, emissivity.
Radiation view factor, Properties of view factor, (numerical treatment on view factor on square cavity , triangular cavity , hemispherical cavity , concentric cylinder and sphere only)
Radiation heat exchange between two diffuse gray parallel surface, radiation shields.

Unit–V:	No. of Lectures: 08 Hours	Marks: 12

Heat Exchangers:
Classification of heat exchangers, temperature distribution in parallel, counter flow arrangement, condenser and evaporator, Overall heat transfer coefficient, fouling factor.
Log-mean temperature difference method and NTU –effectiveness method of analysis for rating and sizing of heat exchangers.
Construction aspects in brief. For good heat exchanger, Design aspects of Condensers, Reboilers and Evaporators.

Text Books:

1. J. P. Holman, "Heat Transfer" McGraw Hill, VII Edition.
2. P. Kothandaraman, "Fundamentals of Heat and Mass Transfer".
3. R. K. Rajput, "Heat and Mass Transfer", S. Chand & Company Ltd., New Delhi.
4. D. S. Kumar "Heat and Mass Transfer" D.S. Kumar, S. K. Kataria & Sons, Delhi.
5. P. K. Nag "Heat Transfer" Tata McGraw Hill Publishing Company Ltd., New Delhi.
6. Sachdeva R.C., "Fundamentals of Heat and Mass Transfer" Wiley Eastern Limited, Third Edition.
7. Sukhatme S.P, "A Text Book on Heat Transfer" (1989), 3rd Edition, Orient Longmans Ltd., New Delhi.
8. Arora S.C. & Domkundwar S., "A Course in Heat and Mass Transfer" (1994), Dhanpat Rai & Sons, IVth Edition.
9. Chapman A.J., "Heat Transfer" (1989), IVth Edition.
10. Yunus A. Cengel, "Heat Transfer –A Practical Approach" (Tata McGraw Hill)
11. M. M. Rathore "Engineering Heat and Mass Transfer", 2nd Edition, Laxmi Publications, New Delhi.
12. M. Thirumalseshwar,"Fundamentals of Heat and Mass Transfer" Pearson Education.
13. R. Rudramoorthy, K. Mayilsomy, "Heat Transfer", Pearson Education.

Reference Books:

1. Bejan, A., A. D. Kraus, Heat Transfer Handbook, John Wiley (2003).
2. W. J. McCabe, J. Smith, P. Harriot, Unit Operations of Chemical Engineering, Sixth Edition, McGraw Hill (2005).
3. Holman, J. P., S. Bhattacharya, Heat Transfer, 10th Ed., Tata McGraw-Hill (2011).
4. D. Q. Kern, Process Heat Transfer, Tata-McGraw Hill (1997).
5. R. Welty, C. E. Wicks, R. E. Wilson, G. Rorrer, "Fundamentals of Momentum, Heat and Mass Transfer", 4th Ed.,Wiley (2007).
6. F.P.Incropera, and D.P. Dewitt, "Fundamentals of Heat and Mass Transfer", John Wiley, Sixth Edition, 2007.
7. Massoud Kaviany, "Principles of Heat Transfer", John Wiley, 2002
8. Yunus A Cengel, "Heat Transfer : A Practical Approach", McGraw Hill, 2002

MANUFACTURING PROCESSES					
COURSE OUTLINE					
Course Title:	**Manufacturing Processes**	**Short Title:**	**MP**	**Course Code:**	

Course description:

This course is designed to introduce students with different manufacturing processes. The course will help students understand the manufacturing and joining processes and their applications. Students will be able to solve the problems related to load design for forming process and poring time in casting processes. They will be familiarized with different machining process and machine tools such as lathe machine, shaper machine and planer machine.

	Hours/week	No. of weeks	Total hours	Semester credits
Lecture	03	14	42	3

Prerequisite course(s):

Workshop practice, Physics.

Course objectives:

To motivate and challenge students to understand and develop an appreciation of the processes in correlation with material properties which change the shape, size and form of the raw materials into the desirable product by conventional or unconventional manufacturing methods.

Course outcomes:

Upon Successful completion of this course, students will be able to understand:

1. Understand metal casting process, calculate pouring time, elements of gating system and defects in it.
2. Understand principle of metal forming and working of various metal forming processes.
3. Understand meaning, use of welding, techniques and types of it.
4. Understand working of machines used in manufacturing and their use.
5. Understand process of powder metallurgy, use and properties of products.

COURSE CONTENT

Manufacturing Processes		**Semester:**	**V**
Teaching Scheme:		**Examination scheme**	
Lectures:	**3 hours/week**	**End semester exam (ESE):**	**60 marks**
		Duration of ESE:	**03 hours**
		Internal Sessional Exams (ISE):	**40 marks**

Unit–I:	No. of Lectures: 09 Hours	Marks: 12

Metal Casting Process: Casting and moulding: Casting, Patterns; types, material and design including pattern allowances; Moulding sands; composition, preparation, properties and testing; Core; Purpose, definition, materials, preparation and applications; Gating system; elements of gating system, characteristics, Classification, Estimation of pouring time for top gate and bottom gate type moulds. Heat transfer and Solidification, Inspection of casting, Special casting processes, Defects in casting processes. Design of gating system; pouring basin, sprue, runner and risers; Advantages.

Unit–II:	**No. of Lectures: 09 Hours**	**Marks: 12**
Metal Forming Processes: Theoretical basis for metal forming process, Advantages and disadvantages of metal forming, Classification of metal forming, Effect of variables on metal forming, forging; Classification, considerations for sound forging, forging defects, rolling; Hot and cold rolling, Mechanism of rolling, Analysis of rolling process, Types of rolling mill, rolling defects, Drawing; Wire, Rod and Tube. Extrusion; types of extrusion, Advantages and disadvantages.		
Unit–III:	**No. of Lectures: 08 Hours**	**Marks: 12**
Welding/ Joining Process: Welding; Definition, Advantages, Limitations, Applications, Classification of welding process, Gas welding processes, types of flame, Torch angle, Factors influencing torch angle, welding techniques in gas welding, use of filler rod and fluxes. Arc welding operation, Design of weld bead, Electrode, designation of electrode, Crowning, Spatter, Magnetic arc blow, TIG welding, MIG welding, Soldering, Brazing and Braze welding operation, Thermit welding, Electro-slag welding, Defects in welding.		
Unit–IV:	**No. of Lectures: 08 Hours**	**Marks: 12**
Machining: Lathe machine; Parts of lathe machines (Tail stock, Head stock, Carriage, Bed), Operations on lathe (Plain turning, Taper turning, Thread cutting, Chamfering, Knurling). Shapers and Planners; Introduction, Shaper machine, cutting tools used in shaping, Planning machine, Principal of working. Milling Process; Introduction, Basic Milling process, types of milling process; peripheral milling, Face milling, End Milling, Milling machines. Grinding; Introduction, Specification of grinding wheel, Glazing.		
Unit–V:	**No. of Lectures: 08 Hours**	**Marks: 12**
Powder Metallurgy: Introduction, Advantages and limitations of P/M, Manufacturing of metal powders, Mixing and blending, Compaction, Sintering, Secondary operations, Recent trends in powder metallurgy, properties of powder metallurgy parts, Comparison of P/M parts with other processes.		
Text Books:		
1. Dr. P. C. Sharma, Production Technology (Manufacturing Processes), S. Chand & Company Ltd. 2. Dr. P. C. Sharma, Production Engineering, S. Chand & Company Ltd. 3. H. N. Gupta, R. C. Gupta, Arun Mittal, Manufacturing Processes, , New Age International Publishers 4. Kalpakjian and Schmid, Manufacturing processes for engineering materials, (5th Edition) Pearson India, 2014. 5. Mikell P. Groover, Fundamentals of modern manufacturing, John Wiley and Sons, Inc. 6. Degarmo, Black & Kohser, Materials and Processes in Manufacturing		
Reference Books:		
1. R. K. Jain, Production Technology, Khanna Publishers. 2. P. N. Rao, Manufacturing technology, Vol-I & II McGraw Hill publications 3. Hajara Choudhari, Bose S.K Elements of Workshop Technology Volume I & II		

4. H. S. Shah, Manufacturing process Vol-I, Pearson New Delhi.
5. Serope Kalpakjian, Manufacturing Processes, Pearson New Delhi.
6. Amitabha Ghosh, Asok Kumar Mallik, Manufacturing Science, Pearson, India.

STRENGTH OF MATERIALS

COURSE OUTLINE

Course Title:	Strength of Materials	Short Title:	SOM	Course Code:	

Course description:

The course is designed to understand the basic concepts of stress, strain and their variations due to different type of loading. The concept of Mechanical properties, Poisson's ratio, bulk modulus, elastic modulus, modulus of rigidity, combined stress and strain, principal stress, principal plane, bending moment and shear force in beam under various loading conditions.

It focuses on the concepts of bending stresses and shear stresses in beams. Understanding of torsional shear stress in solid and hollow shaft; principal and maximum shear stress in a circular shaft subjected to combined stresses.

Lecture	Hours/week	No. of weeks	Total hours	Semester credits
	03	14	42	3

Prerequisite course(s):

Mathematics (Calculus) and Engineering Mechanics

Course objectives:

1. To understand the nature of stresses developed in simple geometries such as bars, cantilevers, beams, shafts, cylinders and spheres for various types of simple loads.
2. To calculate the elastic deformation occurring in various simple geometries for different types of loading**.**

Course outcomes:

After successful completion of this course the student will be able to:

1. Recognize various types loads applied on machine components of simple geometry and understand the nature of internal stresses that will develop within the components
2. Evaluate principal stresses, strains and apply the concept for design and Draw the SFD and BMD for different types of loads and support conditions
3. Determine the stresses and strains in the members subjected bending and Evaluate the slope and deflection of beams subjected to loads
4. Determine the stresses and strains in the members subjected to torsional loads.
5. Determine the stresses and strains in the pressure vessels due to intensity of pressure

COURSE CONTENT

Strength of Materials		Semester:	V
Teaching Scheme:		Examination scheme	
Lectures:	3 hours/week	End semester exam (ESE):	60 marks
		Duration of ESE:	03 hours
		Internal Sessional Exams (ISE):	40 marks

Unit–I:	No. of Lectures: 09 Hours	Marks: 12

Deformation in solids- Hooke's law, stress and strain, tension, compression and shear Stresses, elastic constants and their relations, volumetric, linear and shear strains, bars with cross-sections

varying in steps, bars subjected to varying loads, indeterminate structural problems, compound bars.		
Unit–II:	**No. of Lectures: 09 Hours**	**Marks: 12**
Principal stresses and principal planes, Mohr's circle. Beams and type's transverse loading on beams, shear force and bend moment diagrams, Types of beam supports, simply supported and over-hanging beams, cantilevers.		
Unit–III:	**No. of Lectures: 08 Hours**	**Marks: 12**
Theory of bending of beams, bending stress distribution and neutral axis, shear stress distribution, point and distributed loads. Deflection of a beam using double integration method, computation of slopes and deflection in beams, Maxwell's reciprocal theorems.		
Unit–IV:	**No. of Lectures: 08 Hours**	**Marks: 12**
Torsion, stresses and deformation in circular and hollow shafts, stepped shafts, deflection of shafts fixed at both ends, stresses and deflection of helical springs.		
Unit–V:	**No. of Lectures: 08 Hours**	**Marks: 12**
Axial and hoop stresses in cylinders subjected to internal pressure, deformation of thick and thin cylinders, deformation in spherical shells subjected to internal pressure.		
Text Books:		
1. S. Ramamruthan, Strength of Materials, Dhanpat Rai & Co. (p) Ltd. New Delhi, 2001. 2. R. Subramanian, Strength of Materials, Oxford University Press, 2007. 3. Ferdinand P. Been, Russel Johnson Jr and John J. Dewole, Mechanics of Materials, Tata McGraw Hill Publishing Co. Ltd., New Delhi 2005.		
Reference Books:		
1. Pytel A H and Singer F L, "Strength of Materials", Harper Collins, New Delhi. 2. Beer P F and Johston (Jr) E R, "Mechanics of Materials", SI Version, McGraw Hill, NY. 3. Popov E P, "Engineering Mechanics of Solids", SI Version, Prentice Hall, New Delhi. 4. Timoshenko S P and Young D H, "Elements of Strength of Materials", East West Press, New Delhi. 5. Shames, I. H., Pitarresi, J. M., "Introduction to Solid Mechanics," Prentice-Hall, NJ. 6. NPTEL courses, http://nptel.iitm.ac.in/courses.php, web and video courses on Strength of Materials by Prof. Sharma, S. C., and Prof. Harsha, S. P.		

INSTRUMENTATION AND CONTROL

COURSE OUTLINE

Course Title:	Instrumentation and Control	Short Title:	IC	Course Code:	

Course description:

This course is designed to provide a knowledge base in the area of industrial sensors and transducers used to measure temperature, pressure, flow & level. Topics will include: operating theory of principal industrial process sensors; instrument calibration and installation practices with industrial applications as working examples in a modern automated control system.

Lecture	Hours/week	No. of weeks	Total hours	Semester credits
	3	14	42	3

Prerequisite course(s):

Electrical drives and Controls, Physics,

Course objectives:

1. To provide basic knowledge about measurement systems and their components.
2. To learn about various sensors, use for measurement of mechanical quantities.
3. To learn about systems stability and control.
4. To integrate the measurement systems with the process for process monitoring and control.

Course outcomes:

After successful completion of this course the student will be able to:

1. Understand the measurement of various quantities using instruments, their accuracy and range, and the techniques for controlling devices automatically.
2. Describe a given instruments basic theory of operation and its inherent capabilities and limitations.
3. Select an instrument based on his knowledge of basic applications.
4. Interpret measurement data properly, supported by his developed appreciation for a given instruments accuracy, precision and operating limits.
5. Define certain terms used in the calibration of instrumentation

COURSE CONTENT

Instrumentation and Control		Semester:	V
Teaching Scheme:		**Examination scheme**	
Lectures:	**3 hours/week**	**End semester exam (ESE):**	**60 marks**
		Duration of ESE:	**03 hours**
		Internal Sessional Exams (ISE):	**40 marks**

Unit–I:	No. of Lectures: 09 Hours	Marks: 12

Introduction to Measurement Systems : Introduction, Monitoring and control of processes and operations, Experimental engineering analysis, Functional elements of an instrument, active and passive transducers, analog and digital modes of operations, Null and deflection methods, input-output configurations, methods of correction

Unit–II:	No. of Lectures: 09 Hours	Marks: 12
Performance Characteristics of Measurement systems: systems, Instrumentation systems, Sensors, signal processors, data presentation, accuracy and error, hysteresis error, non-linearity error, insertion error, Range, Precision, Repeatability, reproducibility, Sensitivity, Stability, Dynamic characteristics, response, rise and setting time, Reliability, Calibration		
Unit–III:	**No. of Lectures: 08 Hours**	**Marks: 12**
Sensors for common Engineering measurements: Displacement sensors – Potentiometers, Strain gauges, Capacitive elements, LVDT, Optical encoders, Proximity sensors Speed Sensors – Tachogenerators, Diaphragm sensors, Piezoelectric sensors, Fluid Flow Sensors - Orifice plate, Rotameter, Turbine meter, Liquid level Sensors - Ultrasonic liquid gauge, Lad cell Temperature sensors – Bimetallic strips, Resistance temperature detectors, Thermisters, Thermocouples, Pyrometers,		
Unit–IV:	**No. of Lectures: 08 Hours**	**Marks: 12**
Control system: Introduction, history of automatic control, basic elements, open and closed loop systems, use of feedback in Control system , – Transfer function: Block diagram, control method, selection of control method, P, PI, PID, tuning of controllers		
Unit–V:	**No. of Lectures: 08 Hours**	**Marks: 12**
Control system design & Applications: Control system design process, Design Examples such as Turntable Speed Control, Insulin Delivery Control System, Disk Drive Read System, Examples of modern control systems, Automatic assembly and Robots, Mechatronic systems, The Future Evolution of Control Systems		
Text Books:		
1. Ernest O. Doeblin (2004), Measurement Systems: Application and Design, 5th Edition, Tata McGraw- Hill. 2. Katsuhiko Ogata (2010), Modern Control Engineering, 5th Edition, Prentice Hall of India Pvt. Ltd. 3. D S Kumar, Mechanical Measurements and Control Engineering, Metropolitan Book Company Pvt. Limited 4. Patranabis D, Instrumentation and Control, PHI learning. 5. Arun K Ghosh, Introduction to control systems, PHI learning. 6. R K Rajput, Mechanical Measurements & Instrumentation, S. K. Kataria & Sons.		
Reference Books:		
1. R. Munasinghe, Classical Control Systems: Design and Implementation, Alpha Science 2. J.P. Holman (2004), Experimental Methods for Engineers, Tata McGraw-Hill. 3. Williams Bolton (2004), Instrumentation and control, Elsevier Ltd. 4. Kevin James (2000), PC Interfacing and Data Acquisition: Techniques for Measurement, Instrumentation and Control, Newnes Publishers.		

PROCESS PLANNING AND TOOL DESIGN					
COURSE OUTLINE					
Course Title:	**Process Planning and Tool Design**	**Short Title:**	**PPTD**	**Course Code:**	
Course description:					
Tools are as basic component for any machining process. The quality and efficiency of any machining operation basically depends upon quality of tools which in turn depends upon the proper shape, size and material of the tools. Productivity and quality of machining operations may further be enhanced by proper and quick mounting of tools and jobs on machines. Jigs and fixture play an import roll in this process. Therefore, this course attempts to develop abilities in students to select a tool of proper size and shape for required machining operation. The design of cutting tools, jigs and fixtures are also dealt with in this course. This course is therefore a core course for mechanical engineers.					

Lecture	**Hours/week**	**No. of weeks**	**Total hours**	**Semester credits**
	03	14	42	3

Prerequisite course(s):
Manufacturing processes, Workshop Practice
Course objectives:
i. To introduce process planning concepts ii. To aware about cutting tool standards iii. To introduce design and operations of jigs, fixtures & press design
Course outcomes:
After successful completion of this course the student will be able to:
1. Understand methods of process planning and interpret manufacturing drawing. 2. Calculate process parameters for various machining processes. 3. Select proper tool for given manufacturing operation 4. Select and design jig and fixture for given simple component. 5. Classify and explain various press tools and press tools operations.

COURSE CONTENT			
Process Planning and Tool Design		**Semester:**	**V**
Teaching Scheme:		**Examination scheme**	
Lectures:	**3 hours/week**	**End semester exam (ESE):**	**60 marks**
		Duration of ESE:	**03 hours**
		Internal Sessional Exams (ISE):	**40 marks**

Unit–I:	**No. of Lectures: 08 Hours**	**Marks: 12**
Introduction of Process Planning- methods of process planning, 1. Manual Process planning 2. Computer Aided Process planning (CAPP) a. Retrieval CAPP system b. Generative CAPP system, drawing interpretation, material evaluation, steps in process selection, production equipment and tooling selection.		
Unit–II:	**No. of Lectures: 08 Hours**	**Marks: 12**

Process planning activities- process parameter calculation for various production processes, selection of jigs and fixtures, selection of quality assurance methods, documents for process planning, economics of process planning, case studies.

Unit–III:	No. of Lectures: 08 Hours	Marks: 12

Cutting tool standards and materials; Economic of cutting tools; Design of Single point cutting tool; Form tool; Design of circular & tangential form tools, drills, reamers, milling cutters and Broaches.

Unit–IV:	No. of Lectures: 09 Hours	Marks: 12

Locating and clamping principles; Degree of freedom; Fool proofing and ejecting; Locating & Clamping devices; Concept, meaning, differences and benefits of jigs and fixtures; Types, sketches with nomenclature, working and applications of jigs; Types, sketches with nomenclature, working and applications of fixtures; Steps to design jigs and fixture; Design jig and fixture for given simple component.

Unit–V:	No. of Lectures: 09 Hours	Marks: 12

Press working processes-types, sketches and applications; Press tools: types, working, components and their functions; Concept, meaning, definitions and calculations of press tonnage and shut height of press tool, Shear action in die cutting operation, Centre of pressure; Die clearance; Cutting force; Shear angle; Scrap strip layout; Cutting dies-types and applications; Design of progressive cutting die, Design of drawing die.

Text Books:

1. Process, Planning and Cost Estimation By R. Kesava, C. Elanchezhian and B. Vijaya Ramnath, 2nd ed. New Age International 2018.
2. Process Planning and Cost Estimation by Panneerselvam R., Prentice-Hall of India Pvt. Ltd.
3. Machine Tool Engineering by Nagpal, Khanna Publishers.
4. Press Tool Design by P H Joshi, Tata Mc Graw Hill
5. Jigs & Fixtures by P H Joshi, Tata Mc Graw Hill

Reference Books:

1. Peter Scalon, Process Planning, Design/ Manufacture Interface, Elsevier Sci. &Tech. 2002.
2. Ostwaal P.F. and Munez J., Manufacturing Processes and Systems, 9th Ed, John Wiley 1998
3. Chitale A.V. and Gupta R.C., Product Design and Manufacturing, Prentice Hall.
4. Tool Design, Donaldson, Mc Graw Hill

ENERGY CONSERVATION AND MANAGEMENT

COURSE OUTLINE

Course Title:	Energy Conservation and Management	Short Title:	ECM	Course Code:	

Course description:

Compare and contrast energy management practices and opportunities, including monitoring. Describe and analysis energy efficiency tools. Describe key issues in energy resource management and green building. Discuss and discern the history of energy sources and the conservation of and future of resources needed to maintain our economy. Describe and discuss a variety of world and regional energy policies. Communicate reasons for environmental protection and renewable energy implementation. Explain energy accounting and analysis and how it is used in energy assessment. Demonstrate understanding of rate of return and life cycle cost analysis

Lecture	Hours/week	No. of weeks	Total hours	Semester credits
	03	14	42	03

Prerequisite course(s):

Fundamental knowledge of basic thermodynamic, energy conservation systems, Applied Thermodynamics and Fluid Mechanics.

Course objectives:

At the end of the course, the student is expected to

- Understand and analyse the energy data of industries
- Carryout energy accounting and balancing
- Conduct energy audit and suggest methodologies for energy savings and
- Utilise the available resources in optimal ways

Course outcomes:

Upon completion of this course, the students can able to:

1. utilise the available resources in optimal ways
2. apply the knowledge of the subject to calculate the efficiency of various thermal utilities.
3. to design suitable energy monitoring system to analyze and optimize the energy consumption in electrical utilities
4. handle various measuring devices needed for energy audit
5. understand and analyse the energy data of industries

COURSE CONTENT

Energy Conservation and Management		Semester:	V
Teaching Scheme:		Examination scheme	
Lectures:	3 hours/week	End semester exam (ESE):	60 marks
		Duration of ESE:	03 hours
		Internal Sessional Exams (ISE):	40 marks

UNIT I	No. of Lectures: 08 Hours	Marks: 12

Energy – Power – Past & Present Scenario of World; National Energy Consumption Data – Environmental Aspects Associated with Energy Utilization –Energy Auditing: Need, Types, Methodology and Barriers. Role of Energy Managers. Future Energy Options: Sustainable

Development, Energy Crisis: Transition from carbon rich and nuclear to carbon free technologies, parameters of transition. Energy Security: Chemical and Nuclear: Non Proliferation, Energy Security, Energy Consumption and its impact on environmental climatic change.		
UNIT II	**No. of Lectures: 08 Hours**	**Marks: 12**
Thermal systems, Boilers, Furnaces and Thermic Fluid heaters- efficiency computation and energy conservation measures; Steam distribution and usage, steam traps, condensate recovery, flash steam utilization; Insulation & Refractories.		
UNIT III	**No. of Lectures: 08 Hours**	**Marks: 12**
Energy conservation in major utilities; pumps, fans, blowers, compressed air systems, Refrigeration & Air Conditioning systems, Cooling Towers, DG sets.		
UNIT–IV	**No. of Lectures: 08 Hours**	**Marks: 12**
Defining monitoring & targeting, elements of monitoring & targeting, data and information-analysis, techniques – energy consumption, production, cumulative sum of differences (CUSUM). Energy Management Information Systems (EMIS) Basic measurements – Electrical measurements, Light, Pressure, Temperature and heat flux, Velocity and Flow rate, Vibrations, etc. Instruments Used in Energy systems: Load and power factor measuring equipment's, Wattmeter, flue gas analysis, Temperature and thermal loss measurements, air quality analysis etc. Mathematical and statistical modelling and analysis.		
Unit–V:	**No. of Lectures: 08 Hours**	**Marks: 12**
Definition, Energy management (audit) approach-understanding energy costs. Bench marking, energy performance, matching energy use to requirement, Maximizing system efficiencies, optimizing the input energy requirements, fuel and energy substitution. Financial Management: Energy Economics- discount period, payback period, internal rate of return, net present value; Life Cycle costing- ESCO concept.		
Text Books:		
1. Energy Manager Training Manual (4 Volumes) Available At www.Energymanager Training.Com, A Website Administered by Bureau of Energy Efficiency (BEE), A Statutory Body Under Ministry of Power, Government of India, 2004.		
Reference Books:		
1. Witte. L.C., P.S. Schmidt, D.R. Brown, "Industrial Energy Management And Utilisation" Hemisphere Publ, Washington, 1988. 2. Callaghn, P.W. "Design And Management For Energy Conservation", Pergamon Press, Oxford, 1981. 3. Dryden. I.G.C., "The Efficient Use Of Energy" Butterworths, London, 1982 4. Turner. W.C., "Energy Management Hand Book", Wiley, New York, 1982. 5. Murphy. W.R. And G. Mc KAY, "Energy Management", Butterworths, London 1987.		

TRIBOLOGY

COURSE OUTLINE

Course Title:	Tribology	Short Title:	TRB	Course Code:	

Course description:

The course aim of imparting the knowledge of Tribology. The background required includes knowledge of mathematics, chemistry, engineering materials, and fluid mechanics. The objective of the course is to understand the tribilogical concept, bearing design and its application, lubrication practices.

Lecture	Hours/week	No. of weeks	Total hours	Semester credits
	3	14	42	3

Prerequisite course(s):

Fundamental Knowledge of Physics, Chemistry, Engineering Maths, Fluid Mechanics, Machine Design and Engineering materials.

Course objectives:

1. To introduce tribology as an important design consideration that affects the performance of engine and automotive elements.
2. To teach different bearing types, modelling and performance considerations.
3. To introduce concepts in friction and wear phenomena.

Course outcomes:

After successful completion of this course the student will be able to:

1. select tribological elements based on design considerations.
2. realize the importance of wear
3. apply the knowledge of and lubricants for different applications.
4. describe the concept of idealized journal bearing and slider bearing under different load carrying conditions
5. Illustrate the behaviour of tribological components subjected to different working conditions and describe different tribological measures

COURSE CONTENT

Tribology		Semester:	V
Teaching Scheme:		Examination scheme	
Lectures:	3 hours/week	End semester exam (ESE):	60 marks
		Duration of ESE:	03 hours
		Internal Sessional Exams (ISE):	40 marks

Unit–I:	No. of Lectures: 09 Hours	Marks: 12

Surfaces and Friction- Topography of Engineering surfaces- Contact between surfaces - Sources of sliding Friction -Adhesion Ploughint- Energy dissipation mechanisms, Friction Characteristics of metals - Friction of non-metals. Friction of lamellar solids - friction of Ceramic materials and polymers - Rolling Friction. Source of Rolling Friction - Stick slip motion - Measurement of Friction.

Unit–II	No. of Lectures: 09 Hours	Marks: 12
Wear- Types of wear - Simple theory of Sliding Wear Mechanism of sliding wear of metals - Abrasive wear. Materials for Adhesive and Abrasive wear situations - Corrosive wear -Surface Fatigue wear situations - Brittle Fracture wear - Wear of Ceramics and Polymers – Wear Measurements.		
Unit–III	**No. of Lectures: 08 Hours**	**Marks: 12**
Lubricants and Lubrication Types- Types and properties of Lubricants – Testing methods - Hydrodynamic Lubrication – Elasto hydrodynamic lubrication- Boundary Lubrication - Solid Lubrication Hydrostatic Lubrication.		
Unit–IV	**No. of Lectures: 08 Hours**	**Marks: 12**
Film Lubrication Theory- 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 - Reaction torque on the bearings –Virtual Coefficient of friction - The Somerfield diagram.		
Unit–V	**No. of Lectures: 08 Hours**	**Marks: 12**
Surface Engineering and Materials for Bearings- Surface modifications - Transformation Hardening, surface fusion – Thermo-chemical processes - Surface coatings – Plating and anodizing Fusion Processes - Vapour Phase processes - Materials for rolling Element bearings - Materials for fluid film bearings - Materials for marginally lubricated and dry bearings.		
Text Books:		
1. Prasanta Sahoo, (2009) Engineering Tribology, PHI Learning Private Limited. 2. Bharat Bhushan, (2002), Introduction to tribology, John Wiley and Sons. 3. T.A. Stolarski, Tribology in Machine Design , Industrial Press Inc		
Reference Books:		
1. I.M. Hutchings, Tribology, Friction and Wear of Engineering Material, Edward Arnold 2. E. P. Bowden and Tabor. D., Friction and Lubrication, Heinemann Educational Books Ltd 3. A. Cameron, Basic Lubrication theory, Longman, U.K.., 1981. 4. M. J. Neale (Editor), Tribology Handbook, Newnes Butter worth, Heinemann, U.K. 5. Fuller D.D., (1999), Theory and practice of Lubrication for engineers, John Wiley sons.		

ELECTRONIC DEVICES

COURSE OUTLINE

Course Title:	Electronic Devices	Short Title:	ED	Course Code:	

Course description:

This is a fundamental course, basic knowledge of which is required by all the engineers in every sphere of engineering & industry. This course includes study of semiconductor based electronic devices such as diodes, bipolar junction transistors, FETs, SCR, Integrated circuits its applications and related components. This course is designed to introduce to the students to the basic principles, characteristics, analysis and applications of electronic devices.

Lecture	Hours/week	No. of weeks	Total hours	Semester credits
	03	14	42	3

Prerequisite course(s):

Introduction to basics of Electronics Engineering

Course objectives:

1. To deliver the knowledge about physics of basic semiconductor devices and circuits.
2. To enhance comprehension capabilities of students through understanding of electronic devices and circuits.
3. To perform DC and AC analysis of single stage amplifiers
4. To introduce and motivate students to the use of advanced electronic devices.
5. To analyze and design electronic circuits using semiconductor devices

Course outcomes:

After successful completion of this course the student will be able to:

1. Students will be able to explain working of electronic devices.
2. Students will be able to analyze characteristics of semiconductor devices like diode, BJT, FET, MOSFET, OPAMP etc.
3. Students will be able to perform DC and AC analysis of Electronics circuits.
4. Students will be able to select best circuit for the given specifications/application.
5. Students will be able to learn the different power devices and their applications.

COURSE CONTENT

Electronic Devices		Semester:	V
Teaching Scheme:		**Examination scheme**	
Lectures:	**3 hours/week**	**End semester exam (ESE):**	**60 marks**
		Duration of ESE:	**03 hours**
		Internal Sessional Exams (ISE):	**40 marks**

Unit–I:	No. of Lectures: 09 Hours	Marks: 12

SEMICONDUCTOR DIODES:

PN junction diode, Current equation, equivalent circuit of diode, Breakdown in PN Junction Diodes, Diode applications: Full wave Rectifier with capacitor filter Circuit, Clipper, Clamper, Voltage Multipliers. Principle of Operation and Characteristics of Tunnel Diode, Power diode, Varactor Diode, Photo diode, Zener diode characteristics, Zener as regulator.

Unit–II:	No. of Lectures: 09Hours	Marks: 12

BIPOLAR JUNCTION TRANSISTORS:

Operating Point, The DC and AC Load line, Need of biasing, Voltage Divider Bias, Bias Stability, Hybrid parameter model of BJT for Low frequency, Analysis of a Transistor Amplifier Circuit using h - Parameters for Common Base, Common Emitter and Common Collector Configurations, Comparison of CB, CE, and CC Amplifier Configurations.

Unit–III:	No. of Lectures: 08 Hours	Marks: 12

FIELD EFFECT TRANSISTORS:

JFET, MOSFET and their parameters, Transfer characteristics equations, JFET Biasing, Different biasing methods, FET as Voltage Variable Resistor, JFET Small Signal Model, Small signal analysis of JFET for Common Source Amplifier and Common Drain Amplifier, Comparison of MOSFET with JFET and BJT.

Unit–IV:	No. of Lectures: 08 Hours	Marks: 12

OPERATIONAL AMPLIFIER AND TIMER CIRCUIT :

Block diagram of OPAMP, Differential Amplifier - Ad, Ac & CMRR, OPAMP Applications: Inverting and Non inverting amplifier, Voltage follower (Buffer), Instrumentation Amplifier, Active first order filter: Low pass and high pass filter; IC 555 timer Operating modes: monostable, astable multivibrator.

Unit–V:	No. of Lectures: 08 Hours	Marks: 12

POWER DEVICES AND DISPLAY DEVICES

SCR Construction & V-I characteristics, UJT triggering circuit, turning-off of a SCR (preliminary discussion), Gate Turn-off thyristor (GTO), Structure and V-I characteristics of Triac and Diac, Applications of Triac-Diac circuit. Power BJT, IGBT, Power MOSFET-DMOS-VMOS, LED, LCD, Photo transistor, Opto Coupler, Solar cell.

Text Books:

1. Millman and Halkies, “Integrated Electronics”, TATA McGraw Hill.
2. David A. Bell, “Electronic Devices and Circuits” Oxford.

Reference Books:

1. R.L. Boylestad and Louis Nashelsky, " Electronic Devices and Circuit Theory", Pearson
2. S. Salivahanan, N. Suresh Kumar,“Electronic Devices and Circuits”, Tata McGraw Hill
3. T. Floyd, “Electronics Devices” conventional current version, Pearson,
4. D. Cheruku, B. Tirumala Krishna, “Electronics Devices and Circuits”, Pearson
5. R. Gaikward, “Op amp and Integrated circuit”, 4 th Edition, Prentice Hall India Ltd

OBJECT ORIENTED PROGRAMMING					
COURSE OUTLINE					
Course Title:	**Object Oriented Programming**	**Short Title:**	**OOP**	**Course Code:**	
Course description: This course covers object-oriented programming principles and techniques using C++.					
Lecture	**Hours/week**	**No. of weeks**	**Total hours**	**Semester credits**	
	3	14	42	3	
Prerequisite:					
Computer Programming					
Course objectives:					
1. Understand Object Oriented Programming concepts 2. To become a good programmer					
Course outcomes:					
After successful completion of this course the student will be able to:					
1. To differentiate between applying either procedure oriented or object oriented technique to a given problem. 2. To apply the advanced features of C++ such as inheritance, polymorphism 3. To apply object oriented techniques to solve bigger computing problems.					
COURSE CONTENT					
Object Oriented Programming		**Semester:**	V		
Teaching Scheme:		**Examination scheme**			
Lectures:	**3 hours/week**	**End semester exam (ESE):**		**60 marks**	
		Duration of ESE:		**03 hours**	
		Internal Sessional Exams (ISE):		**40 marks**	
Unit–I:	**No. of Lectures: 09 Hours**	**Marks: 12**			
Principles of OOP: Software crisis, Software evolution, OOP paradigm, Basic Concepts of OOP, Benefits & applications of OOP. **Functions:** Function, function prototype, accessing function and utility function. **Moving from C to C++:** Declaration of variable, Reference variables, Scope resolution operator, Member dereferencing operator, memory management operators. **Beginning with C++:** What is C++, Applications of C++, A Simple C++ Program.					
Unit–II:	**No. of Lectures: 09 Hours**	**Marks: 12**			
Classes and Objects: Class, Object, class and data abstraction, class scope and accessing class members, Controlling access to members, Objects and Memory requirements, Defining member functions, A C++ program with class, Making an outside function inline, Nesting of member function, Private member function, Arrays within class, Member allocation for objects, Arrays of objects, Objects as function arguments. Static Class members, Static Functions, inline function, Friend Function					

Constructors & Destructors: Constructors, Parameterized constructors, Multiple constructors in a class, Constructors with default arguments, Destructors.		
Unit–III:	**No. of Lectures: 08 Hours**	**Marks: 12**
Polymorphism: Operator overloading concept, Use of operator overloading, defining operator overloading, Binary operator overloading. **Inheritance-** Base Class and derived Class, protected members, relationship between base Class and derived Class, Constructor and destructor in Derived Class, Overriding Member Functions, Class Hierarchies, Inheritance, Public and Private Inheritance, Levels of Inheritance, Multiple Inheritance, Ambiguity in Multiple Inheritance.		
Unit–IV:	**No. of Lectures: 08 Hours**	**Marks: 12**
Virtual Functions-Pointers- indirection Operators, Memory Management: new and delete, Pointers to Objects, accessing Arrays using pointers, Function pointers, Pointers to Pointers, this Pointer, virtual function, pure virtual functions, dynamic binding, Virtual destructor. **Manipulators:** Input, Output, Parameterized		
Unit–V:	**No. of Lectures: 08 Hours**	**Marks: 12**
Files and Streams : Classes for File Stream Operation, Opening and closing a file, Detecting end of file, File modes, File pointer and their manipulation, Sequential input and output operation, Updating a file: Random Access, Error handling during file operations, Command line arguments.		
Text Books:		
1. E. Balagurusamy, Object Oriented Programming with C++, McGraw Hill Company, 5^{th} /6^{th} edition 2. Yashawant Kanetkar, Let us C++, BPB publications		
Reference Books:		
1. Barbara Johnson, C++ programing today, 2. Schmidt, The complete reference C++		

INTRODUCTION TO PLASTIC ENGINEERING					
COURSE OUTLINE					
Course Title:	**Introduction to Plastic Engineering**	**Short Title:**	**IPE**	**Course Code:**	
Course description:					
The course consists of the study of properties of polymers (bulk and rheological and thermal properties) and why they are important to understanding polymer processing. This course will emphasize the fundamental principles of the extrusion process and examine the correlation between elements of the extruder, polymer properties, and processing variables and why they all must be considered when studying and understanding a plastics processing technique.					

Lecture	**Hours/week**	**No. of weeks**	**Total hours**	**Semester credits**
	3	14	42	3

Prerequisite course(s):

Chemistry, Engineering Mechanics, Introduction to Engineering design principles,

Course objectives:

1. To evaluate the properties and processing methods.
2. To evaluate the different methods of processing plastics in terms of their fundamental advantages and disadvantages from a product design perspective.
3. To describe engineering design methods for plastic products including stress analysis and creep analysis.
4. To provide an appreciation of the environmental, life cycle and recycling issues related to the use of plastics.

Course outcomes:

After successful completion of this course the student will be able to:

1. Know variety of methods used to process commercial plastic resins, including limitations.
2. Know the basic tooling requirements for various plastic processing methods.
3. Critique the design of a product made with commercial plastic resins and recommends a preferred process for production.
4. Perform basic creep analysis of plastic parts.
5. know the impact of plastic on environment and can develop safety measures on it.

COURSE CONTENT

Introduction to Plastic Engineering		**Semester:**	**V**
Teaching Scheme:		**Examination scheme**	
Lectures:	**3 hours/week**	**End semester exam (ESE):**	**60 marks**
		Duration of ESE:	**03 hours**
		Internal Sessional Exams (ISE):	**40 marks**

Unit–I:	**No. of Lectures: 09 Hours**	**Marks: 12**

Plastics: Introduction, Concept of Macromolecules and Polymers, Sources of Polymers, Natural, Synthetic, Semisynthetic or regenerated, Thermoplastics and Thermosets, Morphology of Plastics, Crystalline materials, Amorphous and semi-crystalline polymers, Temperature

dependency of Polymers, Glass Transition and Melting Temperature, Flexible and rigid behavior, Commodity and Engineering plastics

Unit–II:	No. of Lectures: 09 Hours	Marks: 12

Plastic Properties & Testing: Physical Properties – Density, Size, Ash content, Mechanical Properties – Stress, Strain, Deformation, Creep and Stress relaxation, Friction and wear Resistance, viscosity, Thermal behavior – Heat capacity or Specific heat, Thermal expansion and contraction, Thermal conductivity, working temperature range, Effect of Processing on properties – Processing temperature, residence time, shear, drying temperature, Testing standards – ASTM and ISO

Unit–III:	No. of Lectures: 08 Hours	Marks: 12

Plastic Processing: Introduction, Extrusion, Single and Twin Screw Extruders, Extrusion Dies, Injection molding, Reaction and Gas assisted Injection molding, Blow Molding, Extrusion, Injection and Stretch blow molding, Compression, Transfer and Rotational molding, Thermoforming, Calendering, Coating, Process monitoring, Rapid prototyping.

Unit–IV:	No. of Lectures: 08 Hours	Marks: 12

Plastic Part Design & Applications: Introduction, Safety factor, Material selection, Process selection, Structural design - Design for Stiffness, design for Strength, designing for assembly of Plastic parts – Joining of plastic components, mechanical fasteners, Bonding, Welding, Plastic assembly method selection, Finishing, Prototyping, Prototype parts, rapid tooling

Unit–V:	No. of Lectures: 08 Hours	Marks: 12

Environmental aspects of Plastics: Introduction, Physical and Chemical Effects of Weathering on Plastic Parts, Accelerated Weathering testing, Environmental Toll of using Plastics, Plastic Consumption, Plastic Waste – Sources, Production, Global and Indian Context, Plastic Recycling and Landfills, Plastic waste management, Best Practices of Managing Plastic Waste,

Text Books:

1. Anshuman Shrivastav, Introduction to Plastic Engineering" Plastic Design Engineering, Elsevier
2. R J Crawford, Plastic Engineering, Pergamon Press
3. V R Gowarikar, "Polymers Science"

Reference Books:

1. Osswald and Menges, Materials Science of Polymers for Engineers, Hanser (1995)
2. Pötsch and Michaeli, Injection Molding an Introduction, Hanser (1995)
3. Osswald, Polymer Processing Fundamentals, Hanser (1998)
4. Avery, Injection Molding Alternatives, Hanser (1998)
5. Progelhof and Throne, Polymer Engineering Principles, Hanser (1993)
6. Ehrenstein, Polymeric Materials, Hanser (2001)

INDUSTRIAL SAFETY ENGINEERING					
COURSE OUTLINE					
Course Title:	**Industrial Safety Engineering**	**Short Title:**	**ISE**	**Course Code:**	
Course description:					
Safety is one of the key dimensions of engineering asset management. Safety by design or prevention through design is in the core for maintaining engineering systems safe. Industrial safety is important as it safeguards human life, especially in high-risk areas such as nuclear, aircraft, chemical, oil and gases, and mining industries, where a fatal mistake can be catastrophic. Industrial Safety reduces risks to people, and processes.					

Lecture	Hours/week	No. of weeks	Total hours	Semester credits
	03	14	42	03

Prerequisite course(s):

Industrial Psychology, Industrial Economics,

Course objectives:

The objective of this course is to impart knowledge on different facets and aspects of engineering systems safety, focusing on tools, techniques and methodologies needed for prevention of occurrences of unsafe operations and accidents under different industrial settings.

Course outcomes:

After successful completion of this course the student will be able to:

1. understand and practice the concepts of industrial safety engineering
2. apply different assessment techniques to calculate and predict losses
3. understand various human error factors and remedies
4. understand scientific way of investigation of accident
5. understand the various safety precautions to be taken in various industries and remedies for the same

COURSE CONTENT

Industrial Safety Engineering		**Semester:**	**V**
Teaching Scheme:		**Examination scheme**	
Lectures:	**3 hours/week**	**End semester exam (ESE):**	**60 marks**
		Duration of ESE:	**03 hours**
		Internal Sessional Exams (ISE):	**40 marks**

Unit–I:	No. of Lectures: 09 Hours	Marks: 12

Introduction to industrial safety engineering: Key concepts and terminology, safety domain ontology, risk assessment and control, safety engineering and accident causing mechanism, preliminary Hazard list, Hazard analysis, Hazard and Operability study, failure modes and effect analysis, identification of failure modes, Applications of Hazard identification techniques.

Unit–II:	No. of Lectures: 09 Hours	Marks: 12

Risk Assessment: Risk assessment process, Risk contour map, Individual risk assessment, Societal risk assessment, Consequences Assessment, Identification and classification of losses,

Categories of losses, Framework for consequence assessment, Estimation of losses, Energy control model, Hazard control hierarchy, safety function deployment, steps, design principles, deployment of design solutions,

Unit–III:	No. of Lectures: 08 Hours	Marks: 12

Human Errors: Basic elements of production and human contribution, Controlling safer operations, Generic definition of human error, Working definition of human error, Classification of human errors, Causes of human errors/ brain bottlenecks, human error identification, Task analysis, Hierarchical Task Analysis, Action error mode analysis, Human reliability assessment, HRA steps and methods,

Unit–IV:	No. of Lectures: 08 Hours	Marks: 12

Accident Investigation: Introduction, Incident investigation process, Risk score calculation, Guidelines for investigation, Guidelines for team formation, Root cause analysis, Recommendation & release of report, Accident Analysis and descriptive statistics, Control charts • Safety variables for control chart analysis, Patterns in control chart, Classification And Regression Tree classification (CART), Basics of safety performance indicators

Unit–V:	No. of Lectures: 08 Hours	Marks: 12

Safety in Industries: Safety in food processing, textile, mines, nuclear plants, thermal power plants, hydro power plants, cement, ship building, Chemical industries. Safety in Mechanical, Electrical equipment's, Disaster management.

Text Books:

1. "Accident Prevention Manual for Industrial Operations", N.S.C.Chicago, 1982
2. Heinrich H.W. "Industrial Accident Prevention" McGraw-Hill Company, New York, 1980.
3. Krishnan N.V. "Safety Management in Industry" Jaico Publishing House, Bombay, 1997.
4. John Ridley, "Safety at Work", Butterworth & Co., London, 1983.
5. Blake R.B., "Industrial Safety" Prentice Hall, Inc., New Jersey, 1973
6. "Accident Prevention Manual" – NSC, Chicago, 1982.
7. "Occupational safety Manual" BHEL, Trichy, 1988.
8. "Safety Management by John V. Grimaldi and Rollin H. Simonds, All India Travelers Book seller, New Delhi, 1989.
9. "Safety in Industry" N.V. Krishnan Jaico Publishery House, 1996.
10. Indian Boiler acts and Regulations, Government of India.
11. Maynard, Industrial Engineering. Hand book, McGraw Hill book company
12. ILO, Introduction to Work Study
13. Krishnan N.V. "Safety Management in Industry" Jaico Publishing House,
14. Khanna O.P., Industrial Engineering. And Management, Dhanpat Rai Publication, New Delhi.
15. Factory Act -1948
16. Indian Boiler Act- 1923 (Revised 1983)
17. L.C. Jhamb, "A text book of Industrial Engineering", Everest Publishing House, India.

Reference Books:

1. Komamoto and Henley, “Probabilistic Risk Assessment for Engineering and Scientists”, IEEE Press, 1995
2. Heinrich et al., “Industrial Accident Prevention”, McGraw Hill, 1980
3. Petersen D, “Techniques for safety management - A systems approach”, ASSE 1998.
4. McCornick, E.J., “Human Factors in Engineering and Design”, Tata McGraw-Hill, 1982.
5. “Accident Prevention Manual for Industrial Operations”, NSC, Chicago, 1982.

HEAT TRANSFER LAB

LAB COURSE OUTLINE

Course Title:	**Heat Transfer Lab**	**Short Title:**	**HT lab**	**Course Code:**	

Course description:

This lab includes different practical of Heat Transfer. The course aims at imparting knowledge of Heat Transfer and its modes.

Laboratory	**Hours/week**	**No. of weeks**	**Total hours**	**Semester credits**
	2	14	28	1

End Semester Exam (ESE) Pattern:	**Practical (PR)**

Prerequisite course(s):

The knowledge of basic heat flow and differential equation of heat transfer is required. The student must be aware about correlation and analogies to cope up with practical.
Mathematics (Calculus) at first year level and Engineering Thermodynamics, Applied Thermodynamics and Fluid Mechanics at Second Year Level.

Course objectives:

The lab work should clear the vision about all the modes of heat transfer. The practical knowledge should enhance the approach of student to the subject, which should facilitate him for solving derivations and numerical.

Course outcomes:

Upon successful completion of lab Course, student will be able to:

Understand the modes of heat transfer. The boundary conditions in different modes of heat transfer.

LAB COURSE CONTENT

Heat transfer Lab		**Semester:**	**V**
Teaching Scheme:		**Examination scheme**	
Practical:	**2 hours/week**	**End semester exam (ESE):**	***25 marks***
		Internal Continuous Assessment (ICA):	***25 marks***

1. Determination of thermal conductivity of metal rod / insulating powder / composite wall.
2. Determination of heat transfer coefficient in natural convection and forced convection.
3. Determination of temperature distribution, fin efficiency, effectiveness in natural convection and forced convection
4. Determination of emissivity of a test surface.
5. Determination of Stefan Boltzmann constant.
6. Determination of LMTD, overall heat transfer coefficient and effectiveness of heat exchanger in parallel and counter flow arrangement and compare them.
7. Study of pool boiling phenomenon and determination of critical heat flux.
8. Determination / Study of flash & fire point of a given fuel.
9. Determination of convective heat transfer coefficient for flow over a heated plate.
10. Determination / Study of specific heat of object.

Note: Lab file should contain at list EIGHT experiments from above mentioned list.

Text Books:

1. J. P. Holman, 1992 "Heat Transfer" McGraw Hill VII Edition.
2. P. Kothandaraman, "Fundamentals of Heat and Mass Transfer".
3. R. K. Rajput, "Heat and Mass Transfer", S. Chand& Company Ltd., New Delhi.
4. D. S. Kumar, "Heat and Mass Transfer" D. S. Kumar, S. K. Kataria & Sons, Delhi.
5. P. K. Nag, "Heat Transfer" Tata McGraw Hill Publishing Company Ltd., New Delhi.
6. Sachdeva R.C., "Fundamentals of Heat and Mass Transfer" Wiley Eastern Limited, Third Edition.
7. Sukhatme S.P., "A Text Book on Heat Transfer" (1989), IIIrd Edition, Orient Longmans Ltd., New Delhi.
8. Arora S.C. & Domkundwar S., "A Course in Heat and Mass Transfer" (1994), Dhanpat Rai & Sons, IVth Edition.
9. Chapman A.J., "Heat Transfer" (1989), IVth Edition.
10. Yunus A. Cengel, "Heat Transfer –A Practical Approach" (Tata McGraw Hill)
11. M. M. Rathore, "Engineering Heat and Mass Transfer", 2nd Edition, Laxmi Publications, New Delhi.
12. M. Thirumalseshwar, "Fundamentals of Heat and Mass Transfer" Pearson Education.
13. R. Rudramoorthy, K. Mayilsomy, "Heat Transfer", Pearson Education.

Reference Books:

1. Bejan, A., A. D. Kraus, "Heat Transfer Handbook", John Wiley (2003).
2. W. J. McCabe, J. Smith, P. Harriot, "Unit Operations of Chemical Engineering", Sixth Edition, McGraw Hill (2005).
3. Holman, J. P., S. Bhattacharya, "Heat Transfer", 10th Ed., Tata McGraw-Hill (2011).
4. D. Q. Kern, "Process Heat Transfer", Tata-McGraw Hill (1997).
5. R. Welty, C. E. Wicks, R. E. Wilson, G. Rorrer, "Fundamentals of Momentum, Heat and Mass Transfer", 4th Ed.,Wiley (2007).

Guide lines for ICA:

Lab file should contain EIGHT experiments conducted in lab

Guidelines for ESE:

The Practical Examination will comprise of performing the experiment and viva on the Practical

Instructions for practical Exam. :-

1. Five experiments should be selected for Practical Examination.
2. The Number of Students for each Practical set up should not be more than 5 Students.

MANUFACTURING PROCESSES LAB

LAB COURSE OUTLINE

Course Title:	Manufacturing Processes Lab	Short Title:	MPL	Course Code:	

Course description:
The lab is to gain a practical understanding of various manufacturing processes in a hands-on environment.

Laboratory	Hours/week	No. of weeks	Total hours	Semester credits
	02	14	28	01

End Semester Exam (ESE) Pattern: ***Practical (PR) / Oral (OR)***

Prerequisite course(s):
Engineering Graphics; Workshop Practice

Course objectives:
In this laboratory you will be exposed to the common manufacturing processes such as casting, metal forming, and welding processing. Laboratory experiments will consist of hands expression and demonstration of the above mentioned processes.

Course outcomes:
Upon successful completion of lab Course, student will be able to:
1. Develop a practical understanding of basic manufacturing processes and capabilities of each.
2. Set-up and conduct engineering experiments related to various manufacturing processes.
3. Learn to make engineering judgments

LAB COURSE CONTENT

Manufacturing Processes Lab		Semester:	V
Teaching Scheme:		**Examination scheme**	
Practical:	**2 hours/week**	**End semester exam (ESE):**	***25 marks***
		Internal Continuous Assessment (ICA):	***25 marks***

1. To prepare a sheet metal product (Funnel)
2. To prepare a pattern for given object for lost form casting.
3. To prepare a Green sand mold from the prepared pattern.
4. To melt and pour Aluminum metal into the mold.
5. To study and observe the Powder Metallurgy techniques through demonstration
6. To study and observe the Closed Die Forging techniques through demonstration

Text Books:
1. R. K. Jain, “Production Technology’, Khanna Publishers.
2. P. N. Rao, “Manufacturing technology, Vol-I & II”, McGraw Hill publications
3. Hajara Choudhari, Bose S.K, “Elements of Workshop Technology Volume I & II”.

Reference Books:

1. G.S. Upadhyaya and A. Upadhyaya, "Materials Science & Engineering".
2. M.P. Groover, "Fundamentals of Modern Manufacturing"
3. G.K. Lal and S.K. Choudhury, "Fundamentals of Manufacturing Processes"
4. E. P. DeGarmo, J.T. Black and R. Kohser, "Materials & Processes in Manufacturing"
5. S. Kalpakjian, "Manufacturing Engineering and Technology"
6. E.P. DeGarmo, "Materials and Processes in Manufacturing", Macmillan.
7. J.S. Campbell, "Principles of Manufacturing Materials and Process", McGraw Hill.
8. J.S. Schey, "Introduction of Manufacturing Processes", McGraw Hill International.
9. M.L. Begeman & B.H. Amstead, "Manufacturing Process", John Wiley.
10. H.W. Pollack, "Manufacturing and Machine Tool Operations", Prentice-Hall.
11. R.A. Lindberg, "Process and Materials for Manufacturing", Prentice-Hall.
12. L.E. Doyle, "Manufacturing Processes & Materials for Engineers", Prentice-Hall.

Guide lines for ICA:

Lab file should be from above said syllabus and to be drawn in lab.

Guidelines for ESE:

Oral will be based on the Practical Performed in the examination and the sheets included in the Journal.

MACHINE DRAWING LAB

LAB COURSE OUTLINE

Course Title:	Machine Drawing Lab	Short Title:	MDL	Course Code:	

Course description:

This course is essential for understanding of working drawings in order to manufacture the parts with specified tolerances and accuracy. The emphasis is given on understanding and preparing the assembly and detailed drawings of the machine units.

Laboratory	Hours/week	No. of weeks	Total hours	Semester credits
	02	14	28	01

End Semester Exam (ESE) Pattern: ***Practical (PR) / Oral (OR)***

Prerequisite course(s):

Engineering Graphics; Workshop Practice

Course objectives:

The student will acquire a knowledge of fastening arrangements such as welding, riveting the different styles of attachment for shaft. The student also is enabled to prepare the assembly of various machine or engine components and miscellaneous machine components.

Course outcomes:

Upon successful completion of lab Course, student will be able to:

i. to define terms used to explain abbreviations
ii. to list / name / sketch different types of machine parts, assemblies and their conventions
iii. to read and interpret the given details of production drawing of machine components
iv. to imagine shapes and sizes of components and visualize / draw their views in different directions
v. to imagine and assemble the given set of components to form a workable machine assembly

LAB COURSE CONTENT

Machine Drawing Lab		Semester:	V
Teaching Scheme:		**Examination scheme**	
Practical:	**2 hours/week**	**End semester exam (ESE):**	***25 marks***
		Internal Continuous Assessment (ICA):	***25 marks***

1. Assignment on Conventional representation of machine components, conventional signs used for welding as per BIS, standard abbreviations in droughting

2. Detail and assembly drawing of the following with complete dimensioning, tolerances, material and surface finish specifications. (Any one of the following manually and with CAD)
(i) Foot Step Bearing (ii) Stuffing Box (iii) Cross Head of IC engine (iv) Eccentric (v) Petrol Engine Connecting rod (vi) Piston assembly (vii) Screw jacks (viii) Machine Vice (ix) Plummer Block (x) Tailstock of lathe (xi) Steam Stop Valve (xii) Spring loaded Safety Valve (xiii) Feed Check Valve (xiv) Box type Jig (xv) Marine Engine Connecting rod (xvi) Steam Engine Connecting rod (xvii) Radial Engine Sub Assembly (xviii) Rotary Gear Pump (xix) Air Valve

(xx) Fuel Injector (xxi) Single Plate Clutch (xxii) Square Tool Post (xxiii) Shaper tool head slide (xxiii) Milling Machine Tail stock (xxiv) Revolving Centre (xxv) Floating reamer holder (xxvi) Swivel Machine vice (xxvii) Indexing Drill Jig (xxviii) Self centering chuck (xxix) Four Jaw Chuck (xxx) Gate Valve (xxxi) Non return valve (xxxii) Blow off valve (xxxiii) Pressure Relief Valve (xxxiv) Lever Safety Valve (xxxv) Ramsbottom Safety Valve (xxxvi) Swivel Bearing (xxxvii) Crane hook (xxxviii) Pipe Vice (xxxix) Speed Reducer 3. Prepare single line and double line diagrams of piping layouts & Draw the assembly drawing and sectioned views of pipe joint. 4. Practice the Preparation of working drawing of welded fabrications.
Text Books:
1. “Machine Drawing”, Third Edition, New Age International Publishers, K. L. Narayana, P. Kannaiah, K. Venkata Reddy. 2. “Machine Drawing”, R K Dhawan, S Chand.
Reference Books:
1. T.S.M & S.S.M in respect of Technical Drawing by TTTI, Madras 2. Machine Drawing by A.C. Parkinson. 3. Machine Drawing by Jones & Jones. 4. Machine Drawing by N.D. Bhat. 5. A text book for Technical Schools Engg. Drawing by N.C.E.R.T 6. Machine Drawing by R.B. Gupta. 7. Indian Standard Scheme of symbol for Welding by SP-46-1988. 8. Machine Drawing by Bhattacharyya (Oxford Publishers). 9. Machine Drawing by Ajeeth Singh (MGH Publishers) 10. Machine Drawing by N. Siddeswar, Kannaih, Sastri. (MGH Publishers)
Guide lines for ICA:
Lab file should be from above said syllabus and to be drawn in lab.
Guidelines for ESE:
Oral will be based on the Practical Performed in the examination and the sheets included in the Journal.

Minor Project (Stage – I)

LAB COURSE OUTLINE

Course Title:	**Minor Project (Stage – I)**	**Short Title:**	**MPROJ-SI**	**Course Code:**	

Course description:

Minor project represent the culmination of study towards the Bachelor of Engineering degree. The minor project offers the opportunity to apply and extend material learned throughout the program. The emphasis is necessarily on facilitating student learning in technical, project management and presentation spheres.

Laboratory	**Hours/week**	**No. of weeks**	**Total hours**	**Semester credits**
	6	**14**	**84**	**3**

End Semester Exam (ESE) Pattern:	**----**

Prerequisite course(s):

Course objectives:

1. To understand the basic concepts & broad principles of projects.
2. To understand the value of achieving perfection in project implementation & completion.
3. To apply the theoretical concepts to solve problems with teamwork and multidisciplinary approach.
4. To demonstrate professionalism with ethics; present effective communication skills and relate engineering issues to broader societal context.

Course outcomes:

Upon successful completion of lab Course, student will be able to:

1. Demonstrate a sound technical knowledge of their selected project topic.
2. Undertake problem identification, formulation and solution.
3. Design engineering solutions to complex problems utilizing a systems approach.
4. Conduct an engineering project
5. Demonstrate the knowledge, skills and attitudes of a professional engineer.

LAB COURSE CONTENT

Minor Project (Stage – I)		**Semester:**	**V**
Teaching Scheme:		**Examination scheme:**	
Practical:	**6 hours/week**	**Internal Continuous Assessment (ICA):**	**50 marks**

At third year, the students shall carry out a minor project in a group of maximum up to 5 students. The project work spans both the semesters. By the end of Semester – V the students shall complete the partial work, and by the end of Semester – VI the students shall complete remaining part of the project. Assessment for the project shall also include presentation by the students. Each teacher can guide maximum 04 groups of minor projects.

The students should take project work, as specified in the curriculum, based on the knowledge acquired by the students during the degree course till Semester – IV. The project

may be either fully theoretical/practical or involving both theoretical and practical work to be assigned by the Department. The work may also be Study/Survey/Design.

Minor Project (Stage – I) may involve literature survey, problem identification, design methodology, collection of data etc. The project work shall involve sufficient work so that students get acquainted with different aspects of design and analysis. Approximately more than 50% work should be completed by the end of Semester – V. Each student group should submit partial project report in the form of spiral bound at the end of Semester –V.

Each student group is required to maintain separate log book for documenting various activities of the project.

Suggestive outline for the partial project report is as follows.

Abstract

Chapter 1. Introduction

- Background
- Motivation
- Problem Definition
- Scope
- Objectives
- Selection of Life cycle Model for Development
- Organization of Report
- Summary

Chapter 2. Project Planning and Management

- Feasibility Study
- Risk Analysis
- Project Scheduling
- Effort Allocation
- Cost Estimation
- Summary

Chapter 3. Literature Survey

- Sources of information
- List of important literature
- Literature review
- Summary

Chapter 4. Future Work Plan

- Summary

Chapter 5. Conclusion & Future Work

Bibliography

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Appendix

Guide lines for ICA:

The Internal Continuous Assessment (ICA) for project shall be based on continuous evaluation of students' performance, active participation, knowledge / skill acquired throughout semester and presentation by the students. The assessment shall be done jointly by the guide and departmental committee. A three-member departmental committee including guide, appointed by Head of the department, shall be constituted for the assessment. The assessment for Minor Project (stage – I) in Semester – V shall be as per the guidelines given in Table – A.

Table – A

		Assessment by Guide					Assessment by Departmental Committee		
Sr. No.	Name of the Student	Attendance / Participation	Problem Identification / Project Objectives	Literature Survey	Methodology / Design	Report	Depth of Understanding	Presentation	Total
	Marks	5	5	5	5	5	10	15	50

Constitution of India

Basic features and fundamental principles

The Constitution of India is the supreme law of India. Parliament of India cannot make any law which violates the Fundamental Rights enumerated under the Part III of the Constitution. The Parliament of India has been empowered to amend the Constitution under Article 368, however, it cannot use this power to change the "basic structure" of the constitution, which has been ruled and explained by the Supreme Court of India in its historical judgments. The Constitution of India reflects the idea of "Constitutionalism" – a modern and progressive concept historically developed by the thinkers of "liberalism" – an ideology which has been recognized as one of the most popular political ideology and result of historical struggles against arbitrary use of sovereign power by state. The historic revolutions in France, England, America and particularly European Renaissance and Reformation movement have resulted into progressive legal reforms in the form of "constitutionalism" in many countries. The Constitution of India was made by borrowing models and principles from many countries including United Kingdom and America.

The Constitution of India is not only a legal document but it also reflects social, political and economic perspectives of the Indian Society. It reflects India's legacy of "diversity". It has been said that Indian constitution reflects ideals of its freedom movement, however, few critics have argued that it does not truly incorporate our ancient legal heritage and cultural values. No law can be "static" and therefore the Constitution of India has also been amended more than one hundred times. These amendments reflect political, social and economic developments since the year 1950. The Indian judiciary and particularly the Supreme Court of India has played an historic role as the guardian of people. It has been protecting not only basic ideals of the Constitution but also strengthened the same through progressive interpretations of the text of the Constitution. The judicial activism of the Supreme Court of India and its historic contributions has been recognized throughout the world and it gradually made it "as one of the strongest court in the world".

Course content

1. Meaning of the constitution law and constitutionalism
2. Historical perspective of the Constitution of India
3. Salient features and characteristics of the Constitution of India
4. Scheme of the fundamental rights
5. The scheme of the Fundamental Duties and its legal status
6. The Directive Principles of State Policy – Its importance and implementation
7. Federal structure and distribution of legislative and financial powers between the Union and the States
8. Parliamentary Form of Government in India – The constitution powers and status of the President of India
9. Amendment of the Constitutional Powers and Procedure
10. The historical perspectives of the constitutional amendments in India
11. Emergency Provisions: National Emergency, President Rule, Financial Emergency
12. Local Self Government – Constitutional Scheme in India
13. Scheme of the Fundamental Right to Equality
14. Scheme of the Fundamental Right to certain Freedom under Article 19
15. Scope of the Right to Life and Personal Liberty under Article 21

Kavayatri Bahinabai Chaudhari NORTH MAHARASHTRA UNIVERSITY, JALGAON (M.S.)

Bachelor of Engineering (Mechanical Engineering)

Faculty of Science and Technology

कवयित्री बहिणाबाई चौधरी उत्तर महाराष्ट्र विद्यापीठ
अंतरी पेटवू ज्ञानज्योत
1990
'A' Grade
NAAC Re-Accredited
3rd Cycle

Syllabus Structure & Contents of Third Year of Engineering

Semester-VI

w.e.f. 2020 – 2021

KINEMATICS AND THEORY OF MACHINES					
COURSE OUTLINE					
Course Title:	**Kinematics and Theory of Machines**	**Short Title:**	**KTM**	**Course Code:**	
Course description:					
This course will deal with kinematic analysis of mechanisms and machines. It will include motion and force transmission analysis of linkage mechanisms. It discusses the dynamic force analysis, Cams, Governor, Gyroscope and Balancing methods. The course will demonstrate various concepts by working out problems relevant to real life applications of mechanisms. The course is expected to help students in their basic understanding and use of kinematic analysis.					

Lecture	**Hours/week**	**No. of weeks**	**Total hours**	**Semester credits**
	03	14	42	03

Prerequisite course(s):

Engineering Mechanic, Strength of Materials

Course objectives:

1. To understand the kinematics and rigid- body dynamics of kinematically driven machine components
2. To understand the motion of linked mechanisms in terms of the displacement, velocity and acceleration at any point in a rigid link
3. To be able to design some linkage mechanisms and cam systems to generate specified output motion
4. To understand the kinematics of gear trains

Course outcomes:

After successful completion of this course the student will be able to:

1. Understand basic structure and elements of machines and Identify functional characteristics of various machine elements
2. Determine position, velocity and acceleration of linkages in mechanism at any instant
3. Analyze the motion and the dynamical forces acting on mechanical systems composed of linkages.
4. Design cam for a given motion or a given input/output motion relationship and exemplify concepts of static and dynamic mass balancing.
5. Apply the principles of gyroscopic effects and stabilization on various transport vehicles and applications of various governors.

COURSE CONTENT

Kinematics and Theory of Machines		**Semester:**	**VI**
Teaching Scheme:		**Examination scheme**	
Lectures:	**3 hours/week**	**End semester exam (ESE):**	**60 marks**
		Duration of ESE:	**03 hours**
		Internal Sessional Exams (ISE):	**40 marks**

Unit–I:	**No. of Lectures: 09 Hours**	**Marks: 12**

MECHANISMS & MACHINES: Introduction, Constrained motion, Link, Kinematic pair, Types of Joints, Degree of Freedom, Classification of Kinematic pairs, Kinematic chain, Mechanism and structures, Equivalent Mechanisms, Simple mechanism, Compound mechanism, Planer mechanism, Spatial mechanism, Four Bar Mechanism, Mechanical Advantage, Transmission angle, Slider Crank Mechanism, Double Slider Crank Mechanism. Pantograph, Toggle Mechanism, Geneva Mechanism, Automobile steering Mechanism – Davis Steering Gear, Ackermann Gear, Hooks Joint, Double Hook Joint.

Unit–II:	**No. of Lectures: 09 Hours**	**Marks: 12**

VELOCITY AND ACCELERATION ANALYSIS: Absolute and Relative Motions, motion of a link, Instantaneous centre, Kennedy's Theorem, Locating I-Centers of Four Bar Mechanism and Slider Crank mechanism, Space and Body Centrode, Relative Velocity of Four Bar Mechanism and Slider Crank mechanism, Rubbing Velocity, Acceleration, Radial and Tangential acceleration, Relative acceleration of Four Bar Mechanism and Slider Crank mechanism, Coriolis Acceleration, Klein's Construction.

Unit–III:	**No. of Lectures: 08 Hours**	**Marks: 12**

DYNAMIC FORCE ANALYSIS: D' Alembert's Principle, Inertia Force, Dynamic analysis of Four Bar Mechanism and Slider Crank mechanism, Engine force analysis, Simple and Compound Pendulum, Dynamically Equivalent System, Inertia of Connecting Rod,

Unit–IV:	**No. of Lectures: 08 Hours**	**Marks: 12**

CAMS: Types of Cams and Followers, Terminology, Motions of the Follower, Layout of Cam profiles, Specified Contour Cams, Circular and Tangent Cams, Pressure angle and Undercutting, Sizing of Cams.

BALANCING: Need of Balancing, Static and Dynamic Balancing, Balancing of several masses in different planes, Balancing of reciprocating masses.

Unit–V:	**No. of Lectures: 08 Hours**	**Marks: 12**

GOVERNORS: Introduction, Types of Governors, Watt Governor, Proell Governor, Wilson Hartnell Governor, Inertia Governor, Controlling Force, Sensitiveness, Hunting, Isochronism, Stability, Effort, Power of Governor.

GYROSCOPE: Gyroscopic Principle, Gyroscopic Effect, Gyroscopic Effects on Aeroplanes, Naval ships, Stability of an Automobile, Stability of two wheels Vehicle.

Text Books:

1. Cleghorn W. L., Mechanisms of Machines, Oxford University Press, 2005.
2. Robert L. Norton, Kinematics and Dynamics of Machinery, Tata McGraw Hill, 2009.
3. Ratan S. S., Theory of Machines, 4th edition, Tata McGraw Hill, 2014.
4. Khurmi R. S, Theory of Machines, 14th edition, S. Chand & Co. Ltd., 2005.
5. Singh V. P., Theory of Machines, Dhanpat Rai & Co.
6. Bansal R. K., Theory of Machines, Laxmi Publications.
7. Singh Sadhu, Theory of Machines, Pearson Publication.

Reference Books:

1. Thomas Bevan, Theory of Machines, 3rd edition, CBS Publishers & Distributors, 2005.

2. Ghosh A. and Mallick A. K., Theory of Mechanisms and Machines, Affiliated East-West Pvt. Ltd, New Delhi, 1988.
3. Lal Jagdish, Theory of Mechanisms & Machines, Metropoliton Book Co.
4. Shingley J. E. and Uicker J. J., Theory of Machines and Mechanisms, McGraw Hill International Book Co.
5. Ballaney P. L., Theory of Machine, Khanna Publication.

MANUFACTURING TECHNOLOGY					
COURSE OUTLINE					
Course Title:	**Manufacturing Technology**	**Short Title:**	**MT**	**Course Code:**	

Course description:

This course is designed to help student understand advanced machining process, rapid prototyping and automation of manufacturing process. This course will also help students to estimate different forces and their relationship during metal cutting. They will be familiarized with computer aided manufacturing and computer integrated manufacturing.

Lecture	Hours/week	No. of weeks	Total hours	Semester credits
	03	14	42	3

Prerequisite course(s):

Manufacturing process, Workshop Technology.

Course objectives:

(i)To provide knowledge on machines and related tools for manufacturing various components.
(ii) To understand the relationship between process and system in manufacturing domain.
(iii) To identify the techniques for the quality assurance of the products and the optimality of the process in terms of resources and time management.

Course outcomes:

After successful completion of this course the student will be able to:
1. Understand geometry and use of single point cutting tool, forces of machining and different types of tool wear.
2. Understand working principle of various machining processes their applications.
3. Understand rapid prototyping, its types and role of automation in manufacturing industry.
4. Understand different advanced manufacturing process.
5. Understand aspects product design and manufacturing.

COURSE CONTENT

Manufacturing Technology		**Semester:**	**VI**
Teaching Scheme:		**Examination scheme**	
Lectures:	**3 hours/week**	**End semester exam (ESE):**	**60 marks**
		Duration of ESE:	**03 hours**
		Internal Sessional Exams (ISE):	**40 marks**

Unit–I:	**No. of Lectures: 09 Hours**	**Marks: 12**

Theory of Metal Cutting : Introduction, The mechanics of chip formation, single point cutting tool, methods of machining, Types of chips, Determination of shear angle, Force relations, energy considerations in metal cutting, Tool wear and tool life, Economics of metal cutting.

Unit–II:	**No. of Lectures: 09 Hours**	**Marks: 12**

Advanced Machining Processes: Introduction, Chemical Machining, Electrochemical Machining, Electro Chemical Grinding, Electrical Discharge Machining, Laser Beam

Machining, Electron Beam Machining, Water Jet Machining, Abrasive Jet Machining, Hybrid Machining System, Economics of Advanced Machining Processes.

Unit–III:	No. of Lectures: 08 Hours	Marks: 12

Rapid Prototyping and Automation of manufacturing processes: Rapid Prototyping; Introduction, Subtractive processes, Additive processes, Virtual prototyping, Self-replicating machine, Direct manufacturing and rapid tooling. Automation; Introduction, Automation, Numerical control, Adaptive control, material handling and movement, Industrial robots, sensor technology, flexible fixturing, assembly systems, Design consideration for fixturing, assembly, disassembly and servicing, Economic consideration.

Unit–IV:	No. of Lectures: 08 Hours	Marks: 12

Advanced Manufacturing: Computer aided manufacturing; Introduction, Manufacturing System, Computer Aided Design and Engineering, Computer Aided Process Planning, Computer Simulation of Manufacturing Processes, Group Technology. Computer Integrated Manufacturing; Introduction, Cellular Manufacturing, Flexible Manufacturing system, Holonic Manufacturing, Just in Time Production, Lean Manufacturing, Communication Networks in Manufacturing

Unit–V:	No. of Lectures: 08 Hours	Marks: 12

Product Design and Manufacturing: Introduction, Product Design, Product Quality, Life-Cycle Assessment and sustainable manufacturing, Energy Consumption in Manufacturing, Material Selection for Products, Material Substitution, Manufacturing Process Capabilities, Process Selection, Manufacturing Costs and Cost Reduction.

Text Books:

1. Hajara Chaudhary and Bose, Element of Workshop Technology Volume I and II - S.K.,Asia Publishing House.
2. P.N.Rao, Production Technology Volume I and II –Tata McGraw Hill Publication.
3. R.K.Jain, Production Technology- Khanna Publications.
4. P.C.Sharma, Production Technology-, Khanna Publication.
5. Chapman W.A.J., Workshop Technology- ELBS Publication.
6. HMT, Production Technology- Tata McGraw Hill Publication.

Reference Books:

1. Kalpak Jain and Schmid, Manufacturing processes for engineering materials (7^{th} Edition)-Pearson India, 2014.
2. Taha H. A., Operations Research, 6^{th}Edition, Prentice Hall of India, 2003.
3. Shenoy G.V. and Shrivastava U.K., Operations Research for Management, WileyEastern, 1994.
4. Mikell P. Groover, Fundamentals of Modern Manufacturing: Materials, Processes, andSystems
5. Degarmo, Black &Kohser, Materials and Processes in Manufacturing
6. Materials and processes in manufacturing , J T Black, Ronald A. Kosher, DeGarmos, , Wiley student edition
7. Roy A Lindberg, Process And Material Of Manufacturing, Prentice Hall of India Pvt Ltd.

MATERIAL ENGINEERING					
COURSE OUTLINE					
Course Title:	**Material Engineering**	**Short Title:**	**ME**	**Course Code:**	
Course description:					
This course provides the introduction of the fundamentals of Material Science and Metallurgy to undergraduate students. The objective of the course is to understand the basic principles of material science and metallurgy. It includes mechanical testing to determine mechanical properties. It also includes various heat treatments, introduction of furnaces and various engineering materials and their applications.					

Lecture	**Hours/week**	**No. of weeks**	**Total hours**	**Semester credits**
	03	14	42	03

Prerequisite course(s):

Fundamental knowledge of Engineering Chemistry and Physics

Course objectives:

1. Understanding of the correlation between the internal structure of materials, their mechanical properties and various methods to quantify their mechanical integrity and failure criteria.
2. To provide a detailed interpretation of equilibrium phase diagrams
3. Learning about different phases and heat treatment methods to tailor the properties of Fe-C alloys.

Course outcomes:

After successful completion of this course the student will be able to:

1. Identify crystal structures for various materials and understand the defects in such structures.
2. Understand mechanical properties of materials and use.
3. Interpret phase diagram and understand various reactions on Iron Carbon diagram.
4. Understand how to tailor material properties of ferrous and non-ferrous alloys with the help of heat treatment.
5. Understand composition, properties and use of alloy steel and cast iron.

COURSE CONTENT

Material Engineering		**Semester:**	**VI**
Teaching Scheme:		**Examination scheme**	
Lectures:	**3 hours/week**	**End semester exam (ESE):**	**60 marks**
		Duration of ESE:	**03 hours**
		Internal Sessional Exams (ISE):	**40 marks**

Unit–I	**No. of Lectures: 09 Hours**	**Marks: 12**

Crystal Structure: Unit cells, Metallic crystal structures, Ceramics. Imperfection in solids: Point, line, interfacial and volume defects; dislocation strengthening mechanisms and slip systems, critically resolved shear stress.

Unit–II	**No. of Lectures: 09 Hours**	**Marks: 12**

Mechanical Property measurement: Tensile, compression and torsion tests; Young's modulus, relations between true and engineering stress-strain curves, generalized Hooke's law, yielding and yield strength, ductility, resilience, toughness and elastic recovery; Hardness: Rockwell, Brinell and Vickers and their relation to strength.
Static failure theories: Ductile and brittle failure mechanisms, Fracture mechanics: Introduction to Stress-intensity factor approach and Griffith criterion. Fatigue failure: High cycle fatigue, Stress-life approach, SN curve, endurance and fatigue limits, Fracture with fatigue, Introduction to non-destructive testing (NDT)

Unit–III	No. of Lectures: 08 Hours	Marks: 12

Equilibrium Diagrams: Alloys, substitutional and interstitial solid solutions- Phase diagrams: Interpretation of binary phase diagrams and microstructure development; eutectic, peritectic, peritectoid and monotectic reactions. Iron Iron-carbide phase diagram and microstructural aspects of ledeburite, austenite, ferrite and cementite, cast iron

Unit–IV	No. of Lectures: 08 Hours	Marks: 12

Heat treatment of Steel: Annealing, tempering, normalising and spheroidising, isothermal transformation diagrams for Fe-C alloys and microstructure development. Continuous cooling curves and interpretation of final microstructures and properties- austempering, martempering, case hardening, carburizing, nitriding, cyaniding, carbo-nitriding, flame and induction hardening, vacuum and plasma hardening

Unit–V:	No. of Lectures: 08 Hours	Marks: 12

Alloy steel and Cast Iron: Alloying of steel, properties of stainless steel and tool steels, maraging steels- cast irons; grey, white, malleable and spheroidal cast irons- copper and copper alloys; brass, bronze and cupro-nickel; Aluminium and Al-Cu – Mg alloys- Nickel based superalloys and Titanium alloys

Text Books:

1. W. D. Callister, 2006, "Materials Science and Engineering-An Introduction", 6th Edition, Wiley India.
2. Kenneth G. Budinski and Michael K. Budinski, "Engineering Materials", Prentice Hall of India Private Limited, 4th Indian Reprint, 2002.
3. V. Raghavan, "Material Science and Engineering', Prentice Hall of India Private Limited, 1999.
4. U. C. Jindal, "Engineering Materials and Metallurgy", Pearson, 2011.

Reference Books:

1. J.T. Black, Ronald A. Kosher, Degarmo's "Materials and processes in manufacturing", Willey student edition.
2. V. D. Kodgire, Material Science and Metallurgy for Engineers, Everest Publishing House. Pune
3. B. K. Agrawal, Introduction to Engineering Materials, Tata Mcgraw Hill, New Delhi.
4. S.H. Avner, An Introduction to Physical Metallurgy, Tata Mcgraw Hill, New Delhi.
5. Mikell P. Groover, Fundamentals of modern manufacturing materials, processes and systems", by Wiley student edition, New Delhi.

6. Parashivamurthy K. I., Material Science and Metallurgy, by Pearson Publication
7. U. C. Jindal, Material Science and Metallurgy, by Pearson Publication
8. James F. Shackleford & Madanapalli K. Muralidhara, Introduction to Materials Science for Engineers, by Pearson Publication
9. O. P. Khanna, A textbook of Material Science and Metallurgy, Dhanpat Rai Publication.

MECHANICAL TRANSMISSION SYSTEMS					
COURSE OUTLINE					
Course Title:	**Mechanical Transmission Systems**	**Short Title:**	**MTS**	**Course Code:**	
Course description:					
The course aims to impart basic skills and understanding of transmission systems basic components their working principle, classification and performance characteristics.					

Lecture	**Hours/week**	**No. of weeks**	**Total hours**	**Semester credits**
	03	14	42	04

Prerequisite course(s):

Knowledge of Engineering Mechanics and Theory of Mechanics.

Course objectives:

Understanding of functional requirements of different components of transmission system for designing purpose

Course outcomes:

After successful completion of this course the student will be able to:

1. handle the different power transmitting devices.
2. develop competency in working and use of components those are use while transmitting torque.
3. develop competency in understanding of theory of all types of gear and gear trains.
4. understand the force analysis of power train components gears
5. aware about the Automatic Transmission system and their components.

COURSE CONTENT

Mechanical Transmission Systems		**Semester:**	**VI**
Teaching Scheme:		**Examination scheme**	
Lectures:	**3 hours/week**	**End semester exam (ESE):**	**60 marks**
		Duration of ESE:	**03 hours**
		Internal Sessional Exams (ISE):	**40 marks**

Unit–I	**No. of Lectures: 09 Hours**	**Marks: 12**

Belt Drive: - Introduction, Selection of a Belt Drive, Types of Belt Drives, Types of Belts, Material used for Belts, Types of Flat Belt Drives, Velocity Ratio, Slip of Belt, Creep of Belt. Length of an Open Belt Drive and Cross Belt Drive, Power Transmitted, Ratio of Driving Tensions, Angle of Contact, Centrifugal Tension, Condition for the Transmission of Maximum Power, Initial Tension

Rope Drives: - Introduction, Rope Drive, Fiber Ropes, Advantages, Sheave for Fiber Ropes, Wire Ropes.

Chain Drives: - Introduction, Kinematic of Chain Drive, Classification, Advantages and Disadvantages, Terminology, Chain Speed and Angular Velocity of Sprocket, Length of Chain.

Unit–II	**No. of Lectures: 09 Hours**	**Marks: 12**

Clutches: - Principle of operation, Constructional details, calculation of torque capacity, axial force. Different types of clutches, Operation of single plate helical spring, multiplate clutch, Centrifugal clutch and Cone Clutch, Dry and Wet type of clutch, Friction lining materials. Over-running clutch. Modes of operating a clutch – mechanical, hydraulic and electric, clutch maintenance

Flywheel: - Turning moment diagram and fluctuation of the crankshaft speed, D' Alembert's principle, Equivalent offset inertia force, Determination of flywheel size for different types of engine and machine.

Unit–III	**No. of Lectures: 08 Hours**	**Marks: 12**

Brakes: - Types of brakes, Force analysis of brakes, external and internal expanding shoe brakes block brakes, band brakes, block and band brakes, Breaking torque.

Dynamometer: - Absorption dynamometers, transmission dynamometer- belt transmission type, Eddy current dynamometer: construction and working principle, Torque measurement, Fluid coupling.

Unit–IV	**No. of Lectures: 08 Hours**	**Marks: 12**

Gears and Gear Trains: - Classification and terminology used Fundamental law of gearing – friction wheel, teeth for positive action and condition for constant velocity ratio. Conjugate profiles cycloidal and involute teeth profiles. Involute construction, properties and computation of path of contact and contact ratio. Interference and undercutting- Minimum number of teeth to avoid Interference, methods to avoid Interference. Introduction, classification, examples, gear ratio in simple and compound gear trains.

Unit–V	**No. of Lectures: 08 Hours**	**Marks: 12**

Automatic Transmission Parts and operation, Hydraulic automatic transmissions, Torque converter, Planetary gears train, Hydraulic controls.

Continuously variable transmissions, E-CVT, Dual-clutch transmissions, Automated Manual Transmission.

Automatic transmission modes, Manual controls, Manufacturer-specific modes.

Comparison with manual transmission, Effects on vehicle control, Cornering, maintaining constant speed, controlling wheel spin, Climbing steep slippery slopes, Energy efficiency

Text Books:

1. Sadhu Singh, Theory of Machines, Pearson Publication.
2. P. L. Ballaney, Theory of machine, Khanna publication.

Reference Books:

1. S. S. Rattan, Theory of Machines, Tata McGraw Hill, New Delhi.
2. Jagdish Lal, Theory of Mechanisms & Machines, Metropolitan Book Co.
3. Theory of Machines, Longman's Green & Co., London.
4. W. G. Green, Theory of Machines, Blackie & Sons, London.
5. V.P. Singh, Theory of Machines, Dhanpat Rai & Co.
6. Shigley, J.E and Uicker, J.J Theory of Machines and Mechanisms, McGraw45 Hill International Book Co.
7. Rao J.S. and Dukkipati R.V, Mechanisms and Machines theory, Wiley Eastern Ltd.

8. J.S.Rao, The Theory of Machines through solved problems, New age international publishers.
9. Dr. R. K. Bansal, A text book of Theory of Machines, Laxmi Publications.

MECHANICAL ESTIMATION & COSTING

COURSE OUTLINE

Course Title:	Mechanical Estimation & Costing	Short Title:	MEC	Course Code:	

Course description:

This course is designed to develop the ability in the students to evaluate materials, consumables and process costs in the monetary units. Hence, it will help to increase the productivity of the organization and conservation of valuable resources. This course will also help in developing the skills required in the process of decision making and to plan, use, monitor and control resources optimally and economically. This will also be helpful in budgeting. The realm of this course is enlarged to estimate the process costs for fluid and thermal applications also.

Lecture	Hours/week	No. of weeks	Total hours	Semester credits
	03	14	42	3

Prerequisite course(s):

Manufacturing Processes, Manufacturing Technology

Course objectives:

The course content should be taught and implemented with the aim to develop different types of skills so that students are able to acquire following competencies:

1. Plan, use and control resources optimally and economically.
2. Estimate production/operation cost for budgeting and analysis.

Course outcomes:

After successful completion of this course the student will be able to:

i. Calculate material cost of given component/product.
ii. Identify and estimate elements of cost in various processes.
iii. Perform break even analysis to calculate break even quantity.
iv. Investigate the problem of cost and suggest their solution using cost reduction techniques.
v. Interpret given model of balance sheet and profit loss account.

COURSE CONTENT

Mechanical Estimation & Costing		Semester:	VI
Teaching Scheme:		**Examination scheme**	
Lectures:	**3 hours/week**	**End semester exam (ESE):**	**60 marks**
		Duration of ESE:	**03 hours**
		Internal Sessional Exams (ISE):	**40 marks**

Unit–I:	No. of Lectures: 09 Hours	Marks: 12

Estimating: Importance and aim, objectives, functions, organization of Estimating department, Estimating Procedure, Constituents of Estimation,

Costing: Definition, aims, procedure for Costing, types of costs, Costing controls, Difference between Estimating and Costing, Control of Costs, Elements of PPC and Time & Motion Studies, Allowance, Overheads, Profit and Pricing Policy.

Elements of Costs, Costing methodology for raw materials, Products and Services, Nature of Costs, Direct, Traceable and Non traceable, Wastage. Determining of Cost of raw materials, manufactured products, labor, indirect expenses and methods of overhead allocation.

Unit–II:	**No. of Lectures: 09 Hours**	**Marks: 12**

Labour Costing: Introduction, factors influencing wage rate, methods of wage payments for direct and indirect labour time wage system, piece rate system, Wage incentives: different plans.
Depreciation: Introduction, purpose, methods for calculating depreciation-straight line method, Diminishing balance method, sum of year digit method, machine hour basis method.
Break even analysis: Introduction, assumptions in break-even analysis, important terms and definitions, calculation of breakeven point, advantages and limitations.

Unit–III:	**No. of Lectures: 08 Hours**	**Marks: 12**

Estimating:
Definition, Different types, Methods adopted for estimation, Use of Standard data, parameter estimating, statistical estimating, feedback systems, importance, purpose and functions of estimating, Mensuration.
Estimation in Machine Shop & Foundry Shop:
Calculation of volume of machined component operation time calculation for turning, knurling, facing, drilling, boring, reaming, threading, milling, tapping, shaping, cutting, various grinding operations, planning etc.
Pattern cost estimation: material, labor, overheads, estimation of foundry costs material, labor other costs.

Unit–IV:	**No. of Lectures: 08 Hours**	**Marks: 12**

Estimation in Forging, Welding & Sheet Metal Work:
Forging process: and types, forging operations, Estimation procedure, estimating losses and time.
Welding: Type of welding processes, types of joints. Preparation cost, Actual welding cost; material, labour, finishing on cost, power cost, factors affecting welding cost. Gas cutting cost, material, labour finishing on cost.
Sheet Metal Work: Operations in sheet metal work, joints, blank layout and size, estimation of time, capacity and types of processes.

Unit–V:	**No. of Lectures: 08 Hours**	**Marks: 12**

Budget: Objectives, classification of budgeting, Budgetary control, securing flexibilities of budgeting, limitation of budget. Operational and capital budgets, Cash flow schedules, Estimating cost, Preparing an annual budget for the Engg. Department.
Engineering Contracts: Introduction, Types of contracts and similarities. Terms of payments, firm price contracts, cost reimbursable contracts, Target of cost contracts, schedule of rate contracts, bill of quantities contracts, compound contracts, contract policy, legal rights and commercial interests.

Text Books:

1. Sinha. B. P., “Mechanical Estimating and Costing”, Tata McGraw-Hill, Publishing Co.
2. T. R. Banga and S. C. Sharma, Estimations and Costing, Khanna Publishers.

3. R. Kesava, C. Elanchezhian and B. Vijaya Ramnath, Process, Planning and Cost Estimation by 2nd ed. New Age International 2018.
4. Panneerselvam R., Process Planning and Cost Estimation by Prentice-Hall of India Pvt. Ltd.

Reference Books:

1. Process Planning & Cost Estimation by R. Kesoram & others, New Age International Pub., N. Delhi.
2. Dennis Lock, Handbook of Engineering Management, Butterwork & Heinemanky Ltd.
3. Learning package in ECC, NITTTR, Bhopal.
4. Shrimali and Jain, Mechanical estimating and costing, Khanna Publishers.
5. Singh and Khan, Mechanical costing and estimation, Khanna Publishers.

INTERNAL COMBUSTION ENGINE

COURSE OUTLINE

Course Title:	**Internal Combustion Engine**	**Short Title:**	**ICE**	**Course Code:**	

Course description:

This course provides the knowledge of Internal Combustion Engine. Course includes different engine cycles its performance analysis, Various systems in IC Engine such as fuel feed, lubrication, cooling, ignition. Fundamental of combustion in I C Engine, types and design of combustion chambers. Various emission control norms and recent trends in Internal Combustion Engines

Lecture	**Hours/week**	**No. of weeks**	**Total hours**	**Semester credits**
	3	14	42	3

Prerequisite course(s):

Mathematics (calculus), Basic thermodynamics cycles, various ideal gas processes, Engineering Thermodynamics, Applied Thermodynamics.

Course objectives:

1. To familiarize with the terminology associated with IC engines.
2. To understand the basics of IC engines.
3. To understand combustion, and various parameters and variables affecting it in various types of IC engines.
4. To learn about various systems used in IC engines and the type of IC engine required for various applications

Course outcomes:

After successful completion of this course the student will be able to:
1. perform a thermodynamic analysis of Otto, Diesel, and Dual cycle models.
2. analyze different electronic fuel injection system, supercharging and its effect on performance of SI and CI engine.
3. understand the role of lubrication in reducing friction and wear.
4. perform a combustion analysis of these fuels in the basic cycles.
5. explain the effects of exhaust emission on human health and various pollution norms.

COURSE CONTENT

Internal Combustion Engine		**Semester:**	**VI**
Teaching Scheme:		**Examination scheme**	
Lectures:	**3 hours/week**	**End semester exam (ESE):**	**60 marks**
		Duration of ESE:	**03 hours**
		Internal Sessional Exams (ISE):	**40 marks**

Unit–I	**No. of Lectures: 09 Hours**	**Marks: 12**

Introduction to IC engine: Classification, engine components and their functions, Terminology. Work (indicated and brake), mean effective pressure.

Air Standard Cycles: Assumptions, Otto, Diesel, Dual Combustion cycle, derivation of their efficiency equation, work done and mean effective pressure, Comparison on the basis of heat

input, compression ratio, Maximum pressure and temperature, Actual cycle, deviation from theoretical cycles. Pumping losses, time losses

Unit–II	No. of Lectures: 09 Hours	Marks: 12

Fuel Feeding Systems for SI engine Charge Carburetion Requirement, types of carburetors according to fluid flow, Simple carburetor, Air fuel ratio calculation additional systems in modern carburetors, Solex carburetor. Disadvantages of carburetion and gasoline injection, MPFI.
Fuel feeding systems in CI engines: Requirement, classification, fuel feed pump, jerk type injection fuel pump, distributor type pump, injection pump governor, fuel injector and nozzles.

Unit–III	No. of Lectures: 08 Hours	Marks: 12

Cooling systems: requirement, types of cooling systems, thermostat and additives.
Lubrication: Mechanism of lubrication, different methods, important properties of lubricating oils
Ignition Systems: requirement, battery ignition, magneto ignition, electronic ignition system, Ignition timing, spark timing advance.

Unit–IV	No. of Lectures: 08 Hours	Marks: 12

Combustion in SI engines: Homogeneous and heterogeneous mixtures, Stages in combustion, Ignition lag, velocity of flame propagation, factors influencing flame speed, rate of pressure rise, Detonation, factors affecting the detonation, pre-ignition. Rating of SI engines fuels, Dopes, combustion chamber of SI engines.
Combustion in CI engine; stages of combustion, factors affecting the delay period. Diesel knock, Effect of engine variables on Diesel knock, Rating of CI engine fuels: Cetane number, performance number, comparison of knock in SI and CI engines. Combustion chamber for CI engines

Unit–V	No. of Lectures: 08 Hours	Marks: 12

Advance in IC engine: Recent trends in internal combustion engines. Engine emission, air pollution due to engines, various Euro norms. Un-burnt hydrocarbon, emission in two stroke and CI engines, CO and No_x emission, particulate traps, EGR, emission control methods, catalytic converters (Introductory), crank blow by losses, Advance IC engine concepts. Hybrid engines, Alternative fuels used in IC engine.

Text Books:

1) V. Ganeshan, “Internal Combustion Engines”, 2/e, Tata McGraw Hill, New Delhi.
2) R. K. Rajput, “Internal Combustion Engines”’, Laxmi Publications, New Delhi.
3) Shyam K. Agrawal, “Internal Combustion Engines”, New Edge International Publication.
4) K.K. Ramalingam, “Internal Combustion Engines”, Scitech Publication
5) Sharma R.P. and Mathur M.L., “Internal Combustion Engines”, Standard Publications, New Delhi.

Reference Books:

1) W. W. Pulkrabek, “Fundamentals of Internal Combustion Engines”, Prentice Hall of India (P) Ltd., New Delhi.
2) E. F. Obert, “Internal Combustion Engines and Air Pollution”, Harper and Row, New York.

3) Ferguson C. R, “Internal Combustion Engines”, Wiley Inc. New York.
4) Sharma R.P. and Mathur M.L., “Internal Combustion Engines”, Standard Publications, New Delhi.
5) Domkundwar, “Internal Combustion Engines”, Dhanpat Rai & Co. New Delhi.
6) Willard W Pulkrabek. “Internal Combustion Engines”, Pearson Education
7) Heywood J. B, "Internal Combustion Engine Fundamentals", McGraw Hill Book Co. NY, 1989

SOLID MECHANICS

COURSE OUTLINE

Course Title:	Solid Mechanics	Short Title:	SM	Course Code:	

Course description: In this course "Solid Mechanics" a general theory available to study the response of solids to applied forces will be developed and will be used to study simple boundary value problems. In all the treatment would be three dimensional. The aim of the course material would be to inculcate in the reader some of the available tools to analyze a structure and to elucidate the simplifying assumptions made to make the structure analyzable.

Lecture	Hours/week	No. of weeks	Total hours	Semester credits
	03	14	42	3

Prerequisite course(s):

Mathematics (Calculus) and Engineering Mechanics

Course objectives:

The objective is to present the mathematical and physical principles in understanding the linear continuum behavior of solids.

Course outcomes:

After successful completion of this course the student will be able to:

understand the deformation behavior of solids under different types of loading and obtain mathematical solutions for simple geometries.

COURSE CONTENT

Solid Mechanics		Semester:	VI
Teaching Scheme:		**Examination scheme**	
Lectures:	**3 hours/week**	**End semester exam (ESE):**	**60 marks**
Tutorials:	**1 hours/week**	**Duration of ESE:**	**03 hours**
		Internal Sessional Exams (ISE):	**40 marks**

Unit–I:	No. of Lectures: 09 Hours	Marks: 12

Introduction to Cartesian tensors, Strains: Concept of strain, derivation of small strain tensor and compatibility, Stress: Derivation of Cauchy relations and equilibrium and symmetry equations,

Unit–II:	No. of Lectures: 09 Hours	Marks: 12

Principal stresses and directions, Constitutive equations: Generalized Hooke's law, Linear elasticity, Material symmetry; Boundary Value Problems: concepts of uniqueness and superposition.

Unit–III:	No. of Lectures: 08 Hours	Marks: 12

Plane stress and plane strain problems, introduction to governing equations in cylindrical and spherical coordinates, axisymmetric problems.

Unit–IV:	No. of Lectures: 08 Hours	Marks: 12

Application to thick cylinders, rotating discs, torsion of circular straight rods, torsion of shafts with rectangular cross-sections, torsion of hollow shafts, torsion of thin tubes.		
Unit–V:	**No. of Lectures: 08 Hours**	**Marks: 12**
Stress concentration problems, thermo-elasticity,2-d contact problems. Solutions using potentials. Energy methods. Introduction to plasticity.		
Text Books:		
1. G. T. Mase, R. E. Smelser and G. E. Mase, Continuum Mechanics for Engineers, Third Edition, CRC Press, 2004. 2. Y. C. Fung, Foundations of Solid Mechanics, Prentice Hall International, 1965. 3. Lawrence. E. Malvern, Introduction to Mechanics of a Continuous Medium, Prentice Hall international, 1969.		
Reference Books:		
1. L. S. Srinath,"Advanced Mechanics of Solids" Tata McGraw Hill, 2007. 2. A.R. Ragab, and S. E. Bayoumi, "Engineering Solid Mechanics: Fundamentals and applications", CRC Press, 1999. 3. M. H. Sadd,"Elasticity: Theory,Applications and Numerics",Academic Press, 2006.		

SOFTWARE ENGINEERING					
COURSE OUTLINE					
Course Title:	**Software Engineering**	**Short Title:**	**SE**	**Course Code:**	
Course description: The objective of this course is to introduce students the knowledge of Software Development Life Cycle, application of analysis, design, testing principles and project planning & management concepts to develop quality software economically.					

Lecture	**Hours/week**	**No. of weeks**	**Total hours**	**Semester credits**
	3	14	42	3

Prerequisite: Computer programming

Course objectives:

To help students to develop skills that will enable them to construct software of high quality – software that is reliable, and that is reasonably easy to understand, modify and maintain

Course outcomes:

After successful completion of this course the student will be able to:

- Gather data to analyze and specify the requirements of a system.
- Design system components and environments.
- Build general and detailed models that assist programmers in implementing a system

COURSE CONTENT

Software Engineering		**Semester:**	VI
Teaching Scheme:		**Examination scheme**	
Lectures:	**3 hours/week**	**End semester exam (ESE):**	**60 marks**
		Duration of ESE:	**03 hours**
		Internal Sessional Exams (ISE):	**40 marks**

Unit–I:	**No. of Lectures: 09 Hours**	**Marks: 12**

Nature of Software, Software Process, Software Engineering Practice, Software Myths, Generic Process model, Process Assessment and Improvement, Perspective Process Models, Specialized Process Models, Personal and Team Process Models, Agile Process models: Agile process, Extreme programming

Unit–II:	**No. of Lectures: 09 Hours**	**Marks: 12**

Requirements Engineering Eliciting Requirements, Building the Requirements Model, Negotiating requirements, Validating requirements, Requirements Analysis, Scenario-Based Modeling, Data modeling Concepts, Class based modeling

Unit–III:	**No. of Lectures: 08 Hours**	**Marks: 12**

Design Process, Design Concepts, Design Model, **Architectural Design:** Software architecture, Architectural Style, Architectural design, **User Interface Design**: The Golden

rules, User interface analysis and design, Interface analysis, Interface design steps, Design Evaluation.		
Unit–IV:	**No. of Lectures: 08 Hours**	**Marks: 12**
Software Testing: A strategic approach to software testing, strategic issues, test strategies for conventional software, validation testing, system testing, white box testing, basis path testing, control structure testing, black box testing, model based testing, testing for specialized environments, architectures and applications.		
Unit–V:	**No. of Lectures: 08 Hours**	**Marks: 12**
Software project management: Management spectrum – people, product, process, project. **Software measurement:** Size oriented metrics, function oriented metrics, reconciling LOC and FP metrics. Metrics for software quality, Integrating metrics within the software process. Metrics for small organization, establishing a software metrics program.		
Text Books:		
1. Roger S. Pressman, "Software Engineering – A Practitioner's Approach", 7th edition, McGraw Hill		
Reference Books:		
1. Rajib Mall, Software Engineering, 3rd Edition, PHI. 2. Pankaj Jalote, An Integrated Approach to Software Engineering, 3rd Edition, Springer. 3. Sommerville, Software Engineering, 8th Edition, Pearson. 4. Fairly R., Software Engineering, Tata McGraw Hill. 5. Davis A., Principles of Software Development, Tata McGraw Hill. 6. Shooman, M.L., Software Engineering, Tata McGraw-Hill.		

INTRODUCTION TO DATA STRUCTURES

COURSE OUTLINE

Course Title:	**Introduction to Data Structures**	**Short Title:**	**IDC**	**Course Code:**	

Course description:

Covers the design and analysis of data structures to solve mechanical engineering problems. Topics include elementary data structures, (including arrays, linked lists, stacks, and queues), advanced data structure like tree, the algorithms used to manipulate these structures, and their application to solving practical mechanical engineering problems.

Lecture	**Hours/week**	**No. of weeks**	**Total hours**	**Semester credits**
	3	14	42	3

Prerequisite:

Basics of C Programming Language

Course objectives:

1. To impart the concepts of basic data structures.
2. To understand the concepts of basic searching and sorting techniques
3. To understand the basic concepts of operations in data structures

Course outcomes:

After successful completion of this course the student will be able to:

1. Choose the data structures that effectively model the information in a problem.
2. Judge efficiency tradeoffs among alternative data structure implementations or combinations.
3. Design, implement, test, and debug programs using a variety of data structures including stack, queue, linked list and trees.
4. Implement and know when to apply standard algorithms for searching and sorting.
5. Apply algorithm analysis techniques to evaluate the performance of an algorithm and to compare data structures.

COURSE CONTENT

Introduction to Data Structures		**Semester:**	VI
Teaching Scheme:		**Examination scheme**	
Lectures:	**3 hours/week**	**End semester exam (ESE):**	**60 marks**
		Duration of ESE:	**03 hours**
		Internal Sessional Exams (ISE):	**40 marks**

Unit–I:	**No. of Lectures: 09 Hours**	**Marks: 12**

Algorithms- Problem Solving, Introduction to Algorithms, Characteristics of algorithms, Algorithm design tools: Pseudo code and flowchart, Analysis of Algorithms, Complexity of algorithms- Space complexity, Time complexity, Asymptotic notation- Big-O, Theta and Omega, standard measures of efficiency.

Data Structures- Data structure, Abstract Data Types (ADT), Concept of linear and Non-linear, static and dynamic, persistent and ephemeral data structures, and relationship among data, data structure, and algorithm, From Problem to Program.

Sequential Organization- Linear Data Structure Using Sequential Organization, Array as an Abstract Data Type, Memory Representation and Address Calculation, Inserting an element into an array, Deleting an element, Multidimensional Arrays, Two-dimensional arrays.		
Unit–II:	**No. of Lectures: 09 Hours**	**Marks: 12**
Stack: Operations on stacks: Push & Pop, Array representation of stack, Linked representation of stack, Application of stack, Conversion of infix to prefix and postfix expressions, Evaluation of the postfix expression using a stack.		
Unit–III:	**No. of Lectures: 08 Hours**	**Marks: 12**
Queue: Array and linked representation, Operations on queue, Types of queue: Circular queues, Advantages of Circular queue, Multiqueues, Dequeues and Priority queue, Linked Queue & operations, Applications of Queue		
Unit–IV:	**No. of Lectures: 08 Hours**	**Marks: 12**
Linked List: Basic concept, Representation of linked lists, Comparison of sequential & linked organizations, Operations on linked list, linked list as ADT, Linked list using dynamic memory management, Types of linked list: Linear, Circular linked list, Doubly linked list and operations, Applications of linked list: Polynomial representation and addition, Polynomial addition & Multiplication using linked list		
Unit–V:	**No. of Lectures: 08 Hours**	**Marks: 12**
Searching- Search Techniques, Sequential search, variant of sequential search- sentinel search, Binary search, Fibonacci search. **Sorting-** Insertion, Selection, Merge, Shell, Radix		
Text Books:		
1. Seymour Lipschutz, "Data Structure with C", Schaum outline series, Tata McGraw Hill 2. Rema Thareja "Data Structures Using C", 2nd Edition, Oxford University Press. 2014 3. R.S.Salaria, "Data Structures", Khanna Publishing House , 3rd Edition, 2017. 4. R.B.Patel, "Expert Data Structures with C", Khanna Publishing House, 3rd Edition, 2014		
Reference Books:		
1. Yashwant Kanetkar, "Data Structures through C" , BPB Publications, 2nd Edition, 2003. 2. Ellis Horowitz, Sartaj Sahni and Susan Anderson-Freed, "Fundamentals of Data Structures in C" University Press, 2nd Edition 3. Seymour Lipschutz, "Data Structures", Schaums Outlines McGraw Hill Book Company, International Edition, 2006.		

INTRODUCTION TO MICRO-ELECTRO MECHANICAL SYSTEMS					
COURSE OUTLINE					
Course Title:	**Introduction to Micro-electro Mechanical Systems**	**Short Title:**	**MEMS**	**Course Code:**	
Course description:					
The objective of this course is to make students to gain basic knowledge on overview of MEMS (Micro electro Mechanical System) and to introduce the student's various opportunities in the emerging field of MEMS. Students will acquire an in-depth understanding of MEMS technologies and the Sensors, Actuation, Materials and Applications associated with them. Course includes basic technology features of MEMS devices.					
Lecture	**Hours/week**	**No. of weeks**	**Total hours**	**Semester credits**	
	03	*14*	*42*	*3*	
Prerequisite course(s):					
Introduction to Electronics Engg, Introduction to Elect. Engg., Basic Electrical Drives & Control					
Course objectives:					
1. To study MEMS technology 2. To Introduce Various Sensors And Actuators 3. To Introduce Different Materials Used For MEMS 4. To Educate On The Applications Of MEMS To Disciplines Beyond Electrical And Mechanical Engineering.					
Course outcomes:					
After successful completion of this course the student will be able to:					
1. Understand the scope, importance and application of miniaturized products 2. Analyse and Demonstrate design skills of MEMS devices and products 3. Understand the design process 4. Select an appropriate microsensor and microactuator in a given application. 5. Recommend a suitable material for a MEMS product.					
COURSE CONTENT					
Introduction to Micro-electro Mechanical Systems			**Semester:**	***VI***	
Teaching Scheme:			**Examination scheme**		
Lectures:	**3 hours/week**		**End semester exam (ESE):**		**60 marks**
			Duration of ESE:		**03 hours**
			Internal Sessional Exams (ISE):		**40 marks**
Unit–I:		**No. of Lectures: 09 Hours**		**Marks: 12**	
MEMS: Introduction, What is MEMS?, Definitions and Classifications, History, Intrinsic characteristics of MEMS - Miniaturization, Microelectronics Integration, Parallel fabrication with precision, Future trends, Miniaturization Issues, Scaling, MEMs Materials, Characteristics of MEMS Materials, Performance Characteristic and Cost of MEMS Products					
Unit–II:		**No. of Lectures: 09 Hours**		**Marks: 12**	

MEMS Sensing and Actuation – I : MEMS Sensors and actuators considerations, Electrostatic Sensors – Parallel Plate Capacitors – Applications – Interdigitated Finger Capacitor – Comb Drive Devices – Micro Grippers – Micro Motors – Thermal Sensing And Actuation – Thermal Expansion – Thermal Couples – Thermal Resistors – Thermal Bimorph – Applications – Magnetic Actuators – Micromagnetic Components – Case Studies Of MEMS In Magnetic Actuators- Actuation Using Shape Memory Alloys.

Unit–III:	No. of Lectures: 08 Hours	Marks: 12

MEMS Sensing and Actuation – II: Piezoresistive Sensors – Piezoresistive Sensor Materials – Stress Analysis Of Mechanical Elements – Applications To Inertia, Pressure, Tactile And Flow Sensors – Piezoelectric Sensors And Actuators – Piezoelectric Effects – Piezoelectric Materials – Applications To Inertia , Acoustic, Tactile And Flow Sensors.

Unit–IV:	No. of Lectures: 08 Hours	Marks: 12

MEMS Materials: Overview of Smart Materials, Structures and Products Technologies, Smart Materials (Physical Properties), Piezoelectric Materials, Electrostrictive Materials, Magnetostrictive Materials, Magneto electric Materials, Magneto rheological Fluids Electro rheological Fluids, Super-plastic materials

Design considerations – process design – mechanical design

Unit–V:	No. of Lectures: 08 Hours	Marks: 12

Applications of MEMS: In Automotive, Electronics, Medical, Communication and Deference sector, Automotive airbag sensor, Medical pressure sensor, Inkjet printer head, Overhead projection display, Bio-MEMS, MOEMS, RF-MEMS, MEMS Market, Blood Pressure Sensors, Microphone, Acceleration Sensors, Gyros,

Text Books:

1. Tai-Ran Hsu, "MEMS and Microsystems Design and Manufacture", Tata McGraw Hill Publishing Co. Ltd., New Delhi, 2002.
2. Mark Madou, "Fundamentals of Microfabrication", CRC Press, New York, 1997.
3. Julian W Gardner, "Microsensors: Principles and Applications", John Wiley and Sons, New York, 2001.
4. Sze S M, "Semiconductor Sensors", McGraw Hill, New York, 1994.
5. Chang C Y and Sze S M, "VLSI Technology", McGraw Hill, New York, 2000.
6. Chang Liu, 'Foundations Of MEMS', Pearson Education Inc., 2012.
7. Stephen D Senturia, 'Microsystem Design', Springer Publication, 2000.

Reference Books:

1. https://nptel.ac.in/courses/117105082/
2. MEMS & Microsystems: Design & Manufacture, Tai Ran Hsu, Tata McGraw Hill, 2002.
3. Smart Materials and Structures, M.V. Gandhi and B.S. Thompson, Chapman & Hall, London;
4. Nadim Maluf, "An Introduction to Micro Electro Mechanical System Design", Artech House, 2000.
5. Mohamed Gad-El-Hak, Editor, "The MEMS Handbook", CRC Press Baco Raton, 2001.
6. Julian W. Gardner, Vijay K. Varadan, Osama O.Awadelkarim, Micro Sensors MEMS And Smart Devices, John Wiley & Son LTD, 2002.

7. James J.Allen, Micro Electro Mechanical System Design, CRC Press Publisher, 2005.
8. Thomas M.Adams And Richard A.Layton, "Introduction MEMS, Fabrication & Application," Springer, 2010.

PIPING ENGINEERING					
COURSE OUTLINE					
Course Title:	**Piping Engineering**	**Short Title:**	**PE**	**Course Code:**	
Course description:					
The objective of this course is to make students to gain basic knowledge on overview of MEMS (Micro electro Mechanical System) and to introduce the student's various opportunities in the emerging field of MEMS. Students will acquire an in-depth understanding of MEMS technologies and the Sensors, Actuation, Materials and Applications associated with them. Course includes basic technology features of MEMS devices.					
Lecture	**Hours/week**	**No. of weeks**	**Total hours**	**Semester credits**	
	03	*14*	*42*	*3*	
Prerequisite course(s):					
Introduction to Electronics Engg, Introduction to Elect. Engg., Basic Electrical Drives & Control					
Course objectives:					
1. To study MEMS technology 2. To Introduce Various Sensors And Actuators 3. To Introduce Different Materials Used For MEMS 4. To Educate On The Applications Of MEMS To Disciplines Beyond Electrical And Mechanical Engineering.					
Course outcomes:					
After successful completion of this course the student will be able to:					
1. Understand the scope, importance and application of miniaturized products 2. Analyse and Demonstrate design skills of MEMS devices and products 3. Understand the design process 4. Select an appropriate microsensor and microactuator in a given application. 5. Recommend a suitable material for a MEMS product.					
COURSE CONTENT					
Introduction to Micro-electro Mechanical Systems		**Semester:**	***VI***		
Teaching Scheme:		**Examination scheme**			
Lectures:	**3 hours/week**	**End semester exam (ESE):**		**60 marks**	
		Duration of ESE:		**03 hours**	
		Internal Sessional Exams (ISE):		**40 marks**	
Unit–I:	**No. of Lectures: 09 Hours**	**Marks: 12**			
Introduction to piping designing & engineering: Evolution of piping, Manufacturing methods Piping materials and selection, Pipe dimensioning, Schedule numbers, Common piping abbreviations, Major organizations for standards, Commonly American code in piping ASME/ANSI, Common abbreviations, Basic Piping components required.					
Unit–II:	**No. of Lectures: 09 Hours**	**Marks: 12**			

Piping Equipment: Horizontal vessels/accumulators, fractionation columns, pumps, heat exchangers, re-boiler, air cooled heat exchanger, cooling towers, heaters/boilers, storage tanks, fractional distillation process and vendor data drawings.
Uses of flow diagrams, process flow diagrams, mechanical flow diagrams, utility flow diagrams piping symbols, line symbols, valve symbols, piping isometrics, general arrangement drawings-sections/elevations/ detail drawings, plot plan procedures.

Unit–III:	**No. of Lectures: 08 Hours**	**Marks: 12**

Purpose of P&ID'S, study of P&ID'S, stages of development of P&ID'S, process and instrumentation diagrams, process equipment's, symbols usage according to industrial practices Purpose of P&ID in process industrial/plants.

Unit–IV:	**No. of Lectures: 08 Hours**	**Marks: 12**

Preparation of Piping Material Specification: Valve Material Specification, Pipe Wall thickness Calculations, Preparation of Special Items Datasheets, Pressure Design of Miter Bends – Single & Multiple Miters, Pressure Design of Blanks, Branch reinforcement calculations, Overview of Technical Queries and Technical Bid Evaluations.
Types of stresses, Significance of forces and moments - Introduction to Stress Analysis - Expansion Loop types, Bellows Types.

Unit–V:	**No. of Lectures: 08 Hours**	**Marks: 12**

ASME Engineering: Pipe wall thickness calculations, operating & design pressure, operating & design temperature and maximum allowable operating pressure.
Pipe, elbows, mitre bends, reinforcement pad calculation for branch connections, flanges, blanks, reducers, expansion joints and gaskets as per ASME.
AutoCAD : Drawing Creation (P&ID, PFD, Layouts, and all fabrication Drawings)

Text Books:

1. Rhea and Parisher,
2. G.K. Sahu, Handbook of Piping Design, New Age International Publishers, Delhi
3. A. S. Rangwala, Piping Dynamics, New Age International Publishers.
4. Sanjay Kumar Gupta, Perfect Knowledge of Piping Engineering, Createspace Independent Pub.

Reference Books:

1. Peter Smith, The Fundamentals of piping design, Gulf Publishing co.
2. Liang-Chuan Peng, Tsen-Loong Peng, Pipe Stress Engineering, American Society of Mechanical Engineers.
3. Becht, Charles, IV, Process Piping: The Complete Guide to ASME B31.3, American Society of Mechanical Engineers
4. Mohinder Nayyar, Piping Handbook, McGraw-Hill Handbooks.

KINEMATICS AND THEORY OF MACHINES LAB

LAB COURSE OUTLINE

Course Title:	**Kinematics and Theory of Machines Lab**	**Short Title:**	**KTM Lab**	**Course Code:**	

Course description:

Mechanisms form the basis of any machine and it is an assemblage of rigid bodies so that they move upon each other with definite relative motion. Demonstration exercises are provided with wide varieties of transmission element models to understand machine kinematics. Various experiments with governors, gyroscopes and balancing machines and universal vibration facilities are available to understand machine dynamics.

Laboratory	**Hours/week**	**No. of weeks**	**Total hours**	**Semester credits**
	2	14	28	01

End Semester Exam (ESE) Pattern:	***Oral (OR)***

Prerequisite course(s):

Engineering Mechanic, Strength of Materials

Course objectives:

Objectives of this lab are to impart practical knowledge on design and analysis of mechanisms for the specified type of motion in a machine. With the study of rigid bodies motions and forces for the transmission systems, machine kinematics and dynamics can be well understood.

Course outcomes:

Upon successful completion of lab Course, student will be able to:

1. Distinguish kinematic and kinetic motion.
2. Identify the basic relations between velocity, and acceleration.
3.Use graphical and analytic methods to study the motion of a planar mechanism
4. design linkage, cam and gear mechanisms for a given motion or a given input/output motion or force relationship.
5. analyze the motion and the dynamical forces acting on mechanical systems composed of linkages, gears and cams.

LAB COURSE CONTENT

Kinematics and Theory of Machines		**Semester:**	**VI**
Teaching Scheme:		**Examination scheme**	
Practical:	**2 hours/week**	**End semester exam (ESE):**	***25 marks***
		Internal Continuous Assessment (ICA):	***25 marks***

ASSIGNMENTS:

1) Study of Kinematics of Four Bar, Slider Crank, Crank Rocker and Oscillating cylinder Mechanism.
2) Study of Different Mechanisms.

DRAWING SHEETS:

1) ICR and Relative Velocity.
2) Relative Acceleration and Coriolis Acceleration.

3) Cam and Follower Motions.
4) Balancing of Rotating and Reciprocating Masses.

EXPERIMENTS:

1. To determine the characteristics of Centrifugal Governor and Find its Sensitivity and Stability.
2. To verify the principle of working of gyroscope
3. To determine mass moment of inertia of compound pendulum.
4. To determine mass moment of inertia of Rigid body by using Bifilar suspension or Trifilar suspension method.

Text Books:

1. Cleghorn W. L., Mechanisms of Machines, Oxford University Press, 2005.
2. Robert L. Norton, Kinematics and Dynamics of Machinery, Tata McGraw Hill, 2009.
3. Ratan S. S., Theory of Machines, 4th edition, Tata McGraw Hill, 2014.
4. Khurmi R. S, Theory of Machines, 14th edition, S. Chand & Co. Ltd., 2005.
5. Singh V. P., Theory of Machines, Dhanpat Rai & Co.
6. Phakatkar H. G., Theory of Machines – I
7. Phakatkar H. G., Theory of Machines – II
8. Bansal R. K., Theory of Machines, Laxmi Publications.
9. Singh Sadhu, Theory of Machines, Pearson Publication.

Reference Books:

1. Thomas Bevan, Theory of Machines, 3rd edition, CBS Publishers & Distributors, 2005.
2. Ghosh A. and Mallick A. K., Theory of Mechanisms and Machines, Affiliated East-West Pvt. Ltd, New Delhi, 1988.
3. Lal Jagdish, Theory of Mechanisms & Machines, Metropoliton Book Co.
4. Shingley J. E. And Uicker J. J., Theory of Machines and Mechanisms, McGraw45 Hill International Book Co.
5. Ballaney P. L., Theory of Machine, Khanna Publication.

Guide lines for ICA:

Students must submit ICA in the form of journal. Each assignment should be well documented. Faculty in charge will assess the assignments continuously and grade or mark each assignment on completion date declared for each assignments.

Guidelines for ESE:

ESE will be based on the laboratory assignments submitted by the students in the form of journal.

MANUFACTURING TECHNOLOGY LAB

LAB COURSE OUTLINE

Course Title:	Manufacturing Technology Lab	Short Title:	MT	Course Code:	

Course description:

This course provide student comprehensive study of advanced technology of manufacturing. The will provide practical knowledge of different CNC machine, CNC milling machine and part programming using on these machines. The course will also enlighten students with different concepts like lean manufacturing, 3D manufacturing and its uses, tool life, tool wear, material handling devices etc.

Laboratory	Hours/week	No. of weeks	Total hours	Semester credits
	02	14	28	01

End Semester Exam (ESE) Pattern: ***Oral (OR)***

Prerequisite course(s):

Manufacturing processes, Workshop

Course objectives:

To help students understand student different advanced manufacturing processes used in industry to convert raw material into finished product. To impart practical knowledge of manufacturing processes like 3D manufacturing, CNC machine, CNC milling, concept of lean manufacturing, tool life and factors influencing it.

Course outcomes:

Upon successful completion of lab Course, student will be able to:

Students will be to understand the different advanced production technologies. They will be able to perform and understand different machining operation using CNC machine, CNC milling machine. The students will understand concept of tool life, tool wear, lean manufacturing and different material handling devices used in industry.

LAB COURSE CONTENT

Manufacturing Technology		Semester:	VI
Teaching Scheme:		**Examination scheme**	
Practical:	**2 hours/week**	**End semester exam (ESE):**	**25 marks**
		Internal Continuous Assessment (ICA):	**25 marks**

1) Design and fabrication of milling fixture
2) Demonstration of CNC machine
3) Job programming and manufacturing on CNC milling or CNC Lathe machine.
4) Demonstration of advanced manufacturing process
5) Demonstration of 3D manufacturing process
6) Introduction and demonstration of lean manufacturing process in manufacturing technology
7) Demonstration of various material handling devices used in manufacturing industry.
8) Demonstration of different tool wear and factor affecting tool life.

Text Books:

1. Element of Workshop Technology Volume I and II -Hajara Chaudhary and Bose S.K.,Asia Publishing House.
2. Production Technology Volume I and II –P.N.Rao, Tata McGraw Hill Publication.
3. Production Technology- R.K.Jain, Khanna Publications.
4. Production Technology- P.C.Sharma, Khanna Publication.
5. Workshop Technology-Chapman W.A.J., ELBS Publication.
6. Production Technology- HMT, Tata McGraw Hill Publication.

Reference Books:

1. Kalpak Jain and Schmid, Manufacturing processes for engineering materials (7^{th} Edition)-Pearson India, 2014.
2. Taha H. A., Operations Research, 6^{th} Edition, Prentice Hall of India, 2003.
3. Shenoy G.V. and Shrivastava U.K., Operations Research for Management, Wiley Eastern, 1994.
4. Mikell P. Groover, Fundamentals of Modern Manufacturing: Materials, Processes, and Systems
5. Degarmo, Black &Kohser, Materials and Processes in Manufacturing
6. Materials and processes in manufacturing , J T Black, Ronald A. Kosher, De Garmos, , Wiley student edition

Guide lines for ICA:

Students must submit ICA in the form of journal. Each practical/assignment should be well documented. Faculty in charge will assess the practical/assignments continuously and grade or mark each practical/assignment on completion date declared for each assignments.

Guidelines for ESE:

The End Semester Examination (ESE) (Oral Exam) will be based on the above mentioned assignment/practical and theory topics mentioned in syllabus of manufacturing processes. Evaluation will be based on paper work.

MATERIAL ENGINEERING LAB					
LAB COURSE OUTLINE					
Course Title:	**Material Engineering Lab**	**Short Title:**	**ME Lab**	**Course Code:**	
Course description:					
This lab includes the practical's related to different testing machines. It also includes preparation and study of different microstructures and introduction of furnace.					
Laboratory	**Hours/week**	**No. of weeks**	**Total hours**	**Semester credits**	
	2	14	28	1	
End Semester Exam (ESE) Pattern:	**--**				
Prerequisite course(s):					
Engineering Chemistry and Engineering Physics					
Course objectives:					
(i) To understand the measurement of mechanical properties of materials (ii) To understand the deformation behaviour of materials (iii) To understand the Microstructure and its co-relation with the properties.					
Course outcomes:					
Upon successful completion of lab Course, student will be able to:					
Students who have undergone the course will be able to understand the measurement of mechanical properties of materials and will be able to characterize the dynamic behavior of mechanical systems					
LAB COURSE CONTENT					
Material Engineering Lab		**Semester:**	**VI**		
Teaching Scheme:		**Examination scheme**			
Practical:	**2 hours/week**	**End semester exam (ESE):**		***25 marks***	
		Internal Continuous Assessment (ICA):		***25 marks***	
1. Tensile test, to compare tensile strength, yield point and ductility of three metallic materials. 2. Brinell or Poldi hardness test on steel, cast iron, brass 3. Rockwell and Rockwell superficial hardness measurement. 4. Izod or Charpy impact test to compare impact values of cast iron and mild steel or aluminium and brass 5. Measurement Non-destructive tests: Dye penetrant test, Magnetic particle testing, ultrasonic testing, eddy current test. (any two) 6. Micro Specimen Preparation and use of metallurgical microscope 7. Study and drawing microstructure of mild steel, medium carbon, eutectoid steel, hypereutectoid steel 8. Study and drawing microstructure of white, malleable, gray and ductile cast iron or any four non-ferrous metals. 9. Jominy Hardenability test.					

10. Demonstration of Annealing, Normalising and Hardening of medium carbon steel specimens and measurements of hardness and drawing microstructures.
Note: Perform any Eight from above list
Text Books:
1. W. D. Callister, 2006, "Materials Science and Engineering-An Introduction", 6th Edition, Wiley India. 2. Kenneth G. Budinski and Michael K. Budinski, "Engineering Materials", Prentice Hall of India Private Limited, 4th Indian Reprint, 2002. 3. V. Raghavan, "Material Science and Engineering', Prentice Hall of India Private Limited, 1999. 4. U. C. Jindal, "Engineering Materials and Metallurgy", Pearson, 2011.
Reference Books:
1. Degarmo's "Materials and processes in manufacturing", by J.T. Black, Ronald A. Kosher, Willey student edition. 2. "Material Science and Metallurgy for Engineers", by V. D. Kodgire, Everest Publishing House. Pune 3. "Introduction to Engineering Materials", by B. K. Agrawal, Tata Mcgraw Hill, New Delhi. 4. "An Introduction to Physical Metallurgy", by S.H. Avner, Tata Mcgraw Hill, New Delhi. 5."Fundamentals of modern manufacturing materials, processes and systems", by Mikell P. Groover, Wiley student edition, New Delhi. 6. "Material Science and Metallurgy", by Parashivamurthy K. I., Pearson Publication 7. "Material Science and Metallurgy", by U. C. Jindal, Pearson Publication 8. "Introduction to Materials Science for Engineers", by James F. Shackleford & Madanapalli K. Muralidhara, Pearson Publication 9. "A textbook of Material Science and Metallurgy", by O. P. Khanna, Dhanpat Rai Publication
Guide lines for ICA:
ICA will be based on practical assignments submitted by the student in the form of journal. Evaluation will be based on paper work.

Minor Project

LAB COURSE OUTLINE

Course Title:	**Minor Project**	**Short Title:**	**MPROJ**	**Course Code:**	

Course description:

Minor project represent the culmination of study towards the Bachelor of Engineering degree. The minor project offers the opportunity to apply and extend material learned throughout the program. The emphasis is necessarily on facilitating student learning in technical, project management and presentation spheres.

Laboratory	**Hours/week**	**No. of weeks**	**Total hours**	**Semester credits**
	6	**14**	**84**	**3**

End Semester Exam (ESE) Pattern:	**Oral (OR)**

Prerequisite course(s):

Course objectives:

1. To understand the basic concepts & broad principles of projects.
2. To understand the value of achieving perfection in project implementation & completion.
3. To apply the theoretical concepts to solve problems with teamwork and multidisciplinary approach.
4. To demonstrate professionalism with ethics; present effective communication skills and relate engineering issues to broader societal context.

Course outcomes:

Upon successful completion of lab Course, student will be able to:

1. Demonstrate a sound technical knowledge of their selected project topic.
2. Undertake problem identification, formulation and solution.
3. Design engineering solutions to complex problems utilizing a systems approach.
4. Conduct an engineering project
5. Demonstrate the knowledge, skills and attitudes of a professional engineer.

LAB COURSE CONTENT

Minor Project		**Semester:**	**VI**
Teaching Scheme:		**Examination scheme:**	
Practical:	**6 hours/week**	**End semester exam (ESE): (OR)**	**25 marks**
		Internal Continuous Assessment (ICA):	**50 marks**

In continuation with Minor Project (Stage – I) at Semester – V, by the end of Semester – VI, the student should complete implementation of ideas as formulated in Minor Project (Stage – I). It may involve coding, experimentation, data analysis within realistic constraints such as economic, environmental, social, ethical, health and safety, and sustainability. It may also include testing, results and report writing. Each student group should submit complete project report at the end of Semester-VI in the form of Hard bound. Assessment for the project shall also include presentation by the students.

Each student group is required to maintain separate log book for documenting various activities of the project.

Suggestive outline for the complete project report is as follows.

Abstract
Chapter 1. Introduction

- Background
- Motivation
- Problem Definition
- Scope
- Objective
- Organization of Report
- Summary

Chapter 2. Literature Review

Chapter 3. Design & development / Experimentation & observation / Survey & Data collection

Chapter 4. Testing, Analysis & Validation / Results & discussions / Data interpretation

Chapter 5. Conclusion & Future Work

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Appendix

Guide lines for ICA:

The Internal Continuous Assessment (ICA) for project shall be based on continuous evaluation of students' performance, active participation, knowledge / skill acquired throughout semester and presentation by the students. The assessment shall be done jointly by the guide and departmental committee. A three-member departmental committee including guide, appointed by Head of the department, shall be constituted for the assessment. The assessment for Minor Project in Semester – VI shall be as per the guidelines given in Table – B.

Table – B

		Assessment by Guide				Assessment by Departmental Committee			
Sr. No.	Name of the Student	Attendance / Participation	Implementation	Results	Report	Depth of Understanding	Presentation	Demonstration	Total
	Marks	5	5	5	5	10	10	10	50

Guidelines for ESE:
In End Semester Examination (ESE), the student may be asked for presentation / demonstration and questions on Project. Evaluation will be based on answers given by students in oral examination.

Internship

Internship is a mandatory and non-credit course. It is mandatory for all admitted students to undergo Internship during the degree course. The course shall be of THREE weeks duration during summer vacation after Semester - VI. Following are the intended objectives of internship training:

- Will expose Technical students to the industrial environment, which cannot be simulated in the classroom and hence creating competent professionals for the industry.
- Provide possible opportunities to learn, understand and sharpen the real time technical / managerial skills required at the job.
- Exposure to the current technological developments relevant to the subject area of training.
- Experience gained from the 'Industrial Internship' will be used in classroom discussions.
- Create conditions conducive to quest for knowledge and its applicability on the job.

Students shall choose to undergo Internship / Innovation / Entrepreneurship related activities for Internship. Students shall choose either to work on innovation or entrepreneurial activities resulting in start-up or undergo internship with industry/ NGO's/ Government organizations / Micro / Small / Medium enterprises / academic institutions / research institutions. In case student want to pursue their family business and don't want to undergo internship, a declaration by a parent may be submitted directly to the Department Head / TPO.

During the last year of FOUR-year Bachelor of Engineering course the student should take project work, as specified in the curriculum, based on the knowledge acquired by the student during the degree course and during Internship. The project work provides an opportunity to build a system based on area where the student likes to acquire specialized skills. The work may also be on specified task or project assigned to the student during Internship.

The internship activities and list of sub-activities for Internship are as under.

- Innovation / Entrepreneurship:
    - Participation in innovation related Competitions for eg. Hackathons Robocon, Baha, IIT TechFest, Chemcon, Dipex etc
    - Development of new product/ Business Plan/ registration of start-up
    - Participation in Entrepreneurship Program of THREE weeks duration
    - Online certification courses by SWAYAM, NPTEL, QEEE etc.
    - Working for consultancy/ research project within the institutes
    - Training on Software (As per the need of respective branch);
    - Field Survey / Case Study
    - Work experience at family business
- Internship:
    - Internship with Industry/Govt. / NGO/ PSU/ Any Micro/ Small/ Medium enterprise/ academic institutions / research institutions
    - Online Internship
- Rural Internship
    - Any Long Term Goals may be carried out by students in teams:
        - Prepare and implement plan to create local job opportunities.
        - Prepare and implement plan to improve education quality in village.

- Prepare an actionable DPR for doubling the village Income.
- Developing Sustainable Water Management system.
- Prepare and Improve a plan to improve health parameters of villagers.
- Developing and implementing of Low Cost Sanitation facilities.
- Prepare and implement plan to promote Local Tourism through Innovative Approaches.
- Implement/Develop Technology solutions which will improve quality of life.
- Prepare and implement solution for energy conservation.
- Prepare and implement plan to Skill village youth and provide employment.
- Develop localized techniques for Reduction in construction Cost.
- Prepare and implement plan of sustainable growth of village.
- Setting of Information imparting club for women leading to contribution in social and economic issues.
- Developing and managing efficient garbage disposable system.
- Contribution to any national level initiative of Government of India. For eg. Digital India/ Skill India/ Swachh Bharat Internship etc.

Faculty Mentor/Supervisors have to play active roles during the internship and minimum 20 students are to be supervised by each faculty mentor or as per the departmental strength. Mentor shall be responsible for selection of Internship activities by the student under his/her supervision and shall avoid repetition of activities by the student. The college / Institute shall facilitate internship for the students.

Every student is required to prepare a file for Internship containing documentary proofs (daily training diary, comprehensive report and completion certificate) of the activities done by him/her. The students should record in the daily training diary the day to day account of the observations, impressions, information gathered and suggestions given, if any. It should contain the sketches & drawings related to the observations made by the students. The daily training diary should include Date, Time of Arrival, Time of Departure, Main points of the day. The daily training diary should be signed after every day by the supervisor/ in charge of the section where the student has been working.

After completion of Internship, the student should prepare a comprehensive report to indicate what he / she has observed and learnt in the training period. The report should include Internship Objectives (in measurable terms), Internship Activities, and Internship Outcome.

The completion certificate should be signed by the supervisor / in charge of the section where the student has been working with performance remark as Satisfactory / Good / Excellent.

The evaluation of Internship shall be in Semester – VII. The evaluation shall be done by expert committee constituted by the concerned department including Department Head/ TPO/ faculty mentor or guide. It should be evaluated on the basis of the following criteria:

- Regularity in maintenance of the diary.
- Adequacy & quality of information recorded.

- Originality.
- Adequacy and purposeful write-up.
- Practical applications, relationships with basic theory and concepts taught in the course.
- Skill / knowledge acquired

Hence the satisfactory completion of Internship shall be submitted to the university at the end of Semester - VIII of FOUR year Bachelor of Engineering course. Only after successfully completion of Internship, Internship should be printed in the final year mark sheet as COMPLETED.