Shri. Shamrao Patil (Yadravkar) Educational & Charitable Trust's

Sharad Institute of Technology College of Engineering

Yadrav (Ichalkaranji)-416121, Dist. – Kolhapur

(Approved by AICTE, New Delhi, Recognized by Government of Maharashtra &
Affiliated to BATU University, Lonere)

NBA Accredited Programs, Accredited By NAAC 'A' Grade,
ISO 9001:2015 Certified

Syllabus of B. Tech. (MECH)

Department of Mechanical Engineering

Semester: VII and VIII

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NBA Accredited Programs, Accredited By NAAC 'A' Grade, ISO 9001:2015 Certified

Department: Mechanical Engineering **Rev:** MECH Course Structure/00/2020-21

Class: B. Tech. **Semester:** VII

Course Code	Course Type	Course	Teaching Scheme				Evaluation Scheme					Credits
			L	T	P	Total Hrs.	CA1	CA2	MSE	ESE	Total	
ME701	PCC	Refrigeration and Air-conditioning	3	-	-	3	10	10	30	50	100	3
ME702	PCC	Mechatronics	3	-	-	3	10	10	30	50	100	3
ME703	PEC	Elective-IV	3	-	-	3	10	10	30	50	100	3
ME704	PEC	Elective-V	3	-	-	3	10	10	30	50	100	3
OEXXX	OEC	Open Elective-III	2	-	-	2	10	10	30	50	100	2
ME705	PCC	Refrigeration and Air-conditioning Laboratory	-	-	2	2	15	15	--	20	50	1
ME706	PEC	Mechatronics Laboratory	-	-	2	2	25	25	--	--	50	1
ME707	PCC	Simulation Laboratory	-	-	2	2	25	25			50	1
PROJ06	PROJ	Capstone Project Phase-II	-	-	8	8	25	25	--	50	100	4
PROJ07	PROJ	Industrial Case Studies (Seminar)	-	-	2	2	15	15	--	20	50	1
ME708	MC	Values and Ethics	2	-	-	2	25	25	--	--	50	Audit
			16	**-**	**16**	**32**	**180**	**180**	**150**	**340**	**850**	**22**

Elective-IV:

ME703A: Tool Engineering- Production Group

ME703B: Mechanics of Composite Material-Design

ME703C: Reliability Engineering-Design

ME703D: Advanced Finite Element Analysis

ME703E: Noise and Vibration

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Elective V:

ME704A: Advance Foundry Technology
ME704B: Micro Electro-Mechanical Systems
ME704C: Mechanical System Design
ME704D: Cryogenics
ME704E: Nanotechnology

Open Elective-III:

1. Product Life Cycle Management

Abbreviations:

L: Lecture

T: Tutorial

P: Practical

MSE: Mid Semester Exam

ESE: End Semester Exam

OE: Oral Exam

POE: Practical and Oral Exam

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Department: Mechanical Engineering **Rev:** MECH Course Structure/00/2020-21

Class: B. Tech. **Semester:** VIII

Course Code	Course Type	Course	Teaching Scheme				Evaluation Scheme					Credits
			L	T	P	Total Hrs.	CA1	CA2	MSE	ESE	Total	
ME801	HSMC	Self Learning Course 1*	-	-	-	3	10	10	30	50	100	3
ME802	PEC	Self Learning Course 2*	-	-	-	3	10	10	30	50	100	3
IFT03	PROJ	Internship*			-	20	50	50		100	200	10
		Total	-	-	-	**26**	**70**	**70**	**60**	**200**	**400**	**16**

Self-Learning Course-1- Finance and Entrepreneurship

ME801A	Fundamentals of Financial Management
ME801B	Management Accounting
ME801C	Principles of Management
ME801D	Finance for Non-finance
ME801E	Industrial Management
ME801F	Entrepreneurship Essentials
ME801G	Understanding Incubation and Entrepreneurship

Self-Learning Course-2- Multidisciplinary

ME802A	Machine Learning
ME802B	Artificial Intelligence for Mechatronics Systems
ME802C	Computer Network and Cyber Security
ME802D	Robotics and Machine Vision System
ME802E	Neural Networking
ME801F	Mechanical Behavior of Polymers and Composites
ME801G	Social Innovation in Industry 4.0

Important Note: * indicates that the same course or title may not be available in NPTEL SWAYAM catalogue, then course from same domain or category whichever available on NPTEL SWAYAM catalogue will be offered

***For Internship: student has to go in Mechanical Industry for Internship for 16-18 weeks**

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Semester VII

1. Refrigeration and Air-conditioning

ME701	PCC	Refrigeration and Air-conditioning	3-0-0	3 Credits

Teaching Scheme:	**Examination Scheme:**
Lecture: 3 hrs/week	Continuous Assessment 1: 10 Marks Continuous Assessment 2: 10 Marks Mid Semester Exam: 30 Marks End Semester Exam: 50 Marks

Pre-Requisites: Basic Mechanical Engineering, Thermal Engineering, Fluid Mechanics, Heat and Mass Transfer.

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

CO1	Explain refrigeration cycles with p-h and T-s diagram.
CO2	Outline various refrigeration equipment's and extend the usage of refrigerants
CO3	Summarize Multi Pressure and Vapour Absorption System
CO4	Analyze psychometric terms its application in HVAC, comfort conditions and Design of refrigeration and air conditioning system.
CO5	Estimate heating and cooling load on real life problem by using heat transfer mechanism
CO6	Explain duct design system, air-distribution system and commercial.

Mapping of course outcomes with program outcomes

Course Outcomes	Program Outcomes													
	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO 11	PO 12	PSO1	PSO2
CO1	2	1										1	1	
CO2	2	1					1					1	1	
CO3	2	1										1	1	
CO4	3	2										1	1	
CO5	3	2	1									1	1	
CO6	2	1										1		

Course Contents:

Unit 1: Refrigeration Cycles: Carnot cycle, reversed carnot cycle, simple vapour compression cycle, sub and	[6]

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superheating, liquid to suction vapour heat exchanger, actual vapour compression cycle, bell coleman cycle, air cycles for air craft's.(Theoretical treatment only)	
Unit 2: Refrigeration Equipments and Refrigerants **Refrigeration Equipments**: Compressor, condenser, evaporator, expansion devices, types, selection, use of insulation, methods of charging and testing, non-conventional methods of refrigeration. **Refrigerants**: Classification, desirable properties like thermodynamic, physical, comparison among commonly used refrigerants, selection of refrigerants, effect on ozone depletion and global warming, alternative refrigerants.	[6]
Unit 3: Multi Pressure and Vapour Absorption System Removal of flash gas, flash inter-cooling, water cooling, multistage , multi evaporator and cascade system, introduction to cryogenic engineering system, claude cycle, linde cycle, introduction to vapour absorption system	[6]
Unit 4: Psychrometry and Comfort **Psychometry**: Moist air as a working substance, psychometric properties of air, basic psychrometric processes in air conditioning, apparatus dew point, sensible heat factor, bypass factor, air washer and it's applications. **Comfort**: Thermal exchange between human body and environment, factors affecting comfort, effective temperature comfort chart.	[6]
Unit 5: Heating And Cooling Load Calculation Air Conditioning system, Different heat sources, Load analysis RSHF, GSHF, ESHF, Factors forming the load on air conditioning systems, Different Air Conditioning System, Apllications of Air-conditioing systems.	[6]
Unit 6: Central Air conditioning system Types of supply air outlets, methods used for duct design, losses in duct system, duct arrangement systems, air-distribution system, applications of central air conditioning systems.	[6]

Text Books:

1. "Refrigeration and Air Conditioning" Arora C P, Tata McGraw Hill
2. "Refrigeration and Air Conditioning" Arora Domkundwar , Dhanpat Rai and Sons

Reference Books:

1. "Principal of Refrigeration" Dossat Ray J., S.I. Version, Wiley Eastern Limited, 2000
2. "Refrigeration and Air-conditioning" Manohar Prasad, Wiley Eastern Limited, 1983
3. "Refrigeration and Air-conditioning" Stocker W.F. and Jones J.W., McGraw Hill International editions 1982
4. "Thermal Environmental Engineering", Threlkeld J.L., Prentice Hall Inc. New Delhi
5. "Basic of Refrigeration and Air Conditioning", Anantnarayan, Tata McGraw Hill Publications
6. "Handbook of Refrigeration and Air Conditioning", Shan Wang, McGraw Hill Publications
7. "Industrial Refrigeration", Wilbert Stocker, McGraw Hill Publications
8. "Cryogenics systems" Randall Barron, Mc Graw Hill Book Co
9. "Absorption chillers and Heat Pumps", Keith Harold, McGraw Hill Publications
10. ASHRAE and ISHRAE Handbook
11. ASHRAE, Air Conditioning System Design Manual, 2nd edition ASHRAE

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Mechatronics

ME702	PCC	Mechatronics	3-0-0	3 Credits

Teaching Scheme	Examination Scheme
Lecture: 3 hrs/week	Continuous Assessment 1: 10 Marks Continuous Assessment 2: 10 Marks Mid Semester Exam: 30 Marks End Semester Exam: 50 Marks

Pre-Requisites: Sensor and Instrumentation Laboratory

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

CO1	Explain the importance of mechanical, electronics, computers and control in the design of Mechatronics system.
CO2	Identify different signal conditioning devices.
CO3	Make use of techniques of logic gates and its interfacing with microprocessors, microcontrollers, etc.
CO4	Illustrate the Electro-Pneumatic circuits used for automatic process controls of industrial
CO5	Create ladder diagrams from process control techniques.
CO6	Build systematic approach to the design process for Mechatronics system.

Course Contents:

Unit 1: Introduction to Mechatronics Introduction to Mechatronic systems – elements – advantages - practical examples of Mechatronic systems. Introduction to Programmable Logic Controllers (PLC), Human Machine Interface (HMI) and Supervisory Control and Data Acquisition System (SCADA)	[6]
Unit 2: Signal Conditioning: Signal conditioning process, Operational amplifier (inverting amplifier, non-inverting amplifier), Analog to digital converter (ADC), digital to analog converter (DAC). Interfacing of input and output ports, serial and parallel interfacing requirements	[6]
Unit 3: Microprocessor and Microcontroller: 8085 microprocessors – architecture - various types of registers and their functions - Instruction sets – interfacing - applications. 8081 microcontrollers – architecture - Instruction sets - various pins and their functions - interfacing - applications.	[6]
Unit 4: Design and Operation of Electro-Pneumatic Logic Control Circuits Electro-pneumatic systems, solenoid valves, different sensors, factory automation	

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sensors, electrical sensors, process automation sensors and their interfaces as per application criteria, Electro pneumatic systems using relay logic circuits, Logic operations - OR circuit, AND circuit,	[6]
Unit 5: Programmable Logic Controllers (PLC) PLC – Introduction - Definition, - Input output module - advantages – disadvantages, Ladder diagram and PLC programming fundamentals – symbols - Fundamentals of ladder diagram - Light control example - Holding (latches) contacts, Always ON always OFF contacts, PLC timer counters.	[6]
Unit 6: Mechatronics Systems Traditional Vs Mechatronics Design, Case studies of Mechatronics systems designs like - piece counting system - Pick and place manipulator - Part loading / unloading system, Automatic tool and pallet changers etc. Fault finding and troubleshooting	[6]
Text Books: 1. Antony Espossito, "Fluid power with Applications ", Pearson, Sixth Edition., 2003. 2. W. Bolton, "Mechatronics: Electronic Control Systems in Mechanical and Electrical Engineering" - PrenticeHall - 2013 - 5 th Edition Singh, Shio Kumar. 3. Industrial Instrumentation and Control, Tata McGraw-Hill Education, 2010 4. Mikell P Groover, "Automation Production Systems and Computer- Integrated Manufacturing"Pearson Education, New Delhi, 2001.	
Reference Books: 1. Mechatronics – W. Bolton, Pearson education 2. Mechatronics – Mahalik, TATA McGraw Hill 3. Mikell P Groover, "Industrial Robots – Technology Programmes and Applications , McGraw Hill ,New York, USA. 2000. 4. Mechatronics – Appu Kuttam, Oxford publications 5. Introduction to PLC programming, NIIT, 6. Programmable logical controller, Hackworth, Pearson Education 7. Programmable logical controller, Reis Webb, Prentice Hall 8. Mechatronics and Microproceesor by Ramchandran Willey India 9. Mechatronics : Integrated Mechanical Electronic System by Ramchandran Willey India 10. Programmable logical controller,3e Gary Dunning Cengage Learning 11. Mechatronics Source Book by N C Braga Cengage Learning 12. Fluid Power with Applications by Anthony Esposito - Pearson Education 2000. 13. Power Hydraulics by Michael J, Prinches and Ashby J. G, - Prentice Hall, 1989	

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Elective-IV

Tool Engineering

ME703A	PEC	Tool Engineering	3-0-0	3 Credits

Teaching Scheme:	**Examination Scheme:**
Lecture: 3 hrs/week	Continuous Assessment 1: 10 Marks Continuous Assessment 2: 10 Marks Mid Semester Exam: 30 Marks End Semester Exam: 50 Marks

Pre-Requisites: Manufacturing Processes, Metallurgy, Machine Drawing

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

CO1	Explain the geometry of different tools.
CO2	Construct the press tool
CO3	Construct jigs and fixtures
CO4	Explain tooling for automats and economics of tooling
CO5	Explain manufacturing and sharpening of cutting tools
CO6	Determine selection of cutting fluid, tool life and wear mechanism during machining operations

Mapping of course outcomes with program outcomes

Course Outcomes	Program Outcomes													
	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
CO1	2	1											1	
CO2	2	1		1									1	
CO3	2	2												
CO4	2	2		1								1	1	
CO5	2	2										1		
CO6	2	2										1		1

Course Contents:

Unit 1: Design of Cutting Tools Single point cutting tools - geometry, Drills - geometry, Reamers – geometry, Face milling cutter - geometry - minimum number of teeth, tolerances, effect of feed	[6]
Unit 2: Design of Press Tools Design of press tools for blanking, punching and drawing, center of pressure clearances,	

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strip layout, punch force, blank size, number of draws, compound and progressive dies.	[6]
Unit 3: Jigs and Fixtures Design Principles of location and clamping, locating and clamping elements and their standardization, classification of jigs and fixtures, Designing of jigs and fixtures for simple components.	[6]
Unit 4: Tooling for Automats Cam design for automats, Plug gauge design – gauge allowances and tolerance –materials for gauges. Economics of Tooling - Selection of economical method – amortization of tooling costs.	[6]
Unit 5: Manufacturing and Sharpening of Cutting Tools Manufacture of single point cutting tool, drills, reamers, milling cutters, sharpening of single point tools, drills, reamers, milling cutters.	[6]
Unit 6: Tool Wear Tool life and Machinability, Mechanism of tool wear – Adhesive, Abrasive, Diffusive and Chemical wear – Taylor's tool life equation. Cutting Fluids: Functions, characteristics and types, Selection of cutting fluids.	[6]
Text Books: 1. "Elements of Workshop Technology Vol. II", S. K Hajra Choudhury, Media Promoters and Publishers, Mumbai. 2. "Text Book of Production Engineering", P.C. Sharma, S. Chand Publication, 11th Edition. 3. "Machine Tool Engineering" G.R. Nagarpal, Khanna Publication. 4. "Principles of Modern Manufacturing", Groover, Wiley Publication. 5th Edition.	
Reference Books: 1. "Production Technology", HMT –Tata McGraw-Hill Publishing Ltd, 2. "Tool Design", Donaldson, THM Publication, 3rd Edition. 3. "Jigs and Fixtures", Kempster, ELBS.	

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Mechanics of Composite Materials

ME703B	PEC	Mechanics of Composite Materials	3-0-0	3 Credits

Teaching Scheme:	**Examination Scheme:**
Lecture: 3 hrs/week	Continuous Assessment 1: 10 Marks Continuous Assessment 2: 10 Marks Mid Semester Exam: 30 Marks End Semester Exam: 50 Marks

Pre-Requisites: Engineering Mechanics, Engineering Materials, Engineering Physics, Strength of Materials

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

CO1	Explain the basic terms of Composite Material
CO2	Classify the types of Fibers and Matrix
CO3	Illustrate different manufacturing processes of composites
CO4	Illustrate different lamination theories
CO5	Analyze the different test methods for composite materials
CO6	Analyze the composite material under different loading conditions.

Mapping of course outcomes with program outcomes

Course Outcomes	Program Outcomes													
	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
CO1	3													
CO2	3													
CO3	3	1												
CO4	3	1												
CO5	3	2												
CO6	3	2	1											

Course Contents:

Unit 1: Introduction of Composite Material: Definition, Composite Material and its Application, Classification, Advantages, Limitations, Properties of composite Material	[6]
Unit 2: Materials:(Fibers and Matrix) Types of fibers, Glass fiber, Graphite fiber, Armid fiber, Boron Fiber, Ceramic Fiber, Carbon Fiber, Matrix: Polymer Matrix and Thermoset Matrix Thermoplastic Matrix	[6]
Unit 3: Manufacturing of Composites Fundamentals, Hand lay-up process, Bag moulding, Compression moulding, Pultrusion, Filament Winding, Liquid composite moulding process	[6]
Unit 4: Mechanics of Laminate Composite	

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Basic Terminology, Behavior of Unidirectional composite-Longitudinal Tensile Loading, Transverse Tensile Loading, Longitudinal Compressive Loading, Transverse Compressive Loading, Laminated structure, Lamination Theories	[6]
Unit 5: Performance of Composite Static Mechanical Properties, Tensile Properties-Test Method and Analysis, Unidirectional Laminates, Cross-Ply Laminates, Multidirectional Laminates, Woven Fabric Laminates, Sheet-Molding Compounds, Compressive Properties, Flexural Properties	[6]
Unit 6: Design of Composites Laminate Design Considerations- Design Philosophy, Design Criteria, Design Allowable, Design of a Tension Member, Design of a Compression Member, Design of a Beam, Design of a Torsional Member	[6]

Text Books:

1. P.K. Mallick, "Fiber-Reinforced Composite Materials", ISBN 13:978-0-8493-4205-9, Third Edition, USA.
2. Robert M. Jones, "Mechanics of Composite Material", ISBN 1-56032-712-X, Second Edition, USA.
3. Carl T Herakovich " Mechanics of Fibourous Composite" ISBN 0-471-10636-4, First Edition USA

Reference Books:

1. Author K Kaw "Mechanics of Composite Material" ISBN-0-8493-1343-0, USA
2. Ronald F Gibson "Principles of Composite Material Mechanics" ISBN O-07-023451-5, USA.

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Reliability Engineering

ME703C	PEC	Reliability Engineering	3-0-0	3 Credits

Teaching Scheme:	**Examination Scheme:**
Lecture: 3 hrs/week	Continuous Assessment 1: 10 Marks Continuous Assessment 2: 10 Marks Mid Semester Exam: 30 Marks End Semester Exam: 50 Marks

Pre-Requisites: –

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

CO1	Explain various terms of reliability.
CO2	Determine various reliability measures.
CO3	Utilize appropriate reliability model to evaluate reliability parameters.
CO4	Determine systems reliability.
CO5	Explain concept of availability and maintainability.
CO6	Explain terms of reliability testing.

Mapping of course outcomes with program outcomes

Course Outcomes	Program Outcomes													
	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
CO1	2												1	
CO2	2												1	
CO3	2	2											1	
CO4	2	2											1	
CO5	2												1	
CO6	2	2											1	

Course Contents:

Unit 1: Introduction: Brief history, concepts, terms and definitions, applications, the life cycle of a system, concept of engineering failures and their causes, theory of probability and reliability, random variables, discrete and continuous probability distributions..	[6]
Unit 2: Reliability Measures: Reliability function R(t), cumulative distribution function (CDF)-F(t), Probability density function (PDF)- f(t), hazard rate function $\lambda(t)$, Mean time to failure (MTTF) and Mean time between failure (MTBF), median time to failure (tmed), mode (tmode), variance ($\sigma 2$) ans standard deviation (σ).	[6]
Unit 3: Basic Reliability Models: Constant failure rate (CFR) model, renewal and poisons process, two parameter	

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exponential distribution, redundancy with CFR model, time-dependent failure models, two and three parameter Weibull distributions, calculation of R(t), F(t), f(t), λ(t), (MTTF) (MTBF), (tmed), (tmode), (σ2) ans (σ).	[6]
Unit 4: Reliability Evaluation of Systems: Reliability block diagram, series configuration, parallel configuration, mixed series-parallel configuration, Redundant systems, high level versus low level redundancy, k-out-of-n redundancy, conflex configurations.	[6]
Unit 5: Maintainability and Availability Concept of maintainability, measurres of maintainability, mean time to repair (MTTR), analysis of downtime, repair time distributions, stochastic point processes, maintenance concept and procedures, availability concepts and definitions, important availability measures.	[6]
Unit 6: Design for Reliability and Maintainability: Reliability design process and design methods, failure modes, effects and criticality analysis (FMECA), fault tree and success tree methods, symbols used. **Reliability Testing**: Product testing, reliability life testing, burn-in testing, acceptance testing accelerated life testing and reliability growth testing.	[6]
Text Books: 1. An Introduction to Reliability and Maintainability Engineering, Charls E. Ebling, Waveland press, Third edition, 2019. 2. Engineering Reliability- New Techniques and Application, B. S. Dhillon, John Wiley and Sons, 1981.	
Reference Books: 1. Reliability Engineering Theory and Practice, Alessandro Birolini, Springer publisher, 2010.	

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Advanced Finite Element Analysis

ME703D	PEC	Advanced Finite Element Analysis	3-0-0	3 Credits

Teaching Scheme:	**Examination Scheme:**
Lecture: 3 hrs/week	Continuous Assessment 1: 10 Marks Continuous Assessment 2: 10 Marks Mid Semester Exam: 30 Marks End Semester Exam: 50 Marks

Pre-Requisites: A basic understanding of vectors, matrices and partial differential equations for thermal and mechanical problems.

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

CO1	Explain fundamental concepts discretization of the problem
CO2	Explain the concept of interpolation functions and simplex elements
CO3	Illustrate formulation of the element characteristic matrices and vectors for elasticity problems
CO4	Develop formulation of the element characteristic matrices and vectors for field problems
CO5	Explain assembly and solution of the finite element equations
CO6	Demonstrate modeling procedures and results processing

Mapping of course outcomes with program outcomes

Course Outcomes	Program Outcomes													
	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
CO1	2													
CO2	2	1												
CO3	2	1												
CO4	2	1												
CO5	2	1												
CO6	2											2	1	1

Course Contents:

Unit 1: Discretization of the problem Introduction, Geometrical approximations, Simplification through symmetry, Basic element shapes and behaviour, Choice of element type, Size and number of elements, Element shape and distortion, Location of nodes, Node and element numbering.	[6]
Unit 2: Interpolation functions and simplex elements Introduction, Simplex, complex and multiplex elements, Linear interpolation polynomials for simplex elements, Natural coordinates, Vector quantities, an axisymmetric element	[6]
Unit 3: Formulation of the element characteristic matrices and vectors for elasticity problems Introduction, The variational formulation, One-dimensional elasticity, Two-dimensional	[6]

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elasticity, Three-dimensional elasticity, Axisymmetric elasticity	
Unit 4: Formulation of the element characteristic matrices and vectors for field problems Introduction, Thermal problems-One-dimensional heat transfer, Two-dimensional heat transfer, Three-dimensional heat transfer, axisymmetric heat transfer, Torsion problems, Fluid flow problems.	[6]
Unit 5: Assembly and solution of the finite element equations Introduction, Coordinate transformations, Assembly of the element equations, Incorporation of the boundary conditions, Solution of the equations	[6]
Unit 6: Modeling procedures and results processing Introduction, Model validity and accuracy, Mesh design and refinement, Element distortion, Results processing, Model checking, Symmetric models with non-symmetric loading, Submodelling and substructuring, Element and program validation	[6]

Reference Books:

1. Finite Element Analysis – Theory and Practice by Fagan (Longman Scientific and Technical)
2. Fundamentals of Finite Element Analysis, David Hutton, TMH
3. Finite Element Method versus Classical Methods,- H.S. Govinda Rao, New Age International Publishers
4. An Introduction to Finite Element Analysis by J. N. Reddy, (Tata McGraw- Hill Pub. Co.)
5. The Finite Element Method: Linear Static and Dynamic Finite Element Analysis by T. J. R. Huges, Dover Publications, 2000
6. Finite Element Procedures by Bathe, Prentice-Hall.
7. Finite Element Analysis by P. Seshu (PHI)
8. Practical Finite Element Analysis - Nitin Gokhale (Finite To Infinite, Pune)
9. Introduction to Finite Elements in Engineering by Chandrupatala and Belegundu.

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Noise and Vibration

ME703E	PEC	Noise and Vibration	3-0-0	3 Credits

Teaching Scheme:	**Examination Scheme:**
Lecture: 3 hrs/week	Continuous Assessment 1: 10 Marks Continuous Assessment 2: 10 Marks Mid Semester Exam: 30 Marks End Semester Exam: 50 Marks

Pre-Requisites: Machine Design I, Machine Design II.

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

CO1	Develop mathematical model to represent dynamic system
CO2	Estimate natural frequency of mechanical element/system
CO3	Analyze vibratory response of mechanical element/system.
CO4	Estimate the parameters of vibration isolation system
CO5	Explain measurement of various vibration parameters
CO6	Determine the sources and control of Noise

Mapping of course outcomes with program outcomes

Course Outcomes	Program Outcomes													
	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
CO1	3	3	1										1	1
CO2	3	3	1										1	1
CO3	3	3	1	2									1	1
CO4	3	3	1										1	1
CO5	3	3	1	3									1	1
CO6	3	3	1			2		2					1	1

Course Contents:

Unit 1 Introduction Vibration and oscillation, Causes and effects of vibrations, Vibration parameters – spring, mass, damper, Damper models, Motion – periodic, non-periodic, harmonic, non-harmonic, Degree of freedom, Static equilibrium position, Vibration classification, Steps involved in vibration analysis, Simple harmonic motion, Vector and Complex method of Representing vibration, Fourier series and harmonic analysis.	[6]
Unit 2 Single DOF System a) Undamped free vibrations, Damped free vibrations, Types of damping, Logarithmic decrement and damping materials.	[6]

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b)Forced Vibrations: Types of excitation, Forced excitation, Support excitation, Excitation due to unbalance in machines, Response of systems to above types of harmonic excitations.	
Unit 3 Two DOF System **a) Free undamped vibrations** – Principal modes and natural frequencies, Co-ordinatecoupling and principal co-ordinates. **b) Forced vibrations (Undamped)** – Harmonic excitation, Vibration Dampers and absorbers, Dynamic vibration absorber – Tuned and Untuned type	[6]
Unit 4 Introduction to Multi DOF System a) Free vibrations of Multi DOF System-Flexibility and stiffness influence coefficientmatrix, Equation of motion b) Rayleigh's method, Matrix iteration method and Holzer method	[6]
Unit 5 Vibration Measuring Instruments Instruments for measurement of displacement, velocity, acceleration and frequency of Vibration, Sensors and Actuators, Introduction of X – Y plotter, Spectral analyzers, Exciters FFT analyzer. Introduction to Condition Monitoring and Fault Diagnosis	[6]
Unit 6 Introduction to Noise **a) Sound Level and Subjective Response to Sound** Frequency dependent human response to sound, Sound pressure dependent human response, Decibel scale, Relation among sound power, Sound intensity and sound pressure level, Octave Band Analysis. Sound measuring instruments. **b) Noise- Effects, Rating and regulation** Non auditory effects of noise on people, Auditory effects of noise, Noise standards and limits, Ambient emission noise standards in INDIA, Hazardous noise explosion, Day night noise level, Noise sources and control (Theory only)	[6]
Text Books 1. "Mechanical Vibrations", Singiresu S.Rao , Pearson Education, ISBM –81-297-0179-0 - (2004). 2. "Mechanical Vibrations", G. K. Grover, Published by Nemchand and Brothers, Roorkee. 3. "Mechanical Vibrations", Dr. V. P. Singh, Published by S. Chand and Sons New Delhi. 4. "Noise and Vibration Control", Leo L. Bernack, Tata Mc- Graw Hill Publication. 5. "Mechanical Vibration and Noise Engineering",A. G. Ambekar, Prentice Hall of India. 6. "Fundamentals of Vibrations", Balchandran Magrab ,Cengage Learning. 7. "Theory of Vibrations with Applications", W. Thomson, Pearson Education,2nd Edition. 8. "Mechanical Vibration",Dr Debabrata Nag, Wiley India Pvt. Ltd ,ISBN 978-81-265-3090-8.	
Reference Books: 1. "Mechanical Vibration",Austin Church, Wiely Eastern. 2nd Edition. 2. "Schaumm's Outline series in Mechanical Vibration", S. Graham Kelly, 6th Edition. 3. "Kinematics, Dynamics and Design of Machinery",Waldron, Willey India, 2nd Edition.	

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4. "Mechanical Vibrations", J.P. Den Hartog, Tata McGrawhill Book Company Inc., 4th Edition.
5. "Introduction to Dynamics and Control", Leonard Meirovitch, J. Wiley, New York.
6. "Elements of Vibration Analysis" Leonard Meirovitch, Tata McGrmv-Hill, New York. 2nd Edition.
7. "Principles of Vibration",Benson H. Tongue,Oxford University Press., 4th Edition.
8. "Vibrations and Noise for Engineers", Kewal Pujara Dhanpat Rai and Sons, (1992).
9. "Mechanical vibration", William J Palm III Wiley India Pvt. Ltd., ISBN 978-81-265-3168-4, 1st Edition.by Ramchandran Willey India

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Elective V

Advanced Foundry Technology

ME704A	PEC	Advanced Foundry Technology	3-0-0	3 Credits

Teaching Scheme:	**Examination Scheme:**
Lecture: 3 hrs/week	Continuous Assessment 1: 10 Marks Continuous Assessment 2: 10 Marks Mid Semester Exam: 30 Marks End Semester Exam: 50 Marks

Pre-Requisites: Machine Design-I, Machine Design-II.

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

CO1	Explain the basic concepts of solidification of casting
CO2	Analyze the gating system
CO3	Explain the casting design process
CO4	Analyze the casing defects
CO5	Explain ferrous foundry practice
CO6	Explain non ferrous foundry practice

Mapping of course outcomes with program outcomes

Course Outcomes	Program Outcomes													
	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
CO1	2	2										1	1	
CO2	3	3	2									2	1	2
CO3	2	2	3									2	1	2
CO4	3	3	2									2	1	2
CO5	2	2										1	1	1
CO6	2	2										1	1	

Course Contents:

Unit 1 Solidification of Casting: Concept of solidification of metals. Homogenous and heterogeneous nucleation. Growth mechanism. Solidification of pure metals and alloys. Mechanism of columnar and dendrite growth. Coring or Segregation. Solidification time and Chvorinov's rule. Concept of progressive and directional solidifications	[6]
Unit 2 Principles of Casting and Risering: Purpose of the gating system. Components of the gating System and its functions. Design of the gating System. Different types of gates. Gating ratio and its functions. Definition	[6]

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and functions of the riser. Types of risers and their application. Design of the riser - its shape. Size and location. Use of insulating material and exothermic compounds in risers.	
Unit 3 Design of Casting: Factors to be considered in casting design. Design consideration in pattern making, moulding techniques and core making and assembly. Cooling stresses and hot spots in casting and modification in casting geometry to overcome them	[6]
Unit 4 Casting Quality Control: Casting defects and factors responsible for them. Different inspection and testing methods to evaluate the casting. Quality control activities in a foundry. Salvaging methods of defective casting.	[6]
Unit 5 (Ferrous) Iron Foundry Practice: **Gray Cast** – Chemical Composition and structure of gray cast iron. Moulding, gating and Risering techniques. Melting of gray cast iron in induction furnace .Inoculation of gray cast iron. Application of gray cast iron castings.	[6]
Unit 6 (Non ferrous) Foundry Practice: Aluminum – Composition, properties and application of common aluminum alloy casting. Melting and casting of AI-alloys. Gating and Risering of AI-alloy casting.	[6]
Text Books: 1. Material science RK Rajput SK Kataria and sons - - 2. Material science and engineering Raghavan Prentice Hall of India, Delhi – 3. Material science and engineering Srivastava New age international (P) Ltd. 4. Materials and metallurgy OP Khanna Dhanpatrai", Dr. S. P. Sukhatme, Orient Longman, Hyderabad (2005)	
Reference Books: 1. Metal Casting Principles and Practice- T.V. RamanaRao- New Age International Publishers 2. Pinciples of Foundry Technology–P.L. Jain- Tata McGraw Hill 3. Principles of Metal casting - R. Heine andRosenthall, TMH 4. Principal of foundry technology- P. L. Jain- Tata McGraw Hill 5. ASM Metal Handbook- Vol.-4, Casting 6. Foseco Ferrous Foundryman's Handbook- John R. Brown- Butterworth Heinemann Pub. 7. Foundry Technology- Peter Beeley- Butterworth Heinemann Pub.	

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Micro Electro-Mechanical Systems

ME704B	PEC	Micro Electro-Mechanical Systems	3-0-0	3 Credits

Teaching Scheme	Examination Scheme
Lecture: 3 hrs/week	Continuous Assessment 1 :10 Marks Continuous Assessment 2:10 Marks Mid Semester Exam: 30 Marks End Semester Exam: 50 Marks

Pre-Requisites: -

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

CO1	Explain the concept of MEMS
CO2	Illustrate the Micro Materials used in engineering.
CO3	Discuss different fabrication process.
CO4	Identify different Micro sensors and actuators used in engineering.
CO5	Illustrate Microsystems Design
CO6	Explain Microsystems Design and Packaging.

Course Contents:

Unit 1: Introduction Overview of microelectronics manufacture and Microsystems technology. Definition - MEMS materials. Laws of scaling, The multi-disciplinary nature of MEMS. Survey of materials central to micro engineering. Applications of MEMS, mechanical MEMS, thermal MEMS, micro-opto electro-mechanical systems, magnetic MEMS, radio frequency (RF) MEMS, micro fluidic systems, bio and chemo devices, Nanotechnology – definition, nanoscale, consequences of the nanoscale for technology and society, need and applications of nano electromechanical systems (NEMS)	[6]
Unit 2 Micro Materials Materials for MEMS – substrate and wafers, silicon as a substrate material, crystal structure, single crystal and polycrystalline, mechanical properties, silicon compounds, silicon piezo resistors, gallium arsenide, quartz, piezo-electric crystals, polymers, packaging materials	[6]
Unit 3: Fabrication Processes: Bulk micro manufacturing, photolithography, photoresists, structural and sacrificial materials, X-ray and electron beam lithography, Thin film deposition – spin coating, thermal oxidation, chemical vapour deposition (CVD), electron beam evaporation, sputtering; Doping – diffusion, ion implantation; Etching – wet etching, dry etching; Surface micromachining, bulk vs. surface micromachining; Wafer bonding – glass-frit,	[6]

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anodic and fusion bonding; LIGA process and applications	
Unit 4: Micro sensors and actuators: Sensing and actuation, Chemical sensors, Opticalsensors, Pressure sensors, Thermal sensors – thermopiles, thermistor, micro machined thermocouple probes, thermal flow sensors, MEMS magnetic sensor, Piezoelectric material as sensing and actuating elements – capacitance, piezo-mechanics, Piezo-actuators as grippers, micro grippers, micro motors, micro valves, micro pumps, micro accelerometers, micro-fluidics, shape memory alloy based optical switch, thermally activated MEMS relay, micro spring thermal actuator, data storage cantilever.	[6]
Unit 5:Microsystem Design: Design constraints and selection of materials, selection of manufacturing process, selection of signal transduction technique, electromechanical system and packaging.	[6]
Unit 6: Microsystems Design and Packaging: Design considerations, Mechanical Design, Process design, Realization of MEMS components using intellisuite. Micro system packaging, Packing Technologies, Assembly of Microsystems, Reliability in MEMS.	[6]

Text Books:

1. "MEMS and Microsystems Design and Manufacture" by Tai-Ran Hsu. Tata McGraw-Hill Publishing Company Ltd.
2. "Foundation of MEMS" by Chang Liu. Pearson Education.
3. Mohamed Gad – el – Hak, "MEMS Handbook", CRC Press, 2002.
4. Rai - Choudhury P. "MEMS and MOEMS Technology and Applications", PHI Learning Private Limited, 2009.
5. Sabrie Solomon, "Sensors Handbook," Mc Graw Hill, 1998.
6. Marc F Madou, "Fundamentals of Micro Fabrication", CRC Press, 2nd Edition, 2002.
   Stephen D. Senturia, "Microsystem Design", Kluwer Academic Publishers, 1st Ed., 2001

Reference Books:

1. Francis E.H. Tay and Choong .W.O, "Micro fluidics and Bio mems application", IEEE Press New York, 1997.
2. Trimmer William S., Ed., "Micromechanics and MEMS", IEEE Press New York, 1997.
3. Maluf, Nadim, "An introduction to Micro electro mechanical Systems Engineering", AR Tech house, Boston 2000.
4. Julian W.Gardner, Vijay K.Varadan, Osama O. Awadel Karim, "Micro sensors MEMS and Smart Devices", John Wiby and sons Ltd., 2001

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Mechanical System Design

ME704C	PEC	Mechanical System Design	3-0-0	3 Credits

Teaching Scheme:	**Examination Scheme:**
Lecture: 3 hrs/week	Continuous Assessment 1: 10 Marks Continuous Assessment 2: 10 Marks Mid Semester Exam: 30 Marks End Semester Exam: 50 Marks

Pre-Requisites: Machine Design-I, Machine Design-II.

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

CO1	Design machine tool gearbox as per standard design guidelines.
CO2	Design process equipment's line pressure vessel using IS codes.
CO3	Design Material handling systems like belt and conveyor.
CO4	Design mechanical system of IC engine and its components.
CO5	Optimize the mechanical equipment's like spring, shaft and gear.
CO6	Make use of DFMA, aesthetics and ergonomics principal during design of system.

Mapping of course outcomes with program outcomes

Course Outcomes	Program Outcomes													
	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
CO1	3	3	3					2		2			1	
CO2	3	3	3							2			1	
CO3	3	3	3	2						2			1	
CO4	3	3	3							2			1	
CO5	3	3	3	3						2			1	
CO6	3	3	3			2		2		2			1	

Course Contents:

Unit 1: Aesthetics and Ergonomics considerations in design: Basic types of product forms, Designing for appearance, shape, Design features, Materials, Finishes, proportions, Symmetry, Contrast etc. Morgon's colour code. Ergonomic considerations Relation between man, machine and environmental factors. Design of displays and controls. Practical examples of products or equipment using Ergonomics and aesthetic design principles.	[6]
Unit 2: Design of IC Engine Components Introduction to selection of material for I. C. engine components, Design of cylinder and Cylinder head, Construction of cylinder liners, Design of piston, Design of piston-pins, piston rings, Design of connecting rod, Design of crank-shaft and crank-pin.	[6]
Unit 3: Design of Pressure Vessel	

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Thick and thin cylinders – Thin cylindrical and spherical vessels , Lame's equation, Clavarino's and Birnie's equation, Design of hydraulic and pneumatic cylinders, Auto frettage and compound cylinders – Gasketed joints in cylindrical vessels, Modes of failures in pressure vessels., Unfired pressure vessels – Classification of pressure vessels as per I.S. 2825 –1965. Thickness of cylindrical and spherical shells and design of end closures as per code, Nozzles and Openings in pressure vessels –Reinforcement of Openings in shell and end closures. Area compensation method	[6]
Unit 4: Machine Tool Gear Box Introduction to machine tool gearboxes, design guidelines and its applications, Basic considerations in design of drives, determination of variable speed range, Graphical representation of speed and structure diagram, ray diagram, Selection of optimum ray diagram, deviation diagram, Difference between numbers of teeth of successive gears in a change gear box, Analysis of twelve speed gear box- Compound ray diagram	[6]
Unit 5: Optimum Design Objectives of optimum design, Johnson's Method of Optimum Design (MOD), Adequate and optimum design. Primary, subsidiary and limit equations, Optimum design with normal specifications, Optimum design with normal specifications of simple machine elements like bar, shaft and spring, Introduction to optimum design with redundant specifications, Introduction to Langrange Multiplier optimization method (Theory only).	[6]
Unit 6: Product Design Engineering Design Process: Considerations of a Good Design, Phases of Design Process Product Development Process: Introduction: Classification and Specifications of Products, Product life cycle, Product mix, Introduction to product design, Innovative thinking, Morphology of design, Conceptual Design, Design for Manufacturing and Assembly: Methods of designing for Manufacturing and Assembly, Designs for Maintainability, Designs for Environment, Product costing, Legal factors and social issues, Engineering ethics and issues of society related to design of products.	[6]
Text Books 1. Bhandari V. B., "Design of Machine Elements" 3rd Edition, 2010, Tata McGraw Hill Education (India) Pvt. Ltd., New Delhi 2. Patil S. P., "Mechanical System Design", 2nd Edition, 2005, Jaico Publishing House, Mumbai 3. George E. Dieter and Linda C. Schmidt, Engineering Design, 4th Ed., McGraw Hill Higher Education, 2000	
Reference Books: 1. Johnson R.C., "Optimum Design of Mechanical Elements" John Wiley and Sons Inc., London. 2. Ray T. K., "Mechanical Handling of Materials", 2005, Asian Book Pvt. Ltd., Delhi 3. RudenkoN."Material Handling Equipment", PEACE Publishers, Moscow. 4. G. Pahl, W. Beitz, J. Feldhusen and K.-H. Grote "Engineering Design-A Systematic Approach", Third Edition, Springer-Verlog 2007 5. "Design Data", P.S.G. College of Technology, Coimbatore. 6. Ullman D.G., "The Mechanical Design Process", McGraw Hill International Editions 7. John F Harvey, "Theory and Design of Pressure vessels", CBS publishers and distributors, Delhi 8. Willium C. Orthwine, "Machine Components Design I and II", Jaico Publishing House,	

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Mumbai.
9. Joshi M. V., Mahajani V. V., "Process Equipment Design", MacMillan India, Ltd., Delhi 10. IS-2825-1969 Code for unfired pressure vessels.
10. S.S.Rao, "Engineering Optimization Theories and Practice", New Age Publication, 3rd Edition.
11. Johnson R.C., "Mechanical Design Synthesis with Optimisation Applications", Von Nostrand-Reynold Publication.

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Cryogenics

ME704D	PEC	Cryogenics	3-0-0	3 Credits

Teaching Scheme:	**Examination Scheme:**
Lecture: 3 hrs/week	Continuous Assessment 1: 10 Marks Continuous Assessment 2: 10 Marks Mid Semester Exam: 30 Marks End Semester Exam: 50 Marks

Pre-Requisites: Mathematics, Heat Transfer, Fluid Mechanics, Thermodynamics, Refrigeration

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

CO1	Illustrate the applications and importance of Cryogenics.
CO2	Explain the gas liquefaction systems, and classify the Cryo-coolers.
CO3	Identify Gas Separation, Purification and Low Temperature applications measurement
CO4	Summarize Cryogenic Fluid Storage and Transfer Systems.

Mapping of course outcomes with program outcomes

Course Outcomes	Program Outcomes													
	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
CO1	3											1		
CO2	3	2	3									2		
CO3	3	3	2									1		
CO4	3			3		2		2				2		

Course Contents:

Unit 1: Introduction to Cryogenic: History and development its importance, cryogenic temperature scale. Properties of cryogenic fluids: behavior of materials at low temperature: properties of cryogenic fluids: behavior of materials at low temperature: low temperature properties of materials, mechanical properties low temperature properties of materials, thermal properties, electric and magnetic properties.	[6]
Unit 2: Gas Liquefaction Systems Introduction to refrigeration system and gas liquefaction system liquefaction systems for n2, neon, hydrogen, he	[6]
Unit 3: Cryo-Coolers Introduction to cryocoolers ideal sterling cycle, g-m cryocoolers, pulse tube cry coolers	[6]
Unit 4: Gas Separation and Purification Systems	

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Thermodynamically ideal separation systems- properties of mixtures, principles of gas separation rectification column-linde single and double column system of air separation.. Measurement systems for low temperatures measurement of different parameters at low temperature like temperature, pressure level mass flow rate etc.	[6]
Unit 5: Cryogenic fluid storage and transfer systems Insulation types Dewar vessel, importance. Components of transfer system	[6]
Unit 6 Application of cryogenic systems Applications in mechanical, electrical, food preservation, biological and medical, space technology etc.	[6]
Text Books: 1. "Cryogenic Systems", Barron F. Randall, Oxford University Press, New York 2. ."Applied Cryogenic Engineering",Vance, R. W, and Duke, Isted, W. M., J ohn Wiley (1962). 3. "Cryogenic Process Engineering",Klaus D. Timmerhaus, Thomas M. Flynn, Plenum Publishing Corporation (1989)	
Reference Books: 1. "Experimental Techniques in low Temperature Physics", Guy, K White, Claredon Press, Oxford, (1987). 2. ."Cryogenic Research and Applications", Marshall Sitting and Stephen Kidd, D. Van Nostrand, Inc USA, (1963). 3. ."Cryo-Cooler: Fundamentals Part-I", G. Walker, Plenum Press, New York. 4. ."Cryo-Cooler: Fundamentals Part-II", G. Walker, Plenum Press New York	

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Nanotechnology

ME704E	PEC	Nanotechnology	3-0-0	3 Credits

Teaching Scheme:	**Examination Scheme:**
Lecture: 3 hrs/week	Continuous Assessment 1: 10 Marks Continuous Assessment 2: 10 Marks Mid Semester Exam: 30 Marks End Semester Exam: 50 Marks

Pre-Requisites:- None

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

CO1	Demonstrate an understanding of length scales concepts, nanostructures and nanotechnology.
CO2	Explain various synthesis and characterization techniques involved in Nanotechnology
CO3	Explain interactions at molecular scale
CO4	Evaluate and analyze the mechanical properties of bulk nanostructured metals and alloys, Nano-composites and carbon nanotubes.
CO5	Explain effects of using nanoparticles over conventional methods
CO6	Explain nano behaviors of materials as am industrial aspects operations.

Mapping of course outcomes with program outcomes

Course Outcomes	Program Outcomes													
	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
CO1	1	1		3	3	2	1		3		1	3	1	
CO2	3	2			3	3	2				1	3		
CO3	1	1	1	3	1				2	1		1	1	1
CO4	1	1		3	3	2	1		3		1	3		1
CO5	1	1	1	3	2				2	1		1		
CO6	1	1			2		1		1	1		1	1	

Course Contents:

Unit 1: Scientific Revolutions: Types of Nanotechnology and Nano machines: the Hybrid nanomaterial. Multiscale hierarchical structures built out of Nano sized building blocks (nano to macro). Nanomaterials in Nature: Nacre, Gecko, Teeth. Periodic table, Atomic Structure, Molecules and phases, Energy, Molecular and atomic size Surfaces and dimensional space: top down and bottom up.	[6]

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Unit 2: Forces between Atoms and Molecules: Particles and grain boundaries, strong Intermolecular forces, Electrostatic and Vander Waals forces between surfaces Similarities and differences between intermolecular and inter particle forces covalent and coulomb interactions Interaction polar molecules. Thermodynamics of self-assembly	[6]
Unit 3: Opportunity at the Nano Scale: Length and time scale in structures Energy landscapes Inter dynamic aspects of inter molecular forces Evolution of band structure and Fermi surface	[6]
Unit 4: Nano Shapes Quantum dots, Nano wires, Nano tubes 2D and 3D films Nano and mesopores, micelles bilayer, vesicles Bio-nano machines, biological membranes	[6]
Unit 5: Influence of Nano Structuring Influence of Nano structuring on mechanical Optical, electronic, magnetic and chemical properties Gram size effects on strength of metals Optical properties of quantum dots	[6]
Unit 6: Nano Behaviour Quantum wires, electronic transport in quantum wires and carbon nano-tubes, magnetic behavior of single domain particles and nanostructures, surface chemistry of Tailored monolayer, self-assembling.	[6]
Text Books: 1. C. Koch, "Nanostructured materials: Processing, Properties and Potential Applications", Noyes Publications, 2002. York 2. C. Koch, I. A. Ovidko, S. Seal and S. Veprek, "Structural Nano crystalline Materials: Fundamentals and Applications", Cambridge University Press, 2011.	
Reference Books: 1. Bharat Bhushan, "Springer Handbook of Nanotechnology", Springer, 2nd edition, 2006 2. Laurier L. Schramm, "Nano and Microtechnology from A-Z: From Nano-systems to Colloids and Interfaces", Wiley, 2014.	

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Refrigeration and Air-conditioning Laboratory

ME705	PCC	Refrigeration and Air-conditioning Laboratory	0-0-2	1 Credits

Teaching Scheme:	**Examination Scheme:**
Lecture: - Practical: 2 hrs./week	Continuous Assessment 1: 15 Marks Continuous Assessment 2: 15 Marks Practical and Oral Examination: 20 Marks

Pre-Requisites: Basic Mechanical Engineering, Thermal Engineering, Fluid Mechanics, Heat and Mass Transfer.

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

CO1	Estimate cooling capacity and coefficient of performance by conducting test on vapour compression refrigeration systems
CO2	Evaluate COP for Ice plant
CO3	Evalute COP for heat pump.

Mapping of course outcomes with program outcomes

Course Outcomes	Program Outcomes													
	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
CO1	3											1		
CO2	3	2	3									2		
CO3	3	3	2									1		

List of Experiments:

1. Study of basic components of simple vapour compression refrigeration system.
2. Study and demonstration of vapour absorption system.
3. Study of controls in refrigeration system
4. Trial on vapour compression refrigeration system.
5. Trial on Ice plant.
6. Study and Trial on heat pump.
7. Trial on ducted air conditioning system.
8. Industrial visit related to refrigeration and air conditioning system.
9. A case study of air-conditioning system.

Text Books:

1. "Refrigeration and Air Conditioning" Arora C P, Tata McGraw Hill
2. "Refrigeration and Air Conditioning" Arora Domkundwar , Dhanpat Rai and Sons

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Reference Books:

1. "Principal of Refrigeration" Dossat Ray J., S.I. Version, Wiley Eastern Limited, 2000
2. "Refrigeration and Air-conditioning" Manohar Prasad, Wiley Eastern Limited, 1983
3. "Refrigeration and Air-conditioning" Stocker W.F. and Jones J.W., McGraw Hill International editions 1982
4. "Thermal Environmental Engineering", Threlkeld J.L., Prentice Hall Inc. New Delhi
5. "Basic of Refrigeration and Air Conditioning", Anantnarayan, Tata McGraw Hill Publications
6. "Handbook of Refrigeration and Air Conditioning", Shan Wang, McGraw Hill Publications
7. "Industrial Refrigeration", Wilbert Stocker, McGraw Hill Publications
8. "Cryogenics systems" Randall Barron, Mc Graw Hill Book Co
9. "Absorption chillers and Heat Pumps", Keith Harold, McGraw Hill Publications
10. ASHRAE and ISHRAE Handbook
11. ASHRAE, Air Conditioning System Design Manual, 2nd edition ASHRAE

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Mechatronics Laboratory

ME706	PCC	Mechatronics Laboratory	0-0-2	1 Credits

Teaching Scheme:	**Examination Scheme:**
Lecture: - Practical: 2 hrs./week	Continuous Assessment 1: 25 Marks Continuous Assessment 2: 25 Marks

Pre-Requisites: Basic Mechanical Engineering, Thermal Engineering, Fluid Mechanics, Heat and Mass Transfer.

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

CO1	Develop a pneumatic circuit for a given application
CO2	Develop a Hydraulic circuit for a given application
CO3	Experiment with Programming of microcontrollers and Microprocessor and fabrication of simple mechatronics system.

Mapping of course outcomes with program outcomes

Course Outcomes	Program Outcomes													
	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
CO1	3											1		
CO2	3	2	3									2		
CO3	3	3	2									1		

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List of Experiments:

At least minimum 6 experiments should be performed from the following list

1. Minimum two circuits on Pneumatic and Electro-Pneumatics to be developed on Electro Pneumatic trainer kit
2. Minimum two circuits on Hydraulics and Electro-hydraulics to be developed on Hydraulic trainer kit
3. Programming of Microprocessor and Microcontroller
4. PLC Programming on Industrial Applications based on Timers, Counters
5. Fabrication of Simple Mechatronics working project by a group of 04 students using Hardware and suitable software.
6. Assignment on SCADA and MEMS.
7. Case study on Mechatronics system by a group of 04 students.
8. Industrial visit to study Mechatronics system application and submission of visit report
9. Speed control of various types of Electrical Motors

Text Books:

1. Antony Espossito, "Fluid power with Applications ", Pearson, Sixth Edition., 2003.
2. W. Bolton, "Mechatronics: Electronic Control Systems in Mechanical and Electrical Engineering" - PrenticeHall - 2013 - 5 th Edition Singh, Shio Kumar.
3. Industrial Instrumentation and Control, Tata McGraw-Hill Education, 2010
4. Mikell P Groover, "Automation Production Systems and Computer- Integrated Manufacturing"Pearson Education, New Delhi, 2001..

Reference Books:

1. Mechatronics – W. Bolton, Pearson education
2. Mechatronics – Mahalik, TATA McGraw Hill
3. Mikell P Groover, "Industrial Robots – Technology Programmes and Applications", McGraw Hill ,New York, USA. 2000.
4. Mechatronics – Appu Kuttam, Oxford publications
5. Introduction to PLC programming, NIIT,
6. Programmable logical controller, Hackworth, Pearson Education
7. Programmable logical controller, Reis Webb, Prentice Hall
8. Mechatronics and Microproceesor by Ramchandran Willey India
9. Mechatronics : Integrated Mechanical Electronic System by Ramchandran Willey India
10. Programmable logical controller,3e Gary Dunning Cengage Learning
11. Mechatronics Source Book by N C Braga Cengage Learning
12. Fluid Power with Applications by Anthony Esposito - Pearson Education 2000.
13. Power Hydraulics by Michael J, Prinches and Ashby J. G, - Prentice Hall, 1989

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Simulation Laboratory

ME707	PCC	Simulation Laboratory	0-0-2	1 Credits

Teaching Scheme:	**Examination Scheme:**
Practical: 2 hrs/week	Continuous Assessment 1: 25 Marks Continuous Assessment 2: 25 Marks

Pre-Requisites: Engineering Graphics

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

CO1	Analyze mechanical components for generative design
CO2	Solve the structural analysis problems using CAE software.
CO3	Solve the thermal analysis problems using CAE software.

Mapping of course outcomes with program outcomes

Course Outcomes	Program Outcomes													
	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
CO1		2	1	1	3				2	2		2	1	
CO2		1	2	1	3				2	2		2	1	
CO3		3	3	3	3				3	2		2	1	

List of Practical's:

1. Generative design optimization for any four mechanical components using suitable software.
2. Minimum 2 structural analysis problems to be solved using a CAE software.
3. Minimum 2 thermal analysis problems to be solved using a CAE software.
4. Minimum 2 casting simulation problems to be solved using a casting simulation software.

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Capstone Project Phase II

PROJ06	PROJ	Capstone Project Phase II	0-0-8	4 Credits

Teaching Scheme:	Examination Scheme:
Lecture: - Practical: 2 hrs./week	Continuous Assessment 1: 25 Marks Continuous Assessment 2: 25 Marks End Semester Examination: 50 Marks

Pre-Requisites: Basic Knowledge of Core Mechanical Engineering Subjects

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

CO1	Identify real life problem and feasibility of solution to the problem
CO2	Analyze and optimize solutions to real life problems with individual and team work
CO3	Improve professional ethics and communication skill and engage with environment

Mapping of course outcomes with program outcomes

Course Outcomes	Program Outcomes													
	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
CO1	3	3	3	3									2	
CO2					3	3			3		3			2
CO3							3	3		3		3		

Term Work:

1. At the end of third year, student have to form project batch of minimum 3 and maximum 5 students
2. At the end of semester student have to submit project phase-1 report for POE

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Industrial Case Studies (Seminar)

PROJ07	PROJ	Industrial Case Studies (Seminar)	1-0-0	1 Credit

Teaching Scheme:	**Examination Scheme:**
Lecture: - Practical: 02 hours/week	Continuous Assessment 1: 15 Marks Continuous Assessment 2: 15 Marks End Semester Exam: 20 Marks

Pre-Requisites:

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

CO1	Identify technical and practical issues related to the area of course specialization.
CO2	Plan a well-organized case studies report employing elements of technical writing and critical thinking.
CO3	Demonstrate the ability to describe, interpret and analyze technical issues and develop competence in presenting.

Mapping of course outcomes with program outcomes

Course Outcomes	Program Outcomes													
	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
CO1						2		3				2		
CO2						3		3				2		
CO3								3						

Course Contents

The Mechanical Engineering Cases group believes that through industrial case studies, students will improve their ability to learn and retain concepts in their courses, on work terms and in their professional lives. One of the best means to create case studies is by converting them from student-generated work reports. As a result, it is in our best interest to ensure that work reports submitted to our group contain an adequate design process and topics that align with topics that professors have suggested would benefit from case studies. We also believe that students will benefit by having suggestions for work term report topics.

The student has to select a Seminar topic/Case Studies work based on topic of interest. Periodically the implementation will be evaluated by the project guide. The work starts after sixth semester and evaluated in the seventh semester. The end of each semester student will be evaluated by departmental committee/faculty assigned by HOD.

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Students are suggested to choose seminar/ case study areas in following areas

1. Thermal engineering problems like losses in steam turbines, waste heat recovery in thermal power plants by visiting any Sugar industry
2. Force analysis of structures and structural components by visiting any design company department/civil constructional sites
3. Mechanical design components at Textile industry
4. Design of Gating system in any foundry by using Autocast Software
5. Quality related issues problem and solution in any Mechanical Industry
6. Production related issues problems and solutions in any Mechanical Industry
7. Foundry problems and its analysis by visiting any foundry
8. Detailed Design methodology of any real field component from industry
9. Marketing strategies applied to any product by visiting any industry
10. Case studies on HVAC like design of air conditioning system
11. Design of Solar PV System/Solar Energy related problems and solutions by visiting any industry
12. Design and development of robotic arm for any industry
13. Use of Industry 4.0 by visiting any industry
14. Account and Finance management related issues and its solution by visiting any industry

Apart from this students can choose any relevant topic which is relevant to industry

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Values and Ethics

ME708	MC	Values and Ethics	1-0-0	Audit

Teaching Scheme:	Examination Scheme:
Lecture: -2 hrs./week Practical:	Continuous Assessment 1: 25 Marks Continuous Assessment 2: 25 Marks

Pre-Requisites:

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

CO1	Relate the Ethics and Human interface
CO2	Improve Attitude, Morals, Aptitude, Integrity towards Society
CO3	Distinguish between values and skills, happiness and accumulation of physical facilities, the Self and the Body, Intention and Competence of an individual, etc.
CO4	Explain the significance of value inputs in a classroom and start applying them in their life and profession
CO5	Develop Publication ethics
CO6	Develop Business ethics in professional careers

Mapping of course outcomes with program outcomes

Course Outcomes	Program Outcomes													
	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
CO1						2		3				2		
CO2						3		3				2		
CO3								3						
CO4						1		3						
CO5						1		3				2		
CO6								3				2		

Course Contents:

Unit 1 Ethics and Human Interface : Ethics and Human Interface, Essence, determinants and consequences of Ethics in human actions; Dimensions of ethics; ethics in private and public relationships Human Values – lessons from the lives and teachings of great leaders, reformers and administrators, Role of family, society in inculcating values, role of educational institutions in inculcating values	[4]
Unit 2: Attitude, Morals, Aptitude, Integrity towards Society Attitude: content, structure, function, Attitude and its influence and relation with thought and behavior, Aptitude and foundational values towards society , integrity, impartiality	[4]

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and non-partisanship, empathy, tolerance and compassion intelligence-concepts.	
Unit 3:Understanding Harmony in the Human Being - Harmony in Myself Understanding human being as a co-existence of the sentient 'I' and the material 'Body', Understanding the needs of Self ('I') and 'Body', Understanding the Body as an instrument of 'I' (I being the doer, seer and enjoyer), Understanding the characteristics and activities of 'I' and harmony in 'I', Programs to ensure Sanyam and Swasthya	[4]
Unit 4: Value Education: Need, Guidelines, content and process for Value Education, Self Exploration–; Natural Acceptance and Experiential Validation, Continuous Happiness and Prosperity, Relationship and Physical Facilities, Method to fulfill the above human aspirations: understanding and living in harmony at various levels.	[4]
Unit 5: Publication Ethics Publication Ethics: Introduction, Scope and importance, Best practices/standards initiatives and Guidelines: COPE, WAME,etc., Conflict of Interest, Publication Misconduct: definition, concept, problems that lead to unethical behavior and Vice versa, complaints and appeals.	[4]
Unit 6: Business Ethics Ethics - Meaning, Importance, and Types of Ethics, Nature and Relevance to Business ethics, Values and Attitudes of Professional Engineers, Seven Principles of Public Life, Ethics in Business: Features, Principles, Need and Importance, Improving ethical behavior in Business	[4]

Text Books:

1. R R Gaur, R Sangal, G P Bagaria, 2009, A Foundation Course in Human Values and Professional Ethics.
2. M Govindrajran, S Natrajan and V.S. Senthil Kumar, Engineering Ethics (including Human Values), Eastern Economy Edition, Prentice Hall of India Ltd.
3. Neeraj Kumar, "Lexicon for Ethics, Integrity and Aptitude", Chronicle Publication, 2016.
4. Santosh Ajmera, Nand Kishor Reddi, "Ethics - Integrity and Aptitude", Tata Mc Graw Hill Publication, 2014.
5. M. Karthikeyan"Ethics, Integrity and Aptitude", Tata Mc Graw Hill Publication, 2015.

Reference Books:

1. Ivan Illich, 1974, Energy and Equity, The Trinity Press, Worcester, and Harper Collins, USA.
2. A N Tripathy, 2003, Human Values, New Age International Publishers.
3. E G Seebauer and Robert L. Berry, 2000, Fundamentals of Ethics for Scientists andEngineers . Oxford University Press.
4. B P Banerjee, 2005, Foundations of Ethics and Management, Excel Books.
5. B L Baipai, 2004, Indian Ethos and Modern Management, New Royal Book Co., Lucknow. Reprinted 2008.
6. P L Dhar, RR Gaur, 1990, Science and Humanism, Commonwealth Publishers.

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