Bansilal Ramnath Agarwal Charitable Trust's

Vishwakarma Institute of Technology

(An Autonomous Institute affiliated to Savitribai Phule Pune University formerly University of Pune)

Structure & Syllabus of

B.Tech. (Mechanical Engineering)

Pattern 'F-11 '

Effective from Academic Year 2016-17

(Final Year B.Tech.)

Prepared by: - Board of Studies in Mechanical Engineering

Approved by: - Academic Board, Vishwakarma Institute of Technology, Pune

Signed by

Chairman – BOS **Chairman – Academic Board**

Final Year B.Tech -Mechanical Engineering Structure with effect from Academic Year 2016-17 MODULE 7

Code	Subject	Type	Teaching Scheme			Assessment Scheme						Credits
			L	P	Tut.	ISA					ESA	
						Test 1	Test 2	HA	Tut.	CA	ESE	
	Elective *	Theory - Core	3	-	1	10	20	5	5	-	60	4
	Elective **	Theory – Core	3	-	1	10	20	5	5	-	60	4
ME 40101	Design of Mechanical Systems	Theory – Core	3	-	-	15	20	5	-	-	60	3
ME40103	CAD/CAM/CAE	Theory – Core	3	-	-	15	20	5	-	-	60	3
ME 40301	Design of Mechanical Systems	Lab – Core	-	2	-	-	-	-		70	30	1
ME40303	CAD/CAM/CAE	Lab – Core	-	2	-	-	-	-		70	30	1
		TOTAL	**12**	**4**	**2**							**16**

Elective*		***Elective*** **	
Tribology	ME42103	Power Plant Engineering	ME42118
Dynamics-Kinematics	ME42123	Turbo Machines	ME42111
Heat exchange Devices	ME42109	Industrial Fluid power	ME42117

Final Year B.Tech -Mechanical Engineering Structure with effect from Academic Year 2016-17 MODULE 8

Code	Subject	Type	Teaching Scheme			Assessment Scheme						Credits
			L	P	Tut.	ISA					ESA	
						Test 1	Test 2	HA	Tut.	CA	ESE	
	Elective[$]	Theory - Core	3	-	1	10	20	5	5	-	60	4
	Elective[$$]	Theory – Core	3	-	1	10	20	5	5	-	60	4
ME 40106	Vibration Analysis	Theory – Core	3	-	-	15	20	5	-	-	60	3
ME 40108	Refrigeration and Air Conditioning	Theory – Core	3	-	-	15	20	5	-	-	60	3
ME 40306	Vibration Analysis	Lab – Core	-	2	-	-	-	-		70	30	1
ME 40308	Refrigeration and Air Conditioning	Lab – Core	-	2	-	-	-	-		70	30	1
		TOTAL	**12**	**4**	**2**							**16**

Elective[$]		***Elective[$$]***	
Finite Element Method	ME 42102	Nonconventional Energy Sources	ME42119
Optimization Techniques and Operations Research	ME42122	Automobile Engineering	ME42120
Robotics	ME42110	Hybrid-Electric vehicles- Performance & Environment Impact	ME42124

Final Year B.Tech --Mechanical Engineering Structure with effect from Academic Year 2016-17

Semester I – Irrespective of Module

Code	Subject	Type	Teaching Scheme			Assessment Scheme						Credits
			L	P	Tut.	ISA					ESA	
						Test 1	Test 2	HA	Tut.	CA	ESE	
ME47303	Major Project – Stage II	Project	-	8	-	-	-	-	-	70	30	4
TOTAL			**-**	**8**	**-**							**4**

Final Year B.Tech --Mechanical Engineering Structure with effect from Academic Year 2016-17

Semester II – Irrespective of Module

Code	Subject	Type	Teaching Scheme			Assessment Scheme						Credits
			L	P	Tut.	ISA					ESA	
						Test 1	Test 2	HA	Tut.	CA	ESE	
ME47304	Major Project- Stage III	Project	-	12	-	-	-	-	-	70	30	6
TOTAL			**-**	**12**	**-**							**6**

MODULE VII

ME42103: TRIBOLOGY

Credits: 03 **Teaching Scheme: 3 Hours / Week**

Unit I: Friction and Wear (8 Hrs)

Part A: Friction: Laws of Friction, Types of Friction, Theories of friction, friction measurement.

Wear: Classification of Wear, Wear Mechanisms, Quantitative Laws of Wear, Wear measurement.

Part B: Friction and wear in metals and non-metals.

Unit II: Basic equations for fluid film lubrication and Hydrodynamic thrust bearings (8 Hrs)

Part A: Modes of lubrication**,** Types of lubricants, properties of lubricants, Mechanics of fluid flow, Reynold's equation.

Hydrodynamic thrust bearings: Pressure development mechanism, Plane slider bearing with fixed inclination, Tilting pad slider bearings, parallel step slider bearing.

Part B: Plane slider bearing with exponential film profile, Finite width thrust bearings.

Unit III: Hydrodynamic Journal Bearings (8 Hrs)

Part A: Mechanism of pressure development in journal bearing, Infinitely long bearing analysis, Infinitely short bearing analysis, Petroff's equation, theoretical and practical considerations in bearing design, Design procedure, Hydrodynamic instability.

Part B: Oil supply grooves in journal bearing, Bearing materials, Finite length journal bearing.

Unit IV: Squeeze film bearings and Gas Lubricated bearings (8 Hrs)

Part A: Squeeze film bearings: Introduction, infinitely long parallel rectangular plates, lubrication between parallel circular plates, lubrication between cylinder and a flat plane.

Gas Lubricated Bearings: Introduction, Governing equation.

Part B: Squeeze film damper, Applications of gas lubricated bearings.

Unit V: Hydrostatic bearings and Elastohydrodynamic lubrication (8 Hrs)

Part A: Hydrostatic bearings: Introduction, classification, hydrostatic circular step bearings, friction and pumping losses, stiffness calculation of hydrostatic circular step bearing

Elastohydrodynamic lubrication: Introduction, Hetrz contact stress theory, lubricant rheology, different regimes in EHL, Grubin theory, Pressure and film thickness distribution in EHL contacts.

Part B: Advantages and applications of Hydrostatic thrust bearings, examples of EHL point contact and line contact.

Total Contact Hours: 40 hours

Text Books

1. Introduction to Tribology of bearings: B.C Majumdar, S. Chand and company ltd. New Delhi (2008)
2. Engineering Tribology: Prasanta Sahoo, Prentice Hall of India, New Delhi (2005)

Reference Books

1. The Principles of lubrication: A. Cameron. Longmans Green & Co. Ltd.
2. Theory of Lubrication: B. C. Majumdar, M. Sarangi, M. K. Ghosh, Tata McGraw Hill Education, (2013).
3. Engineering Tribology: G. W Stachowiak, , A. W. Batchelor, Boston: Butterworth-Heinemann, 2001.

Course Outcomes:

The student will be able to –

1. Demonstrate knowledge about laws / theories of friction and wear.
2. Identify techniques for friction and wear measurement.

3. Identify modes of lubrication: boundary, mixed, EHL, hydrodynamic, hydrostatic lubrication.
4. Apply principles of Tribology to determine the solution to the problem of load carrying capacity across the interface with the acceptable magnitude of friction loss.
5. Design the bearing based on theoretical and practical considerations.

ME 42203: TRIBOLOGY (Tutorial)

Credits: 01 **Teaching Scheme:**Tutorial 1 **Hours / Week**

List of Tutorials

1. Two assignments from unit 1 (co1,2)

2. Two assignments from unit 2 (co3,4)

3. Two assignments from unit 3 (co4,5)

4. Two assignments from unit 4 (co4)

5. Two assignments from unit 5 (co4)

6. Journal Bearing Test: Experimental measurment of the pressure distribution and frictional torque in the journal bearing. (co 2,3)

7. Pin-on-Disc Test: To investigate the behaviour of interacting in terms of Friction and Wear measurment under (co1,2)

8. Four-Ball Test: To investigate the Wear preventive ability (WP), Extreme pressure capacity (EP), and Friction behaviour of lubricants operating under non-conformal (point contact) contact condition. (co 2,3)

Text Books:

1. Introduction to Tribology of bearings: B.C Majumdar, S. Chand and company ltd. New Delhi (2008)
2. Engineering Tribology: Prasanta Sahoo, Prentice Hall of India, New Delhi (2005)

Reference Books :

1. Basic Lubrication Theory: A. Cameron.

   The principles of lubrication: A. Cameron. Longmans Green & Co. Ltd.

2. Theory of Lubrication: B. C. Majumdar, M. Sarangi, M. K. Ghosh, Tata McGraw Hill Education, (2013).

3. Engineering Tribology: G. W Stachowiak, , A. W. Batchelor, Boston: Butterworth-Heinemann, 2001.

Course Outcomes:

The student will be able to –

1. Demonstrate knowledge about laws / theories of friction and wear.
2. Identify techniques for friction and wear measurement.
3. Identify modes of lubrication: boundary, mixed, EHL, hydrodynamic, hydrostatic lubrication.
4. Apply principles of Tribology to determine the solution to the problem of load carrying capacity across the interface with the acceptable magnitude of friction loss.
5. Design the bearing based on theoretical and practical considerations.

ME42123: DYNAMICS-KINEMATICS

Credits: 03 **Teaching Scheme: 3 Hours / Week**

Unit I: Fundamentals and review of basics concepts (8 Hrs)

Part A: Vector representation, free body diagrams, rectilinear motion: position, velocity, acceleration, translation frame of reference.

Part B: Newton laws, conservation of momentum, work-energy principle, Impact, determination of radius of gyration, instantaneous center of rotation of simple mechanisms.

Unit II: Kinematics of particles - 2D (8 Hrs)

Part A: Curvilinear motion of a particle: position, velocity and acceleration, rectangular components, tangential and normal components, radial and transverse components, motion of a particle relative to 2D moving reference frame (translation).

Part B: Relative and constrained motion of connected particles.

Unit III: Kinematics of particles - 3D (8 Hrs)

Part A: Space curvilinear motion: rectangular coordinates, cylindrical coordinates, spherical coordinates.

Part B: motion of a particle relative to 3D moving reference frame (translation).

Unit IV: 2D (Plane) Rigid body Kinematics (8 Hrs)

Part A: Introduction, Translation, rotation about a fixed axis, general plane motion, absolute and relative velocity in plane motion, absolute and relative acceleration in plane motion, plane motion of a particle relative to rotating frame of reference.

Part B: Instantaneous center of rotation in plane motion.

Unit V: 3D Rigid body Kinematics (8 Hrs)

Part A: Translation, fixed-axis rotation, parallel-pane motion, rotation about a fixed point, 3D motion of a particle relative to a rotating frame of reference.

Part B: Body and space cone, angular momentum: moments and products of inertia.

Total Contact Hours: 40 hours

Text Books:

1. Vector Mechanics for Engineer Dynamics: F. P. Beer and E.R. Johnston, Tata McGraw-Hill publication.
2. Engineering Mechanics Dynamics: A. Nelson, Tata McGraw-Hill publication.

Reference Books :

1. Engineering Mechanics Dynamics: R.C. Hibbeler, Prentice Hall publication.

2. Engineering Mechanics Dynamics: J.L. Meriam and L.G. Kraige, Wiley publication.

3. Engineering Mechanics : Statics and Dynamics, H. Shames, 4th Ed, PHI, 2002.

Course Outcomes:

The student will be able to –

1. Perform the kinematic analysis using vector approach.
2. Develop and use the relative motion equations that relate the velocity and acceleration of two points.
3. Analyse the relative kinematics of two points whose motion are constrained by taut inextensible cables.
4. Develop and use the velocity and acceleration equations for the analysis of planar motion of rigid bodies.
5. Solve kinematics problem involving 2-D and 3-D moving reference frame.

ME 42223: DYNAMICS-KINEMATICS (Tutorial)

Credits: 01 **Teaching Scheme:** Tutorial 1 **Hours / Week**

List of Tutorials

1. Two assignments from unit 1 (co1)

2. Two assignments from unit 2 (co1, 2, 3)

3. Two assignments from unit 3 (co1)

4. Two assignments from unit 4 (co1, 4, 5)

5. Two assignments from unit 5 (co1, 5)

Text Books:

1. Vector Mechanics for Engineer Dynamics: F. P. Beer and E.R. Johnston, Tata McGraw-Hill publication.
2. Engineering Mechanics Dynamics: A. Nelson, Tata McGraw-Hill publication.

Reference Books :

1. Engineering Mechanics Dynamics: R.C. Hibbeler, Prentice Hall publication.

2. Engineering Mechanics Dynamics: J.L. Meriam and L.G. Kraige, Wiley publication.

3. Engineering Mechanics : Statics and Dynamics, H. Shames, 4^{th} Ed, PHI, 2002.

Course Outcomes:

The student will be able to –

1. Perform the kinematic analysis using vector approach.
2. Develop and use the relative motion equations that relate the velocity and acceleration of two points.
3. Analyse the relative kinematics of two points whose motion are constrained by taut inextensible cables.
4. Develop and use the velocity and acceleration equations for the analysis of planar motion of rigid bodies.
5. Solve kinematics problem involving 2-D and 3-D moving reference frame.

ME42109 HEAT EXCHANGE DEVICES

Credits: 03 **Teaching Scheme: 03 Hours / Week**

Unit 1: Introduction to Heat Exchange Devices (8 Hours)

Part A: Engineering significance, Classification, Selection and Applications, LMTD, ε - NTU methods. Introduction to fouling, Introduction to TEMA standards

Part B: Constructional details of different Heat Exchangers

Unit 2: Basic Thermal Design Theory-The LMTD approach (8 Hours)

Part A: Heat transfer and pressure loss, Flow configuration, Exchanger Analysis: Logarithmic mean temperature difference for parallel and counter flow heat exchangers. LMTD correction factor. Consideration of fouling factor in the analysis.

Part B: Selection of appropriate correlations for heat transfer and pressure loss. LMTD correction factors charts for various Heat Exchangers

Unit 3: Basic Thermal Design Theory-The ε - NTU approach (8 Hours)

Part A: The ε - NTU method for parallel and counter flow heat exchangers. Design considerations for heat exchangers. Introduction to compact heat exchanger

Part B: Introduction to heat pipes

Unit 4: Additional Considerations in Thermal Design of Heat Exchangers (8 Hours)

Part A: Design standards and codes, key terms in heat exchanger design, material selection, and thickness calculation for major components such as tube sheet, shell, tubes, flanges and nozzles. Design procedure by TEMA standards

Part B: Introduction to Helical baffle heat exchangers and their design considerations, flow induced vibrations

Unit 5: Cooling Towers, Condensing System (8 Hours)

Part A: Design of surface and evaporative condensers, Introduction to Cooling towers and their design and selection aspects.

Part B: Introduction to simulation and optimization of heat exchangers, Heat transfer enhancement

Text Books:

1. Aurther P Frass, "Heat Exchanger design" 2nd Edition, John Wiley and Sons, New York.
2. T. Taborek, G. F. Hewitt and N. Afgan, "Heat Exchangers Theory and Practice" McGraw Hill Book Co.
3. Walker, "Industrial Heat Exchangers a Basic guide", McGraw Hill Book Co.

Reference Books:

1. Kern and Kraus, "Heat Exchanger Design Handbook"

2. Kuppan, "Heat Exchanger Design handbook"

3. "TEMA Standards"

Course Outcomes:

The student will be able to –

1. Know common heat exchanger types, their advantages, limitations and applications
2. Understand use and significance of heat transfer and pressure loss for flow configurations
3. Apply thermal design of heat exchanger and fouling considerations
4. Know how to incorporate Mechanical design and awareness of TEMA standards in designing heat exchanger
5. Understand design and selection aspect of cooling towers and condensers and awareness of simulation methodology in heat exchangers

ME42209 HEAT EXCHANGE DEVICES (Tutorial)

Credits: 01 **Teaching Scheme: 1 Hours / Week**

List of Tutorials*:

1. Tut I - Design of Heat Exchanger for sizing - Unit No II
2. Tut II- Design of Heat Exchanger for rating - Unit No III
3. Tut III - Design of Multi pass/Cross flow Heat Exchanger - Unit No III
4. Tut IV - Design of Condenser/Compact/Plate Heat Exchanger - Unit No I-V

* 1. Solution of any one tutorial by using CFD software.

2. Solution of any one tutorial using HTRI software for designing of heat exchanger.

Text Books: ***(As per IEEE format)***

1. Aurther P Frass, "Heat Exchanger design" 2nd Edition, John Wiley and Sons, New York.
2. T. Taborek, G. F. Hewitt and N. Afgan, "Heat Exchangers Theory and Practice" McGraw Hill Book Co.
3. Walker, "Industrial Heat Exchangers a Basic guide", McGraw Hill Book Co.

Reference Books: ***(As per IEEE format)***

1. Kern and Kraus, "Heat Exchanger Design Handbook"

2. Kuppan, "Heat Exchanger Design handbook"

3. "TEMA Standards"

Course Outcomes:

The student will be able to –

1. Select type of Heat exchanger for given application. Select/Design geometry of Heat exchanger for given application
2. Will understand how to select and use appropriate heat transfer and friction coefficient correlations for the case in hand;
3. Know how to land with appropriate solution for rating and sizing problems in heat exchanger design;
4. Deal with fouling of surfaces at design stage of heat exchangers;
5. Design common types of heat exchangers;

ME42118: POWER PLANT ENGINEERING

Credits: 03 **Teaching Scheme: 3 Hours / Week**

Unit I: Power Plants (8 Hrs)

Part A: Schematic Diagrams and relative merits of Steam, Gas, Diesel and Hydro Power Plants, Factors affecting Selection of site, Nuclear Power Plants Classification, Types of Various Reactors with working of various Components.

Part B: Present status of Power generation in India. Nuclear Power plants In India, Waste Disposal of nuclear power plants, VVER power plants.

Unit II: High pressure boilers and Improved Rankine Cycle (12 Hrs)

Part A: High Pressure Boilers**,** High pressure boilers types, construction and working, Principle of Fluidized bed combustion, Types of fluidized bed combustion boilers (CFBCB, PFBCB). Improved Rankine Cycle, Rankine Cycle with Reheating and Regeneration, Steam Power Plants with process heating (reheating, regeneration and combined reheat regeneration).

Part B: Recent trends in FBCB

Unit III: Essential Components of the power plants (6Hrs)

Part A: DM Plant, Air Preheater, superheater, Introduction to steam nozzles and steam turbines.

Part B: Equipments used for handling, storage, preparation, feeding, burning of coal fired boilers, Ash handling & dust collection, fuel treatment unit, nuclear safety standards.

Unit IV: Steam Condensers (8 Hrs)

Part A: Necessity of condensers, types of condensers, Dalton's law of partial pressures, condenser vacuum and vacuum efficiency, condenser efficiency, air pumps, capacity of air extraction pumps, , cooling water requirements.

Part B: Cooling towers and cooling ponds

Unit V: Economics of Power Generation (6 Hrs)

Part A: Load duration, load curves, demand factor, average factor, capacity factor, reserve factor, diversity factor, plant use factor, construction of load duration curves, effect of variable load on power plant design and operation. Selection of power plant from site to waste disposal, life cycle costing, Fuel costs, Present worth concept,

Part B: Project proposal preparation

Text Books

1. Arora, and Domkundwar "A Course in Power Plant Engineering", 5th Edition, Dhanpat Rai and Co
2. P. K. Nag, "Power Plant Engineering", Tata Mcgraw Hill, New Delhi
3. Yadav R "Steam and gas turbines and Power Plant Engineering",., Central publishing house

Reference Books

1. Rajput R. K. "Power Plant Engineering", , Laxmi Publication, New Delhi
2. Sharma P. C., "Power Plant Engineering", S. Kataria and sons, New Delhi
3. Wesisman and Eckart "Modern Power Plant Engineering" ,Prentice Hall of India
4. Wakil M. M "Power Plant Engineering", Tata McGraw Hill and Co., New Delhi
5. Rai G. D "Introduction to Power Plant Technology" ,Khanna Publishing

Course Outcomes: (Theory + Tut)

The student will be able to –

1. Compare different power plants, their present status and recent trends.
2. Do Mathematical analysis of Improved Rankine cycle and condenser
3. Demonstrate essential and supplementary Power plant components
4. Perform Testing of thermal power plant and data analysis to draw conclusions
5. Perform analysis for power plant economics.

42218 POWER PLANT ENGINEERING (Tutorial)

Credits:1 **Teaching Scheme: 1Hours / Week**

List of Tutorials:

1. Classification, present status and recent trends in power plants (CO1)
2. Classification, present status and recent trends of nuclear reactors (CO1)
3. Analysis based problem solving for Improved Rankine cycle and condenser (CO2)
4. Trial on diesel power plant for load performance (CO4)
5. Trial on Steam power plant for load performance (CO4)
6. Report writing based on visit to Thermal power plant (CO4)

Text Books

1. Arora, and Domkundwar "A Course in Power Plant Engineering", 5th Edition, Dhanpat Rai and Co
2. P. K. Nag, "Power Plant Engineering", Tata Mcgraw Hill, New Delhi
3. Yadav R "Steam and gas turbines and Power Plant Engineering",., Central publishing house

Reference Books

1. Rajput R. K. "Power Plant Engineering", , Laxmi Publication, New Delhi
2. Sharma P. C., "Power Plant Engineering", S. Kataria and sons, New Delhi
3. Wesisman and Eckart "Modern Power Plant Engineering" ,Prentice Hall of India
4. Wakil M. M "Power Plant Engineering", Tata McGraw Hill and Co., New Delhi
5. Rai G. D "Introduction to Power Plant Technology" ,Khanna Publishing

Course Outcomes: (Theory + Tut)

The student will be able to –

1. Compare different power plants, their present status and recent trends.
2. Do Mathematical analysis of Improved Rankine cycle and condenser
3. Demonstrate essential and supplementary Power plant components
4. Perform Testing of thermal power plant and data analysis to draw conclusions
5. Perform analysis for power plant economics.

ME 42111 TURBOMACHINES

Credits: 3 **Teaching Scheme: 3 Hours / Week**

Unit 1: Basics and Dimensional Analysis (12 Hours)

Part A:

1. Review of Fluid Mechanics
2. Velocity Triangles
3. Specific work equation
4. Efficiencies
5. Vane Congruent Flow and Deviations
6. Dimensional Analysis

Part B: Problems based on A

Unit 2: Centrifugal Machines (9 Hours)

Part A:

1. Basic Concepts
2. Analysis of centrifugal fans
3. Design of Fans
4. Operation of Fans
5. Centrifugal Pumps
6. Cavitation analysis

Part B: Problems based on A

Unit 3: Axial Machines (7 Hours)

Part A:

1. Axial Fans
2. Axial Compressors
3. Loss Determination
4. Off Design Analysis

Part B: Problems based on A

Unit 4: Hydraulic Turbines **(5 Hours)**

Part A:

1. Analysis of turbines

2. Design Methodology

3. Cavitation analysis

Part B: Problems based on A

Unit 5: Wind, Gas and Steam Turbines **(7 Hours)**

Part A:

1. Wind turbine analysis
2. Wind turbine design
3. Analysis of gas and steam turbines

Part B: Problems based on A

Text Books:

1. "Turbines Compressors and Fans", Yahya S. M., Tata McGraw Hill
2. "A Treatise on Turbomachines", G. Gopalakrishnan and D. Prithviraj, Scitech Publcns.
3. "Gas Turbine Theory", Saravanamuttoo, Cohen H., and Rogers GFC, Pearson

Reference Books:

1. "Theory of Hydraulic Machinery", Vasandani V. P., Khanna Publishers, Delhi
2. "Hydraulic Machines", Lal J.,Metropolitan Book Co., Delhi.

Course Outcomes:

The student will be able to –

1. Understand the basic principles of turbomachines and scaling laws
2. Analyse and design centrifugal machines, operating point analysis, cavitation
3. Analysis of axial compressors and estimation of performance at design and off-design points
4. Design and analysis of hydraulic turbines and cavitation check
5. Analysis of gas, steam and wind turbines

ME 42211 TURBOMACHINES (Tutorial)

Credits:1 **Teaching Scheme:1 Hour / Week**

List of Tutorials:

1. Specific work, angle calculations
2. Dimensional Analysis
3. Fan Design
4. Cavitation, Operation
5. Axial Compressor
6. Hydraulic Turbine design and analysis
7. Gas Turbine analysis
8. Wind Turbine design and analysis

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Text Books:

1. "Turbines Compressors and Fans", Yahya S. M., Tata McGraw Hill
2. "A Treatise on Turbomachines", G. Gopalakrishnan and D. Prithviraj, Scitech Publcns.
3. "Gas Turbine Theory", Saravanamuttoo, Cohen H., and Rogers GFC, Pearson

Reference Books:

1. "Theory of Hydraulic Machinery", Vasandani V. P., Khanna Publishers, Delhi
2. "Hydraulic Machines", Lal J.,Metropolitan Book Co., Delhi.

Course Outcomes:

The student will be able to –

1. Ability to analyse and design fans, pumps etc.
2. Analysis and design of water turbines
3. Analysis of cavitation in pumps and turbines
4. Gas turbines – analysis
5. Wind turbines – design and analysis

ME42117: INDUSTRIAL FLUID POWER

Credits: 03 **Teaching Scheme:** 03 Hours / Week

Unit 1: Introduction to Fluid Power and Source of Power (08 Hours)

Part A: Fluid power systems: Components, advantages, applications. Hydraulic fluids, Properties of fluids, selection of fluids, Sources of contamination and contamination control. Pumps: Types, classification, working and constructional details, characteristics Power units and accessories, Types of power units, reservoir assembly.

Part B: pressure switches, temperature switches, pipes, hoses, connectors, Seals Accumulators: Types, selection/design procedure, applications of accumulators.

Unit 2: Fluid Power Control (08 Hours)

Part A: Control of fluid power, pressure control, directional control, Flow control valves Direct operated and pilot operated relief valves, pressure reducing valve, Principle of flow control valves, pressure compensated, Temperature compensated flow control valves, directional control valves: types, constructional details, characteristics, centre positions. Cartridge valves

Part B: check valves, pilot operated check valves

Unit 3: Actuators and Hydraulic circuits (08 Hours)

Part A: Linear and Rotary actuators, types, constructional details, characteristics. Hydraulic circuits for different applications

Part B: symbols of fluid power components, trouble shooting

Unit 4: Pneumatics (08 Hours)

Part A: Filters, regulators, lubricators, mufflers, dryers. Direction control valves, rotary and reciprocating actuators, logic elements, pneumatic and electro pneumatic circuits for different applications

Part B: Compressors, selection of compressors, compressed air distribution system

Unit 5: System Design **(08 Hours)**

Part A: Design of hydraulic/pneumatic circuits for practical applications, Selection of different components

Part B: Study of catalogues of pumps and valves.

Text Books:

1. A. Esposito - 'Fluid Power with application', 6th Edition, Pearson Education, New Delhi.
2. Peter Croser, Frank Ebel, 'Pneumatics', Edition: 10/2002, Festo Didactic GmbH & Co.

Reference Books:

1. D. A. Pease – 'Basic Fluid Power', Prentice hall
2. J. Pippenger, T. Hicks; 'Industrial Hydraulics', McGraw Hill Book Co.
3. Yeaple F; 'Fluid Power Design Handbook'; Marcel Dekker, New York.
4. Vickers ; Industrial Hydraulics Manual
5. D. Merkle, B. Schrader, M. Thomes; 'Hydraulics'; Festo Didactic GmbH & Co
6. ISO 1219; Fluid Systems and components, Graphic Symbols
7. Sullivan James A; 'Fluid Power Theory &Applications'; Prentice Hall, New Jercy

Course Outcomes:

The student will be able to –

1. Analyze Hydraulic Systems.
2. Develop Simple Hydraulic Circuits.
3. Select hydraulic components from data sheets for simple hydraulic circuits.
4. Analyze Pneumatic Systems
5. Develop Simple Pneumatic Circuits.

ME42217: INDUSTRIAL FLUID POWER (Tutorial)

Credits: 01 **Teaching Scheme: 01 Hours / Week**

List of Tutorials:

1. Accumulator Sizing
2. Pump And Motor Efficiencies
3. Meter In Circuit
4. Meter Out Circuits
5. Special Speed Control Circuits
6. Hi Lo Circuit
7. Regenerative Circuit
8. Cascaded Pneumatic Circuit
9. Pump Data Sheets
10. Data Sheets For Valves
11. Hydraulic Circuit Design
12. Hydraulic Component Selection
13. Pneumatic Circuit Design
14. Trouble Shooting

Text Books:

1. A. Esposito - 'Fluid Power with application', 6th Edition, Pearson Education, New Delhi
2. Peter Croser, Frank Ebel, 'Pneumatics', Edition: 10/2002, Festo Didactic GmbH & Co.

Reference Books:

1. D. A. Pease – 'Basic Fluid Power', Prentice hall
2. J. Pippenger, T. Hicks; 'Industrial Hydraulics', McGraw Hill Book Co.
3. Yeaple F; 'Fluid Power Design Handbook'; Marcel Dekker, New York.
4. Vickers ; Industrial Hydraulics Manual
5. D. Merkle, B. Schrader, M. Thomes; 'Hydraulics'; Festo Didactic GmbH & Co
6. ISO 1219; Fluid Systems and components, Graphic Symbols
7. Sullivan James A; 'Fluid Power Theory &Applications'; Prentice Hall, New Jercy

Course Outcomes:

The student will be able to –

1. Analyze Hydraulic Systems.
2. Develop Simple Hydraulic Circuits.
3. Select hydraulic components from data sheets for simple hydraulic circuits.
4. Analyze Pneumatic Systems
5. Develop Simple Pneumatic Circuits.

ME40101 : DESIGN OF MECHANICAL SYSTEMS

Credits: 03 **Teaching Scheme: Theory 3 Hrs/Week**

Unit 1: Worm Gears (6 Hours)

Part A:

Worm Gears : Worm and worm gear terminology and geometrical relationship, Types of worm and worm gears, Standard dimensions, Force analysis of worm gear drives, Friction in Worm gears and its efficiency, Worm and worm-wheel material, Strength and wear ratings of worm gears as per IS-7443-1974 , Thermal consideration in worm gear drive

Part B:

Types and Constructional details of worm & worm Gear, Methods of lubrication and Manufacturing, Types of failures in worm gearing.

Unit 2: Design of Cylinders and Pressure vessels: (8 Hours)

Part A:

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- categories and types of welded joints – weld joint efficiency – Corrosion, erosion and protection vessels, stresses induced in pressure vessels, materials of construction. 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.

Part B:

Types of vessel supports and their design, Types of gaskets and their constructional details.

Unit 3: Design of Material Handling System (8 Hours)

Part A:

Material handling system concept, basic principles, objectives of material handling system, unit load and containerization. Flat belt and troughed belt conveyors, capacity of conveyor, rubber covered and fabric ply belts, belt tensions, types of conveyor pulleys, types of belt idlers, types of tension take-up systems, power requirement of horizontal and inclined belt conveyors.

Part B:

Introduction to screw conveyors, capacity of screw conveyor, power requirements, types of screw flights, feed & discharge arrangements.

Unit 4: Optimum Design and Statistical consideration in design (8 Hours)

Part A:

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 of simple machine elements like tension bar, transmission shaft, helical spring– Introduction to optimum design with redundant specifications.

Statistical consideration in design: Frequency distribution – Histogram and frequency polygon – Normal distribution – Units of measurement of central tendency and dispersion – Standard variable – population combinations – Design and natural tolerances –Design for assembly- Statistical analysis of tolerances – Mechanical reliability and factor of safety.

Part B:

Optimum Design of Gear, Clutch, Brake.

Unit 5: Design of I.C. Engine components (8Hours)

Part A:

Introduction to selection of material for I. C. engine components, Design of cylinder and cylinder head, construction of cylinder liners, design of piston and piston-pins, piston rings, design of connecting rod, design of crank-shaft and crank-pin.

Part B:

Fly wheel design, Design of valve gear system.

Text Books: ***(As per IEEE format)***

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. Ray T. K., "Mechanical Handling of Materials", 2005, Asian Book Pvt. Ltd., Delhi

Reference Books: ***(As per IEEE format)***

1. IS-2825-1969 Code for unfired pressure vessels
2. Rudenko N.,"Material Handling Equipment", PEACE Publishers, Moscow.
3. Johnson R.C., "Optimum Design of Mechanical Elements" John Wiley & Sons.Inc., London.
4. "Design Data", P.S.G. College of Technology, Coimbatore.
5. Joshi M. V., Mahajani V. V., "Process Equipment Design", MacMillan India, Ltd.,Delhi
6. Ullman D.G., "The Mechanical Design Process", McGraw Hill International Editions
7. John F Harvey, "Theory and Design of Pressure vessels", CBS publishers & distributors, Delhi
8. Willium C. Orthwine, "Machine Components Design I and II", Jaico Publishing House, Mumbai.

Course Outcomes:

The student will be able to –

1. Design as per IS code the Mechanical components like worm gears, Unfired Pressure vessels.
2. Design components of IC Engine.
3. Design Mechanical systems like IC Engine, Belt Conveyor, Pressure vessels.
4. Apply statistical considerations in designing engineering component or product.
5. Optimize the Design for Mechanical Elements like Shaft, Gear, and Spring.

ME40103-CAD/CAM/CAE

Credits:03 **Teaching Scheme: 3 Hours / Week**

Unit 1: Computer Graphics **(6 Hours)**

Part A: Introduction to Basic Transformations - Translation, Rotation, Scaling, Reflection, Homogenous Coordinate system , Concatenated Transformation, Mapping of Geometric Models, Inverse Transformations.

Part B: Projections - Orthographic, Isometric, Oblique, Perspective.

Unit 2: Geometric Modelling **(10 Hours)**

Part A:

Curves

Introduction to Parametric representation of curves and its advantages. Analytic Curves- Line, Circle, Parabolas, Hyperbolas, Ellipses, Conics. Synthetic Curves- Hermite Cubic Spline, Bezier Curve, B-Spline Curve.

Surfaces

Introduction to Parametric representation of Surfaces. Analytic Surfaces-Plane, Ruled,

Tabulated, Revolved surfaces. Synthetic Surfaces- Bezier Surface, B-Spline Surface

Solids

Introduction to different volume modeling techniques - Constructive Solid Geometry, Boundary Representation, Pure Primitive instancing, Spatial Occupancy Enumeration, Feature Based Modelling.

Part B: curve manipulation

Unit 3: Finite Element Analysis **(8 Hours)**

Part A: Introduction to Finite Element Modelling, Coordinate and Shape function, Potential Energy Approach, Assembly of Global Stiffness Matrix and Load Vector, Properties of Stiffness Matrix, Finite Element Equations.

One dimensional Finite Element Analysis

Linear bar element, Quadratic bar element, frame element. Development of Finite Element Models of discrete systems like linear elastic spring, Torsion of Circular Shaft.

Part B: Galerkin's Approach

Unit 4: Two Dimensional Finite Element Analysis **(8 Hours)**

Part A: Three noded triangular elements, Development of Finite Element Models for plane stress, plain strain, Axisymmetric stress analysis applications.

Part B: Qudartic Shape function

Unit 5: Computer Aided Manufacturing **(8 Hours)**

Part A: Introduction, Integrating CAD, NC and CAM, Preparing CAD data for NC, The Basic components of NC System, Machine Axes and Coordinate system, Positioning System, NC Motion Control System, Point-to-Point and Continuous Path Machining, The NC Procedure, Machine Zero, Job Zero, Manual part Programming (G and M code), The APT Language.

Part B: Rapid Prototyping

Overview of Rapid Prototyping, the Basic Process (RP Sequence), Rapid Prototyping Techniques , Applications of Rapid Prototyping , Benefits of RP

Text Books: ***(As per IEEE format)***

1. Ibrahim Zeid, "Mastering CAD/CAM", Tata McGraw Hill

2.Groover M. P., "Automation, production systems and computer integrated manufacturing" Prentice Hall of India

3.Chandrupatla T. R. and Belegunda A. D., "Introduction to finite elements in engineering", Prentice Hall of India

4. P.N. Rao -CAD/CAM, Principles & Applications-Tata McGraw Hill

Reference Books: ***(As per IEEE format)***

1. Ibrahim Zeid, "CAD/CAM - theory and practice", Tata McGraw Hill.

2. Segerling L. J., "Applied finite elements analysis", John Wiley and Sons.

3. Gebhardt A., "Rapid Prototyping", Hanser Publisher.

4. David F. Rogers, J. Alan Adams, Mathematical Elements for Computer Graphics, Tata McGraw-Hill Publishing Company Ltd., New Delhi-8.

Course Outcomes:

The student will be able to –

1. Able to use the underlying algorithms, mathematical concepts, supporting computer graphics. These include but are not limited to: Composite2D & 3D homogeneous matrices for translation, rotation, and scaling transformations.
2. Able to use and demonstrate fundamental knowledge of CAD/CAM.
3. Able to:─ Understand the basic theory behind the finite element method
4. Able to : ─ Use the finite element method for the solution of practical engineering problems
5. Able to Create the G-code program (with a standard computer post processor) of a work-piece on a standard numerically controlled machine tool with CNC controls.

ME40301:: DESIGN OF MECHANICAL SYSTEMS LAB

Credits:01 **Teaching Scheme: Laboratory 2 Hours / Week**

List of Practicals:

Design Project

The term work shall consist of ONE design project. The design project shall consist of sheet involving assembly drawing with a part list & overall dimensions and sheets involving drawings of individual components with manufacturing tolerances, surface finish symbols, geometric tolerances specified on it so as to make it working drawing. A design report giving all necessary calculations of the design of components and assembly should be submitted in a separate file. Projects shall be in the form of design of mechanical systems such as -

- System involving worm gear box,
- Pressure vessel ,
- I C Engine Design,
- Material Handling System,
- Reciprocating Compressor Design, etc.

Design Assignments:

Three assignments based on any *one* of the following topics from each of the three groups.

A Case study approach is to be used.

Group I: Sr. No. 1 to 3, Group II: Sr. No. 4 to 6, Group III: Sr. No. 7 to 9. 1.

1. Modern engineering materials and their applications / evaluation methods for material selection.
2. Piping design.
3. Aesthetic and Ergonomic Considerations in Design
4. Value engineering
5. Concurrent engineering
6. Reverse engineering.
7. Design for Manufacturing and Assembly.
8. Design of Crankshaft for IC Engine
9. Designs in relation to Patents, Trade Mark and Copy Right.

Text Books: ***(As per IEEE format)***

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
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3. Johnson R.C., "Optimum Design of Mechanical Elements" John Wiley & Sons.Inc., London.
4. "Design Data", P.S.G. College of Technology, Coimbatore.
5. Joshi M. V., Mahajani V. V., "Process Equipment Design", MacMillan India, Ltd.,Delhi
6. Ullman D.G., "The Mechanical Design Process", McGraw Hill International Editions
7. John F Harvey, "Theory and Design of Pressure vessels", CBS publishers & distributors, Delhi
8. Willium C. Orthwine, "Machine Components Design I and II", Jaico Publishing House, Mumbai.

Course Outcomes:

The student will be able to –

1. Design Mechanical systems like IC Engine, Belt Conveyor, Pressure vessels and write design report.
2. Design Mechanical systems considering Aesthetics and Ergonomic considerations in design.
3. Design components and assembly applying DFMA principles.

ME40303 CAD/CAM/CAE LAB

Credits:01 **Teaching Scheme: 2Hours / Week**

List of Practicals:

1. Write a program to fit Bezier / B-Spline curve for given control points. OR Write a program to find points on Bezier / B-Spline surfaces.
2. Part Modeling, Assembly Modeling and preparation of Working Drawings from assembly model
3.Analyzing 1D problem using Finite Element Method of any one mechanical component.
4 .Stress and deflection analysis of any three Mechanical component consisting of 2-D and 3-D elements using finite element package.
5. Analyzing Fatigue Failure of any one mechanical component.
6. Kinematic analysis of any mechanism using motion bundle software
7. Programming and Manufacturing of one job on CNC Machine

Text Books: ***(As per IEEE format)***

1. Ibrahim Zeid, "Mastering CAD/CAM", Tata McGraw Hill
2.Groover M. P., "Automation, production systems and computer integrated manufacturing" Prentice Hall of India
3.Chandrupatla T. R. and Belegunda A. D., "Introduction to finite elements in engineering", Prentice Hall of India
4. P.N. Rao -CAD/CAM, Principles & Applications-Tata McGraw Hill

Reference Books: ***(As per IEEE format)***

1. Ibrahim Zeid, "CAD/CAM - theory and practice", Tata McGraw Hill.
2. Segerling L. J., "Applied finite elements analysis", John Wiley and Sons.
3. Gebhardt A., "Rapid Prototyping", Hanser Publisher.
4. David F. Rogers, J. Alan Adams, Mathematical Elements for Computer Graphics, Tata McGraw-Hill Publishing Company Ltd., New Delhi-8.

Course Outcomes:

The student will be able to –

1. Do geometric modeling of Mechanical component
2. Do analysis of simple Mechanical components
3. Use a commercial FE-package
4. Analaze simple mechanisms
5. Write G & M code for simple mechanical parts

ME47303 :: PROJECT STAGE-2

Credits: 04 **Teaching Scheme : 2 Hours / Week**

The project work could be of the following nature: Design/development and Fabrication of models. Machines and prototypes based on new ideas, robotic and automation systems. Experimental set ups, test rigs/ equipments.

Thermal Systems

Energy audit/conservation studies

Extensive computational analysis of problems relevant to mechanical engineering,

CAD/CA M/CAE

Modeling/simulation of product(s), mechanism(s) or system(s) and its validation or

Comparison with available bench marks I results

The project work shall be taken up individually or in a group consisting of not more than 4 students.

A report containing maximum 30 pages shall be submitted based on the background. need and scope of the project. project specifications, activities involved in the project and activity plan. study of literature and basic theory. and work completed (if any).

Guidelines:

- Report shall be typed or printed.
- Figures and tables shall be on separate pages and attached at respective positions.
- Project title and approval sheets shall be attached at the beginning of the report followed by index and synopsis of the project.

- References shall be mentioned at the end followed by appendices (if any).
- When a group of students is doing a project. names of all the students shall be

included on every certified report copy.

- Each group of students shall submit two copies of reports to the

institute and one copy shall be prepared for each individual student.

Course Outcomes:

The student will be able to –

1) Student will be able to define methodology for executing the project work

2) Student will be able to apply theoretical concepts for solving the project problem

3) Students will be able to decide and apply the manufacturing techniques and instrumentation for the development of working / process model

ME47304:: PROJECT STAGE-3

Credits: 06 **Teaching Scheme: 3 Hours / Week**

The project work could be of the following nature:

Design/development and Fabrication of models. Machines and prototypes based on new ideas, robotic and automation systems, Experimental set ups. Test rigs equipments.

Thermal Systems

Energy audit conservation studies

Extensive computational analysis of problems relevant to mechanical engineering.

CAD/CAM/CAE

Modeling/simulation of product(s). mechanism(s) or system(s) and its validation or comparison with available bench marks I results

The project work shall be taken up individually or in a group consisting of not more than 4 students.

A report containing maximum 50 pages shall be submitted based on the background. Need and scope of the project, project specifications, activities involved in the project and activity plan. Study of literature and basic theory, and work completed (if any)

Guidelines:

1. Report shall be typed or printed.

2. Figures and tables shall be on separate pages and attached at respective positions.

3. Project title and approval sheets shall be attached at the beginning of the report followed by index and synopsis of the project.

4. References shall be mentioned at the end followed by appendices (if any).

5. When a group of students is doing a project, names of all the students shall be included on every certified report copy.
Each group of students shall submit two copies of reports to the institute and one copy shall be prepared for each individual student.

Course Outcomes:

The student will be able to –

1. Student will be able to develop the procurement skills
2. Students will be able to assemble and demonstrate the working model 3)Students will be able to develop skills of technical report writing and presentation