Autonomous Program Structure of
Third Year B. Tech.
Sixth Semester (Mechanical Engineering)
2016 Pattern

Course Code	Course Title	Teaching Scheme Hours /Week			Examination Scheme				Total Marks	Credit
		Lecture	Tutorial	Practical	In Sem	End Sem	Oral	Practical		
ME 3201	Applied Thermodynamics	3	1	0	50	50	0	0	100	4
ME 3202	Machine Design	3	1	0	50	50	0	0	100	4
ME3203	Metrology And Quality Control	3	0	0	50	50	0	0	100	3
PEME 3201	Program Elective - II	3	0	0	50	50	0	0	100	3
PEME 3202	Program Elective - III	3	0	0	50	50	0	0	100	3
ME 3204	Applied Thermodynamics Lab	0	0	2	25	0	0	0	25	1
ME 3205	Machine Design lab	0	0	2	0	0	25	0	25	1
ME 3206	Metrology And Quality Control lab	0	0	2	0	0	0	25	25	1
PEME 3203	Program Elective - III Lab	0	0	2	0	0	25	0	25	1
ME 3207	Seminar	0	0	2	25	0	0	0	25	1
AC 3201	Audit Course	0	0	2	0	0	0	0	0	0
	Total	**15**	**2**	**12**	**300**	**250**	**50**	**25**	**625**	**22**
	Grand Total	**29**			**550**		**75**			

PEME 3201: Program Elective - II

1) Machines and mechanisms
2) Gas Turbine
3) Press Tool Design
4) Nanotechnology
5) Swayam Online Course

PEME 3202: Program Elective - III

PEME 3203: Program Elective – III lab

1) Computational Fluid Dynamics
2) Mechanics of Composite Materials
3) Piping Engineering
4) Jig and Fixture Design

AC 3102: Audit Course: Employability Skills development

ME 3201 Applied Thermodynamics

Teaching Scheme
Lecture: 3 Hrs/week
Tutorial: 1Hr/week

Examination Scheme
In Semester: 50 marks
End semester: 50 marks
Credits: 4

Prerequisite:
1. Engineering Thermodynamics
2. Fluid mechanics
3. Heat Transfer

Course Outcomes:
Students will be able to
1. comprehend combustion processes and cycles in IC engines.
2. ascertain the performance parameters of IC engines from given data.
3. evaluate isothermal and volumetric efficiency of reciprocating compressor
4. analyse refrigeration cycles and calculate COP.
5. plot psychrometric processes and perform air conditioning load calculations
6. construct velocity triangles of turbo machines.

Unit 1: IC Engines (10 Hrs)
Fuel air cycle, actual cycle, combustion in SI engine, combustion in CI engine, Testing and performance of IC engines

Unit 2: Reciprocating Air Compressors (8 Hrs)
Computation of work done, isothermal efficiency, volumetric efficiency, free air delivery, multi-staging of compressor, inter-cooling and after-cooling, capacity control of compressor

Unit 3: Refrigeration (8 Hrs)
Basic refrigeration cycles, cascade and multistage refrigeration, vapor absorption system

Unit 4: Psychrometry (8 Hrs)
Basic concepts and definitions, psychrometric chart, Analysis of various psychrometric processes

Unit 5: Introduction to Turbomachinery (6 Hrs)
Classification of turbo machines, comparison with positive displacement machines, fundamental equation governing turbo machines, velocity triangles and their analysis.

Text Books:

1. V. Ganesan, Internal Combustion Engines, Tata McGraw Hill
2. M. L. Mathur and R. P. Sharma, A course in Internal Combustion Engines
3. S. Domkundwar, C. P. Kothandaraman, A. Domkundwar, Thermal Engineering, Dhanpat Rai & Co.
4. Arora C. P. , Refrigeration and Air Conditioning, Tata McGraw-Hill
5. Manohar Prasad, Refrigeration and Air Conditioning , Wiley Eastern ltd

6. Manohar Prasad, V.kadambi, An introduction to energy Conversion: Turbomachinery, Volume III, New Age International (P)Ltd

References:

1. Dossat Ray J, Principles of refrigeration, Willey Eastern Ltd
2. Stockers W.F. and Jones J.W. , Refrigeration and Air Conditioning, McGraw Hill International
3. ASHRAE and ISHRAE handbooks

ME 3202 – Machine Design

Teaching Scheme
Lecture: 3 Hrs/week
Tutorials: 1 Hr/week

Examination Scheme
In semester: 50 marks
End semester: 50 marks
Credits: 4

Prerequisites:
1. Engineering Mechanics
2. Rigid Body Dynamics
3. Strength of Materials
4. Machine Drawing

Course Objectives:
1. To design simple machine elements subjected to static loads.
2. To compute the torque transmission capacity by the given power screw.
3. To analyse the machine elements subjected to fluctuating loads.
4. To apply A.S.M.E. code for shaft design.
5. To calculate the size of a mechanical joint, subjected to eccentric load.
6. To determine the spring dimensions for given requirement.

Course Outcomes:
Upon completion of this course, the student will be able to:
1. design simple machine elements subjected to static loads.
2. compute the torque transmission capacity by the given power screw.
3. analyse the machine elements subjected to fluctuating loads.
4. apply A.S.M.E. code for shaft design.
5. calculate the size of a mechanical joint, subjected to eccentric load.
6. determine the spring dimensions for given requirements.

Unit I: Introduction to Design Engineering: Design considerations, design process, design synthesis, standards in design, selection of materials, and selection of manufacturing processes.

Unit II: Design against static load: Modes of failures, types of stresses, theories of failures, design of simple machine elements.

Unit III: Design against fluctuating load: Fatigue failure, endurance limit, design for infinite and finite life, for completely reversed and fluctuating loads.

Unit IV: Design of machine elements: Design of shafts, couplings, power screws, mechanical joints, and mechanical springs.

Text Book:

1 Bhandari V.B ,"Design of Machine Elements", Tata McGraw Hill Publication Co. Ltd.

References:

1 Shigley J.E. and Mischke C.R., "Mechanical Engineering Design",McGraw Hill Publication Co. Ltd.

2 Spotts M.F. and Shoup T.E. ,“Design of Machine Elements” ,Prentice Hall International.

3 Black P.H. and O. Eugene Adams ,“Machine Design”,McGraw Hill Book Co. Inc.

4 Willium C. Orthwein,“Machine Components Design”,West Publishing Co. and Jaico Publications House.

5 Bhandari V.B ,“Design of Machine Elements”, Tata McGraw Hill Publication Co. Ltd.

6 Juvinal R.C,“Fundamentals of Machine Components Design”,John Wiley and Sons.

7 Hall A.S., Holowenko A.R. and Laughlin H.G,“Theory and Problems of Machine Design” , Schaum’s Outline Series.

ME 3203 – Metrology and Quality Control

Teaching Scheme
Lecture: 3 Hrs/week

Examination Scheme
In semester: 25 marks
End semester: 50 marks
Credits: 3

Prerequisites:
1. Basic Manufacturing Processes
2. Machine Design

Course Objectives:

1. Understand the objectives of metrology, methods of measurement, selection of measuring instruments and standards of measurement.
2. Understand the concept of tolerance, limits of size, fits, geometric and position tolerances, gauges and their design procedure.
3. Understand the advances in Metrology such as use of CMM, Laser, Machine Vision System for Metrology etc.
4. Understand the process of use of Quality Control Technique in engineering industries.
5. Understand Quality Management System.

Course Outcomes:
Upon completion of this course, the student will be able to:

1. Select suitable instrument / gauge / method to measure linear and angular dimensions.
2. Calibrate measuring instruments
3. Design inspection gauges
4. Select and apply appropriate Quality Management Tool and Quality Control Technique for clearly defined problem.
5. Apply Statistical Quality Control tool(s) to for clearly defined problem.

Unit 1: Introduction to Calibration & Geometric Form Measurement 8 Hrs.

Introduction: Principles of Engineering metrology, Measurement standards, Types and sources of errors, Accuracy and Precision

Calibration: Concept and procedure, traceability Comparators: Mechanical, Pneumatic, Optical, Electrical (LVDT)

Geometric Form Measurement: Straightness, Flatness, Roundness - Straight edge, use of level beam comparator, autocollimator testing of flatness of surface plate.

Unit 2: Design of Gauges and Dedicated Metrology 9 Hrs.

Design of Gauges: Tolerances, Limits and Fits [IS 919-1993], Taylor's principle, Types of gauges, Wear allowance on gauges, Types of gauges-plain plug gauge, ring gauge, snap gauge, limit gauge and gauge materials, Considerations of gauge design (numerical).

Thread Metrology: Thread form errors, Measurement of Minor, Major and Effective diameter (Three Wire Method), Flank angle and Pitch, Floating Carriage Micrometer (Numerical).

Gear Metrology: Errors in Spur Gear form, Gear tooth Vernier, Constant chord, Base tangent (Numerical), Gear Rolling Tester. Profile Projector, Tool maker's microscope and their applications

Unit 3: Advances in Metrology **9 Hrs.**

Coordinate Measuring Machine (CMM): Fundamental features of CMM – development of CMMs – role of CMMs – types of CMM and Applications, – types of probes

Machine Vision Systems: vision system measurement – Multisensory systems.

Interferometer: Principle, NPL Interferometer

Laser Metrology: Basic concepts of lasers, advantages of lasers, laser interferometers, types, applications

Unit 4: Concept of Quality and Statistical quality control **8 Hrs.**

Various Definitions and Quality Statements, Cost of quality & value of quality, Deming's cycles & 14 Points, Juran Trilogy approach, Old New Seven Tools, Quality Circles.

Statistical quality control: Statistical concept, Frequency diagram, Concept of variance analysis, Control Chart for Variable (X & R Chart) & Attribute (P & C Chart), Process capability(Indices: cp, cpk, ppk), Statistical Process Control (Numerical).

Unit 5: Acceptance Sampling and TQM **8 Hrs.**

Acceptance Sampling: Sampling Inspection, OC Curve and its characteristics, sampling methods, Sampling Plan: Single, Double (Numerical), Multiple, Comparison of Plan, calculation of sample size, AOQ, Probability of Acceptance (Numerical)

TQM: Introduction, Quality Function Deployment, 5S, Kaizen, Poka yoke, Kanban, JIT, FMECA, Zero defects, TPM. Six Sigma: DMAIC - Concept and Applications.

Quality Management System: Need for quality management system – design of quality management system - quality management system requirements – ISO 9001, TS-16949, ISO-14000, Quality Audit

References:

1 Jain R.K., Engineering Metrology, Khanna Publication.

2 I. C. Gupta, Engineering Metrology, Dhanpath Rai Publication.

3 Bewoor A. K. and Kulkarni V. A., Metrology and Measurements, Tata McGraw hill Publication.

4 Narayana K.L., Engineering Metrology, Scitech Publications (India) Pvt Limited.

5 Juran J. M., Quality Handbook, McGraw Hill Publications.

6 Grant S.P., Statistical Quality Control, Tata McGraw hill Publication.

7 ASTME, Handbook of Industrial Metrology, Prentice Hall of India Ltd.

8 Basterfield D. H., Quality control, Pearson Education India, 2004.

9 Kulkarni V. A. and Bewoor A. K., Quality Control, John Wiley Publication.

10 Online Education resources: viz. NPTEL web site:

(1) nptel.ac.in/courses/112106179;
(2) www.nptelvideos.in/2012/12/mechanical-measurements-and-metrology.html;
(3) www.me.iitb.ac.in/~ramesh/courses/ME338/metrology6.pdf; nptel.ac.in/courses/110101010/;
(4) freevideolectures.com › Mechanical › IIT Madras
(5) nptel.ac.in/courses/112107143/37.

Resources required for course:

1 Metrology equipment

2 Standard quality tools formats published by ASQ and MCCAI.

PEME 3201 Program Elective II – (A) Machines and Mechanisms

Teaching Scheme
Lecture: 3 Hrs/week

Examination Scheme
In semester: 25 marks
End semester: 50 marks
Credits: 3

Prerequisites:
1. Engineering Mechanics
2. Rigid Body Dynamics
3. Analysis and Synthesis of Mechanisms

Course Objectives:

1. To describe the constructional and operational features of gears.
2. To compute the unbalanced forces and couples for rotating and reciprocating masses.
3. To evaluate the force components in gears.
4. To analyze the gear trains for torque and motion.
5. To explain constructional and operational features of flexible drives.
6. To determine the torque capacity of clutches and brakes.

Course Outcomes: The students will be able to

1. describe the constructional and operational features of gears.
2. compute the unbalanced forces and couples for rotating and reciprocating masses.
3. evaluate the force components in gears.
4. analyze the gear trains for torque and motion.
5. explain constructional and operational features of flexible drives.
6. determine the torque capacity of clutches and brakes.

Unit 1: Spur Gear — 6 Hrs.

Gear drives: Classification, features, selection, applications.
Spur gear: Terminology, law of gearing, tooth profile, arc of contact, contact ratio, interference and undercutting, standard gear tooth systems, force analysis.

Unit 2: Helical, Bevel, Worm and Worm Wheel — 4 Hrs.

Helical gears: Terminology, virtual number of teeth, force analysis.
Bevel Gear: Classification, terminology, formative gear, force analysis
Worm and worm wheel: Advantages and limitations, terminology, geometrical relationships, force analysis, efficiency.

Unit 3: Gear Trains — 6 Hrs.

Types of gear trains, analysis of epicyclic gear trains, holding torque – simple, compound and epicyclic gear trains, torque on sun and planetary gear train. Types of gearboxes.

Unit 4: Friction Clutches, Brakes and Dynamometer 6 Hrs.

Pivot and collar friction, plate clutches, cone clutches, centrifugal clutch, torque transmitting capacity.

Classification of brakes, shoe brakes, block brakes, band brakes, and band and block brakes, braking torque analysis. Different types of absorption and transmission type dynamometer.

Unit 5: Belt, Rope and Chain Drives 6 Hrs.

Belt drive: Materials and construction, classification, features, geometric relationships, tensions in belt, maximum power transmission, selection from manufacturer's catalogue, belt tensioning methods.
Wire Ropes: Construction of wire ropes lay of wire ropes, stresses in wire rope, selection of wire ropes, rope drum construction and design.
Chain Drives: Classification, geometric features, polygon effect, modes of failure for chain, lubrication of chains.

Unit 6: Balancing of machines and Step–Less-Regulation 8 Hrs.

Balancing: Static and dynamic balancing, balancing of rotating masses in single and several planes, primary and secondary balancing of reciprocating masses, balancing in single cylinder engines, balancing in multi-cylinder in-line engines, direct and reverse cranks method -radial and V engines.
Stepless regulation: Continuous Variable Transmissions - Geometry, Velocity and torque analysis of Faceplate variators, Conical variators, Spheroidal and cone variators, Variators with axially displaceable cones, PIV drives.

Text Book:

1 Ashok G. Ambekar, "Mechanism and Machine Theory", Prentice Hall, India

References:

1 S. S. Ratan, "Theory of Machines", Tata McGraw Hill
2 Thomas Bevan, "Theory of Machines" CBS Publisher and Distributors, Delhi
3 Asok Kumar Mallik, Amitabha Ghosh, Gunter Dittrich, "Kinematic Analysis and Synthesis of Mechanisms"
4 Sadhu Singh, "Theory of Machines", Pearson
5 Shigley J. E., and Uicker J.J., "Theory of Machines and Mechanism", McGraw Hill Inc.
6 Hall A. S., "Kinematics and Linkage Design", Prentice Hall
7 Wilson C.E., Sandler J. P. Kinematics and Dynamics of Machinery", Person Education
8 Erdman A.G. and Sandor G.N., "Mechanism Design, Analysis and Synthesis" Volume-I, Prentice - Hall, India

PEME 3201 Program Elective II – (B) Gas Turbine

Teaching Scheme
Lecture: 3 Hrs/week

Examination Scheme
In semester: 25 marks
End semester: 50 marks
Credits: 3

Prerequisites:
1.Thermodynamics
2.Applied Thermodynamics
3. Fluid Mechanics

Course objectives:
1.To Interpret the fundamentals of gas laws and their applications.
2.To apply the conservation laws to components of gas turbines
3.Should be able to apply the principles of basic and applied thermodynamics to solve general equations and find the efficiency.
4.To understand the working of the various components of the system.

Course Outcomes:
1. Student will be able understand the working of gas turbine and its components
2. Student will be able to relate the velocity triangles and their applications.
3. Student will generate the solution for various combustion chamber designs.
4. Student will derive the equations for efficiency of various components.

Unit 1: Centrifugal fans Blowers and Compressors, Brayton cycle, regeneration and reheating cycle analysis.Axial flow fans and compressors.

Unit 2 : Elementary theory: Degree of reaction, simple design methods, blade design, stage performance, degree of reaction, three dimensional flow, simple design methods, blade design, calculation of stage performance, overall performance and compressibility effects.

Unit 3: Performance characteristics.Axial flow turbines: elementary theory, vortex theory, choice of blade profile, pitch and chord ,estimation of stage performance,

Unit 4: Combustion system: Forms of combustion, important factors affecting combustion chamber design, combustion processes,combustion chamber performance, practical problem.,

Unit 5: Simple gas turbines: Components,characteristic, pressure losses, methods of improving part load performance, behaviour of gas turbines, Gas turbine rotors and stresses,

Suggested texts and reference materials:

1. ”Gas Turbine Theory,” Cohen and Rogers,Longman Group .
2. ”Mechanics and Thermodynamics of Propulsion”;Hill Philip, Peterson Carl,Addison Wesly
3. ”Turbines Compressors and Fans” S M Yahya, McGraw-Hill
4. ”Gas Turbines” , V. Ganesan,McGraw-Hill

PEME 3201 Program Elective II – (C) Press Tool Design

Teaching Scheme
Lecture: 3 Hrs/week

Examination Scheme
In semester: 25 marks
End semester: 50 marks
Credits: 3

Prerequisites:
1. Manufacturing Processes-I
2. Manufacturing Processes-II
3. Manufacturing Processes-III

Co-requisites:
NIL

Course Objectives:
1. To learn different sheet metal operations and its tools.
2. To learn different types of forces in different sheet metal operations.
3. To learn different nomenclatures related to dies.

Course Outcomes:
Upon completion of this course, students will be able to:
1. apply numerical method for calculation of forces related to press tool operations.
2. solve strip layout considering various factors involved in press tool operation.
3. select type of dies for various industrial component manufacturing.
4. design different press tool dies.

Unit 1: Introduction (3 hrs)
Shearing of Sheet Metal: Common Press tool operations, Theory of shear action in metal cutting, classification of presses.

Unit 2: Sheet metal forming processes (8 hrs)
Calculation of Force Requirements in Blanking and Piercing, Die Clearances in Blanking and Piercing, Process of Bending through 'V' Die and 'Wiping' Die, Forming Dies, Drawing Dies, Drawing of Box-like Shells, Direct and Reverse Redrawing.

Unit 3: Introduction to press tools (7 hrs)
Standard Die Set, Description of Press Tools.

Unit 4: Introduction to the design of dies (7 hrs)
Design of blanking, piercing, progressive and compound dies, guidelines for the design of press tools, design of progressive dies, compound die, calculation of centre of pressure in unsymmetrically profiled components.

Unit 5: Bending, drawing and forming dies: (8 hrs)
Introduction, classification of bending and other forming dies.

Suggested Texts and Reference Materials:

1 K. Venkataraman, 'Design of jigs, fixtures and press tools', Wiley.
2 Z. Marciniak, J. L. Duncan, S. J. Hu, 'Mechanics of sheet metal forming', Butterworth Heinemann.
3 Ivana Suchy, 'Handbook of dies design', McGraw Hill.
4 Fundamentals of Tool Design - ASTME
5 Tool engineers handbook - ASTM
6 Handbook of press tools - ASTM

PEME 3201 Program Elective II – (D) Nanotechnology

Teaching Scheme	**Examination Scheme**
Lecture: 3 Hrs/week	In semester: 25 marks
	End semester: 50 marks
	Credits: 3

Course Objectives:

1 To understand principle of nanotechnology with tools and techniques used
2 To learn different types of nanomaterials with concern of environment and energy
3 To learn use of nanotechnology to textile and composites.

Course Outcomes:

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

1 understand principle of nanotechnology with tools and techniques used.
2 learn different types of nanomaterials with concern of environment and energy
3 earn use of nanotechnology to textile and composites.

Unit 1. Introduction:

What is a Nanometer? , What is Nanotechnology? , Richard Feynman's Idea of Nanotechnology, General purpose Technology, Why Nanotechnology, Tools and Techniques, History of Nanotechnology, Uses of Nanotechnology, Nanotechnology Hazards, Safety, Hazard and Public Policy Issues.

Unit 2. Tools & Techniques:

Basic Idea of Nanotechnology, Techniques used in Nanotechnology, Tools used in Nanotechnology, Electron Microscope, Imaging in the TEM, Drawbacks of TEM, Applications of the TEM, How a Typical SEM Functions, Differences between SEM and TEM, Sample Preparation for an Electron Microscope, Disadvantages of Electron Microscope.

Unit 3. Nanomaterial's:

What are Nanomaterials? , Properties of Nanomaterials, Method to Produce Nanomaterials, Applications of Nanomaterials, Carbon Nanomaterials, Carbone Nanocones, Fullerene, How to Produce Nanotubes, Types of Nanotubes, Properties of Carbon Nanotubes, Industrial Applications for Carbon Nanotubes, Potential Market for Carbon Nanotubes, Possible Toxicity of Carbon Nanotubes, Nanowires, Types of Nanowires, Properties of Nanowire, Application of Nanowire

Unit 4. Nanotechnology Environment and Energy:

Using Carbon Nanotube Fuel Cells to Store Hydrogen, Photovoltaic, Biomimcry, New Advances made in Hydrogen Fuel Cells, Fuel Cells Potential Applications in Space and Nanotechnology, Applications for Fuel Cells and what Improvements Nanotechnology Can Offer, Nanotechnology Catalysts Might Improve the Efficiency of Direct Methanol Fuel Cells, Nanotechnology Techniques for Improving Solid Oxide Fuel Cells (SOFC), Material Types Used for Hydrogen Storage.

Unit 5. Nanotechnology and Textiles:

The use of Nanotechnology in the Textile Industry, Commercial Potential of Nanotechnology for the Textile Industry, Methods of Apply Coating onto Fabrics, Well-known Properties Imparted by Nano treatment, Nanotechnology Textile Developments, Innovations Seen in the Textile Industry, Smart Materials, Electro textile, Smart Textiles.

Unit 6. Nano composites:
Introduction, Designing Novel Nanocomposites, Advantages of Nano Sized Additions, Disadvantages of Nano sized Additions, Applications of Nanocomposites, Areas of Application, Clay Based Nanocomposties, Processing of Clay Based Nanocomposites.

References and books

1. Manasi Karkare, Nanotechnology: Fundamentals and Applications, I K International Publishing House 2013
2. Gabor L. Hornyak, John J. Moore, H.F. Tibbals, Fundamentals of Nanotechnology, CRC Press
3. Horst-Günter Rubahn, Basics of Nanotechnology, Wiley, 2008

PEME 3202 Program Elective III – (A) Computational Fluid Dynamics

Teaching Scheme
Lecture: 3 Hrs/week

Examination Scheme
In semester: 25 marks
End semester: 50 marks
Credits: 3

Prerequisites
Fluid dynamics, Heat transfer, Numerical methods

Course Objectives
To introduce students to,
1. Finite volume method (FVM) of discretization for differential equations ,
2. Development of solution of discretized equations using various methods,
3. Development of numerical codes for diffusion and convection problems,
4. CFD techniques to fluid dynamics and heat transfer problem,

Course Outcomes
Students will be able to
1. Discretize a given differential equation with FVM,
2. Write a numerical code for diffusion and convection problems,
3. Develop a Navier-Stokes equation solver,
4. Apply CFD techniques to real life industrial problems.

Unit 1. Governing equations: the continuity equation, momentum equation and energy equations, convective forms of the equations and general description, Reynolds transport theorem. Classification of partial differential equations; physical examples of elliptic, parabolic and hyperbolic equations. Mathematical nature of the flow equations & their boundary conditions.

Unit 2. Discretization Methods and Solution of Discretized Equations: The discretization concept, the structure of discretization equations, methods of deriving the discretization equations. Finite difference method, Finite volume method. Concept of consistency, accuracy, stability and Convergence. Tri-Diagonal Matrix Algorithm (TDMA), Application of TDMA Method to Two dimensional Problems. Gauss-Seidel Method.

Unit 3. Finite Volume Method for Diffusion Problems: Finite Volume Method for one dimensional steady state Diffusion, Finite Volume Method for Two Dimensional Diffusion Problems.

Unit 4. Finite Volume Method for Convection-Diffusion Problem: Steady one dimensional convection and Diffusion, Central Differencing Scheme, Properties of Discretization Schemes, Assessment of Central Differencing Schemes for Convection Diffusion Problem, Upwind Differencing Scheme Hybrid Differencing Scheme.

Unit 5. Solution Algorithms: Pressure-Velocity Coupling Steady Flow, Staggered Grid, Momentum Equations, Simple Algorithm, PISO Algorithm.

References and books

1 S. V. Patankar, Numerical Heat Transfer and Fluid Flow, McGraw-Hill.

2 John C. Tannehill, Dale A. Anderson and Richard H. Pletcher, Computational Fluid Mechanics and Heat Transfer, Taylor & Francis
3 Versteeg, H. K. and Malalasekara, W. (2008). Introduction to Computational Fluid Dynamics: The Finite Volume Method. Second Edition (Indian Reprint) Pearson Education.
4 Anderson, J.D. Computational Fluid Dynamics, McGraw Hill, 1995.

PEME 3202 Program Elective III – (B) Mechanics of Composite Material

Teaching Scheme
Lecture: 3 Hrs/week

Examination Scheme
In semester: 25 marks
End semester: 50 marks
Credits: 3

Prerequisites:
1. Engineering Mechanics
2. Strength of Materials
3. Engineering Metallurgy

Course Objectives:

1. To understand a perspective utilization and processing of composite materials
2. To analyze lamina of composite material at micro and macro level
3. To analyze the laminated composite material at macro level
4. To understand testing methods of composite materials to evaluate mechanical properties

Course Outcomes:

Upon completion of this course, the student will be able to:

1. Define need, utilization of class of composite material, its constitution, list its application fields and demonstrate the various fabrication process
2. Micro and macro-mechanical analysis of the composite material at lamina level
3. Analyze the laminated composite material at a macro level using classical lamination theory
4. Define testing methods of composite materials to evaluate mechanical properties

Unit 1. Introduction to composite (6 Hr)

Introduction to advanced materials and types, Definition, General Characteristics, Applications, Fibers, Types of fibers, Mechanical Properties of fibers; Matrix, Types of matrix, Polymer Matrix- Thermoset and Thermoplastic, Fillers/Additives/Modifiers of Fiber Reinforced Composites

Unit 2. Manufacturing of composites (6 Hr)

fabrication process for thermoset and thermoplastic PMC, open mould process as hand layup techniques; structural laminate bag molding, production procedures for bag molding; filament winding, and Closed mould process as pultrusion, performing, thermo-forming, injection molding, blow molding, Process parameters.

Unit 3. Elastic and strength Behavior of Lamina (12 Hr)

Introduction, Volume and mass fraction, density, void content, evaluation of elastic moduli, ultimate strength of unidirectional lamina

Review and definition of stress, strain and Elastic Moduli, Hooke's Law for different types of materials, Hook's law for 2D unidirectional and angular lamina, engineering constants of an angle lamina, Strength failure theories of an angle lamina

Unit 4. Elastic Behavior of Laminate (10 Hr)

Introduction to Laminate Code, Strain-displacement relations, Stress-strain relation for a laminate, force and moment resultants related to mid plane strains and curvatures, In-Plane engineering constants of a laminate, Flexural engineering constants of a laminate

Unit 5. Testing of Composites (6 Hr)

Societies for Testing Standards, Background to Mechanical Testing of Composites: Test Method of Tensile Properties, Compressive Properties, Flexural Properties, In-Plane Shear Properties, Interlaminar Shear Strength, Impact Properties.

Text and Reference Books:

1 Autar K. Kaw, “Mechanics of Composite Materials”, CRC Press, Taylor & Francis Group, 2012.

2 Isaac M. Daniels, Ori Ishai, “Engineering Mechaincs of Composite Materials”, Oxford University Press, 2010

3 Madhujit Mukhopadhyay, “Mechanics of Composite Materials and Structures”, University Press, 2004.

4 Robert M. Jones, “Mechanics of Composite Materials” 2nd Edition, CRC Press 1998

PEME 3202 Program Elective III – (C) Piping Engineering

Teaching Scheme
Lecture: 3 Hrs/week

Examination Scheme
In semester: 25 marks
End semester: 50 marks
Credits: 3

Prerequisites:
1. Fluid Mechanics, Machine Drawing
2. MAchine Design
3. Strength of Materials

Co-requisites:
NIL

Course Objectives:
1. Student will able to learn different joint utilized in piping.
2. Student will able to learn piping layout.
3. Student will able to learn to calculate stresses in piping system.

Course Outcomes:
Upon completion of this course, students will be able to:
1. Student will select proper joints for different piping layouts.
2. Student will draw piping layout for different applications
3. Student will calculate piping stress in different industrial applications.

Unit 1: Introduction to Piping: Introduction to phases of plant design, Role of Piping within project plan. Design Philosophy.
Process data sheets, Process flow diagram, Piping & Instrumentation diagrams, and Equipment layout. Interdisciplinary inputs/coordination.

Unit 2: Piping fundamentals: Piping elements (pipes, fittings, flanges, gasket, bolting, Valves), Pipe schedule, Pipe thickness calculations.

Pipe fittings (bends, elbow, Tees, Reducers, Stub ends, cross), Special pipe fittings, expansion joints, types of flanges, pressure temperature rating for flanges.

Unit 3: Piping Codes & Standards American Standards, Indian standards, British Standards for Piping Engineering. Selection of Design code. Unified numbering system (UNS).
Piping materials : ASME, ASTM , IS materials for piping components such as pipe, fittings, flanges, bolting, supports, expansion joints, valves etc. Selection of materials

Unit 4: Piping Drawing Piping symbols, orthographic (Plan & Elevation) drawings.
Plot Plan Development & Requirements (General guidelines) Equipment Layout Terminology, Control Point & Battery Limits.

Preparation of Equipment Layout. Piping GA Drawing Requirements and Layout Procedure. Pump GA Drawing and Layout Consideration.

Unit 5: Piping supports Fixed supports like Rest , Line guide, Line stop, Hold down, Rigid strut etc., Flexible supports like variable spring support, constant spring support, Snubber etc.

Piping Stress Analysis : Need of Stress Analysis, Procedure to carry out stress analysis, Loads on the piping system(such as sustained , thermal, hydro-test loads, water hammer, relief valve outlet), Allowable stress, Flexibility analysis, thermal load calculations, critical line list preparation , Steps involve in stress analysis of piping system, Pipe support

Suggested texts and reference materials

1. Piping Handbook, Mohinder L. Nayyar, McGraw-Hill Publication
2. Piping Design Handbook, Macetta John, M. Dekker , 1992
3. ASME code for Process Piping ,ASME B31.1
4. ASME code for Process Piping , ASME B31.3
5. ASME B16.5 , Pipe ,Flanges & Flange Fittings
6. An International Code 2007 ASME Boiler & Pressure Vessel Code, Rules For Construction of Pressure Vessels, Section II A, B, C & D

PEME 3202 Program Elective III – (D) Jig and Fixture Design

Teaching Scheme
Lecture: 3 Hrs/week

Examination Scheme
In semester: 25 marks
End semester: 50 marks
Credits: 3

Prerequisites:
1. Manufacturing Processes-I
2. Manufacturing Processes-II
3. Manufacturing Processes-III

Course Objectives:
1 To learn appropriate clamping method for jig or fixture.
2 To learn about locating devices and redundant location in jig or fixture.
3 To develop capability to design jigs and fixtures for lathe, milling and drilling M/C.

Course Outcomes:
Upon completion of this course, students will be able to:
1 Select appropriate clamping devices for jig or fixture.
2 Define basics of jig or fixture and choose locating devices for jig or fixture.
3 Index component and design jig for a given application.
4 Design milling fixtures for a given applications.
5 Apply knowledge of turning, grinding, boring, broaching, welding and modular fixtures for mass production applications

Unit 1: Introduction **(3 hrs)**
Definition of Jigs and Fixtures, Difference between jigs and fixtures, Advantages, Steps for design.

Unit 2: Design of locators **(6 hrs)**
General principle of degrees of freedom and constraints, foolproofing, other principles in the design of locators, various types of locators.

Unit 3: Design of clamps **(6 hrs)**
Principles of Clamping, Classification of Clamps.

Unit 4: Drilling Jigs **(6 hrs)**
Introduction, types of jigs, components of jig.

Unit 5: Design of milling fixtures **(6 hrs)**
Introduction, salient features of milling fixtures, classification of milling fixtures.

Unit 6: Other types of fixtures **(6 hrs)**
Turning, grinding, boring, broaching, welding and modular fixtures, advantages and disadvantages of modular fixtures, consideration of safety factors while designing of jig and fixtures.

Suggested Texts and Reference Materials:

1 K. Venkataraman, ‘Design of jigs, fixtures and press tools’, Wiley.
2 Kempster, ‘Introduction to Jigs & Tool Design’, Viva Books Pvt Ltd,1998.
3 D. Cyryll, G. H. Lecain, V. C. Goold, ‘Tool Design’, McGraw Hill, 2002.

ME 3204 Applied Thermodynamics Lab

Teaching Scheme
Practical: 2 Hrs/week

Examination Scheme
Insem: 25 Marks
Credits: 1

Prerequisites:
1. Engineering Thermodynamics
2. Fluid Mechanics
3. Heat Transfer

Course Objectives:
1. To study performance parameters of IC engines.
2. To conduct trial and do performance calculations for reciprocating air compressor.
3. To evaluate performance of refrigeration cycles.
4. To analyze various psychrometric processes.
5. To verify impulse momentum principle.

Course Outcomes:

Upon completion of this lab course, the student will be able to:
1. conduct trial on IC engine and calculate performance parameters
2. conduct trial on reciprocating air compressor to ascertain volumetric and isothermal efficiency.
3. compute performance parameters of refrigeration systems.
4. perform trial on air conditioning tutor to understand different psychrometric processes
5. perform experiment to understand impulse momentum principle

List of Experiments:

1. Trial on petrol engine
2. Trial on Diesel engine.
3. Trial on vapor compression test rig
4. Trial on ice plant test rig.
5. Trial on air conditioning test rig
6. Trial on reciprocating air compressor
7. Verification of impulse momentum principle

Text Book:

1. V. Ganesan, Internal Combustion Engines, Tata McGraw Hill
2. M. L. Mathur and R. P. Sharma, A course in Internal Combustion Engines
3. S. Domkundwar, C. P. Kothandraman, A. Domkundwar, Thermal Engineering, Dhanpat Rai& Co
4. Arora C. P. , Refrigeration and Air Conditioning, Tata McGraw-Hill
5. Dr.Bansal R.K, Fluid mechanics and hydraulic machines, Laxmi publications

ME 3205 Machine Design Lab

Teaching Scheme
Practical: 2 Hrs/week

Examination Scheme
Oral: 25 marks
Credits: 1

Prerequisites:
1. Engineering Mechanics
2. Rigid Body Dynamics
3. Analysis and Synthesis of Mechanisms

Course Objectives:

1. To describe the design process, materials and manufacturing aspects and theories of failures
2. To select the necessary data from relevant standards/standard guidelines.
3. To design the given assembly for the required application
4. To present the design work in the form of report and drawings.

Course Outcomes: Upon completion of this course, the student will be able to,

1. To describe the design process, materials and manufacturing aspects and theories of failures.
2. To select the necessary data from relevant standards/standard guidelines.
3. To design the given assembly for the required application
4. To present the design work in the form of report and drawings.

A) Two design projects on assemblies: - Group of students will be designing an assembly for the given application. The design process and the calculations will be mentioned in design report. Assembly and details drawings will be prepared on drawing sheets.
B) Two Assignments: - Group of students will be preparing assignment report on given topic and presenting it in the form of powerpoint presentation.

Suggested Texts and Reference Materials:

1. Shigley J.E. and Mischke C.R., "Mechanical Engineering Design",McGraw Hill Publication Co. Ltd
2. Spotts M.F. and Shoup T.E. ,"Design of Machine Elements" ,Prentice Hall International.
3. Black P.H. and O. Eugene Adams ,"Machine Design",McGraw Hill Book Co. Inc.
4. William C. Orthwein,"Machine Components Design",West Publishing Co. and Jaico Publications House.
5. Bhandari V.B ,"Design of Machine Elements", Tata McGraw Hill Publication Co. Ltd.
6. Juvinal R.C,"Fundamentals of Machine Components Design",John Wiley and Sons.
7. Hall A.S., Holowenko A.R. and Laughlin H.G,"Theory and Problems of Machine Design" , Schaum's Outline Series.
8. "Design Data",P.S.G. College of Technology, Coimbatore.

ME 3206 Metrology and Quality Control Lab

Teaching Scheme
Practical: 2 Hrs/week

Examination Scheme
In semester: 25 marks
Credits: 1

Course Objectives: Students are expected to –

1. **Understand** the methods of measurement and selection of measuring instruments.
2. To learn the concept of tolerance, limits of size, fits, geometric and position tolerances, gauges and their design procedure..
3. To learn the process of use of Quality Control Technique in engineering industries.

Course Outcomes:

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

1. **Select** suitable instrument / gauge / method to measure linear and angular dimensions.
2. **Calibrate** measuring instruments
3. **Select** and **apply** appropriate Quality Management Tool and Quality Control Technique for clearly defined problem.
4. **Apply** statistical quality control tool to for clearly defined problem.

List of Experiments:

Part [A] Experiment no. 1 and 6 are mandatory. Perform <u>any three from experiments</u> no. 2 to 5 & any three

1. Measurement of linear and angular dimensions using standard measuring instruments.
2. Error determination of linear / angular measuring instruments and determination of linear and angular dimensions of given part, MSA (Gauge R & R).
3. Calibration of measuring instrument. Example – Dial gauge, Micrometer, Vernier (any one)
4. Verification of dimensions & geometry of given components using Mechanical comparator.
5. Machine tool alignment testing on machine tool – Lathe / Drilling / Milling.
6. Demonstration of surfaces inspection using optical flat/interferometers.
7. Determination of geometry & dimensions of given composite object / single point tool, using profile projector and tool maker's microscope.
8. Measurement of thread parameters using floating carriage diameter measuring machine.
9. Measurement of spur gear parameters using Gear Tooth Vernier, Span Micrometer/ Gear Rolling Tester.
10. Determination of given geometry using coordinate measuring machine (CMM).

Part [B] Statistical Quality Control (SQC) (<u>Any 2 assignments</u>)

<u>Note</u> - Use of computational tools [such as Minitab / Matlab / MS Excel] are recommended

1. Analyze the fault in given batch of specimens by using Seven quality control tools for engineering application <u>USING STD. FORMATS</u>.
2. Determination of process capability from given components and plot variable control chart/attribute chart.
3. Case study on various tools in Total Quality Management (TQM).

Text Book:

1. Jain R.K., Engineering Metrology, Khanna Publication.
2. I. C. Gupta, Engineering Metrology, Dhanpath Rai Publication.
3. Bewoor A. K. and Kulkarni V. A., Metrology and Measurements, Tata McGraw hill Publication.
4. Narayana K.L., Engineering Metrology, Scitech Publications (India) Pvt Limited.
5. Juran J. M., Quality Handbook, McGraw Hill Publications.
6. Grant S.P., Statistical Quality Control, Tata McGraw hill Publication.
7. ASTME, Handbook of Industrial Metrology, Prentice Hall of India Ltd.
8. Basterfield D. H., Quality control, Pearson Education India, 2004.
9. Kulkarni V. A. and Bewoor A. K., Quality Control, John Wiley Publication.

PEME 3203 Program Elective III Lab – (A) Computational Fluid Dynamics

Teaching Scheme
Practical: 2 Hrs/week

Examination Scheme
End semester: 25 marks
Credits: 1

Course Objectives
To introduce students to,
1. Finite volume method (FVM) of discretization for differential equations ,
2. Development of solution of discretized equations using various methods,
3. Development of numerical codes for diffusion and convection problems,
4. CFD techniques to fluid dynamics and heat transfer problem,

Course Outcomes
Students will be able to
1. Carry out discretization and numerical formulation of a given differential equation with FVM,
2. Write a numerical code for diffusion and convection and pressure-velocity coupling
3. Develop a Navier-Stokes equation solver
4. Apply CFD techniques to real life industrial problems using CFD softwares

Programming Assignments:

1	Development of FVM code for one dimensional steady state and unsteady conduction problem
2	Development of FVM code for two dimensional steady state conduction problem
3	Development of FVM code for steady state one dimensional Convection-Diffusion Problem using central differencing scheme
4	Development of FVM code for steady state one dimensional Convection-Diffusion Problem using upwind and other convection schemes
5	Lid Driven Cavity problem using SIMPLE algorithm on structured grid
6	Lid Driven Cavity problem using PISO algorithm unstructured grid
7	Assignment on conduction through a composite slab using Fluent
8	Assignment on Lid Driven cavity on Fluent and comparison with the code
9	Assignment on flow through a pipe using Fluent
10	Assignment on meshing of a complex geometry

PEME 3203 Program Elective III Lab – (B) Mechanics of Composite Material

Teaching Scheme
Practical: 2 Hrs/week

Examination Scheme
End semester: 25 marks
Credits: 1

Course Objectives:

1. To understand a perspective on utilization of composite materials in structure
2. To analyze the composite material at lamina level
3. To analyze the laminated composite material
4. To understand methods of composite materials testing

Course Outcomes:
Upon completion of this course, the student will be able to:

1. Demonstrate fabrication process of unidirectional polymer composites
2. Develop program to analyze lamina made of polymer matrix composite material
3. Develop program to analyze laminate made up of polymer composites
4. Test and evaluate mechanical properties of polymer composites as per ASTM standards

Lab work to be accomplished

1. Develop Program for micro mechanical analysis of composite lamina
2. Develop Program for macro mechanical analysis of composite lamina and laminate
3. Develop program for failure analysis of composite laminate using different failure theories.
4. Manufacturing of unidirectional and multidirectional fiber reinforced polymer matrix composites
5. Tensile testing of composite lamina to find out tensile strength and tensile modulus
6. Flexural testing of composite lamina to find out flexural strength and flexural modulus
7. Izod/Charpy impact test of composite lamina to find out impact strength

Reference Book

1. Fiber-Reinforced Composites: Materials, Manufacturing, and Design, Third Edition (Mechanical Engineering). by P.K. Mallick | 19 November 2007

PEME 3203 Program Elective III Lab – (C) Piping Engineering

Teaching Scheme
Practical: 2 Hrs/week

Examination Scheme
End semester: 25 marks
Credits: 1

Course Objectives:

1. Understand and Draw different Layouts required in piping
2. Study nature of stress and calculate stresses in pipe.
3. Three D Modeling of different equipments used in piping
4. Design optimum Piping Route

Course Outcomes:

Upon completion of this course, the student will be able to:

1. Draw different Layouts required in piping
2. Analyze stresses in pipe.
3. Model different equipments used in piping
4. Route Piping Effectively

Lab work to be accomplished

1. Drawing Creation (P&ID, PFD, Layouts, and all fabrication Drawings)
2. PIPE STRESS ANALYSIS - CAESAR II
3. Equipment Modeling
4. Pipe Routing

PEME 3203 Program Elective III Lab – (D) Jig and Fixture Design Lab

Teaching Scheme
Practical: 2 Hrs/week

Examination Scheme
End semester: 25 marks
Credits: 1

Course Objectives:

1. To learn appropriate clamping method for jig or fixture.
2. To learn about locating devices and redundant location in jig or fixture.
3. To develop capability to design jigs and fixtures for lathe, milling and drilling M/C.

Course Outcomes:

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

1. Select appropriate clamping devices for jig or fixture.
2. Utilize locating devices jig or fixture.
3. Index component for mass production using jig or fixture.
4. Design jigs and fixtures for a given applications.

Lab work to be accomplished

1. Design of jig for machine component
2. Design of fixture for machine component

ME 3207 Seminar

Teaching Scheme
Practical: 2 Hrs/week

Examination Scheme
In semester: 25 marks
Credits: 1

Course Objectives:

1. Identify and compare technical and practical issues related to the area of course specialization.
2. Outline annotated bibliography of research demonstrating scholarly skills.
3. Prepare a well organized report employing elements of technical writing and critical thinking.
4. Demonstrate the ability to describe, interpret and analyze technical issues and develop competence in presentation.

Course Outcome: With this seminar report and presentation, the student will be able to

1. identify historic points of technological advance in engineering
2. read, understand and interpret technical and non-technical information
3. source and comprehend technical literature and other credible sources of information
4. analyze sourced technical information for feasibility, viability, and sustainability
5. produce clear, well-constructed, and well-supported written engineering documents
6. demonstrate effective communication skills using various presentation techniques

Course Contents: The evaluation of the seminar report is proposed with the following stages. **Stage-I** In this stage the student is expected to deliver the following: 1. Topic selection 2. Literature review 3. State of the art related to the topic of interest
Stage-II 1. Problem statement 2. Methodology 3. Scope and objectives A review of the student's progress should be made after In-Sem examination, within a week. During this review, the student is expected to complete Stage-1 and Stage-2.
Stage-III 1. Quantification of results 2. Concluding remarks or summary
Stage-IV 1. Final report 2. Final presentation/viva.

The final presentation/viva will be assessed by an internal panel. The internal panel will consist of the seminar guide and a subject expert, approved by the HOD.

The contents of the seminar report and presentation (as mentioned in section-3 and section-4) are expected to include the following: Abstract/Summary, Introduction: Scope and Methodology, Literature review (The review should be conducted from recent research papers), Case study and References.