B. Tech. Degree

IN

MECHANICAL ENGINEERING

SYLLABUS
FOR
CREDIT BASED CURRICULUM

(For Students Admitted in 2011 – 2012)

DEPARTMENT OF MECHANICAL ENGINEERING

NATIONAL INSTITUTE OF TECHNOLOGY

TIRUCHIRAPPALLI - 620 015

TAMIL NADU, INDIA

VISION AND MISSION OF THE INSTITUTE

VISION

- To provide valuable resources for industry and society through excellence in technical education and research.

MISSION

- To offer state-of-the-art undergraduate, postgraduate and doctoral programmes.
- To generate new knowledge by engaging in cutting-edge research.
- To undertake collaborative projects with academia and industries.
- To develop human intellectual capability to its fullest potential.

VISION AND MISSION OF THE DEPARTMENT

VISION

- To be a centre of excellence in Mechanical Engineering where the best of teaching, learning and research synergize.

MISSION

- Prepare intellectually sharp and ethically responsible graduate and post-graduate engineers for global requirements by providing quality education.
- Conduct basic and applied research, provide consultancy services and cultivate the spirit of entrepreneurship.
- Develop the habit of continuous learning, team work and fulfill the societal needs.

Programme Educational Objectives (PEOs)

The Programme Educational Objectives (PEO) of the under-graduate programme Bachelor of Technology (B.Tech.) in Mechanical Engineering offered by National Institute of Technology (NIT) Tiruchirappalli, INDIA are:

- PEO1: Graduates will be successful mechanical engineers in the industry or in technical or professional careers.
- PEO2: Graduates will continue to constantly learn in the emerging technology and advanced field of study.

Programme Outcomes (POs)

On successful completion of the under-graduate programme B.Tech. Mechanical Engineering, the Mechanical Engineering graduates will,

PO1 Apply knowledge of mathematics, science and engineering to arrive solutions.
PO2 Identify, formulate and analyze engineering problems through technical literature.
PO3 Design a component, a process and a system to meet desired needs considering economic, environmental, social, ethical, health and safety, manufacturability and sustainability.
PO4 Conduct experiment, analyze and interpret data to arrive valid conclusions.
PO5 Use the techniques, skills, and modern engineering tools for modeling and prediction of problems by understanding the limitations.
PO6 Recognize the importance of health and safety, societal, cultural responsibility in the design and implementation of engineering projects.
PO7 Know and apply societal and environmental context to engineering solutions for sustainable development.
PO8 Apply the standards and professional ethics in engineering practice.
PO9 Function effectively as a member or leader of a team.
PO10 Express effectively, comprehend and write reports on the engineering activities.
PO11 Apply engineering and management principles to manage projects in multidisciplinary environments.
PO12 Engage themselves in life-long learning by recognizing the need and technological changes.

CURRICULUM

The total credits required for completing the B.Tech. Programme in Mechanical Engineering is 180 (45 + (135)).

SEMESTER III

CODE	COURSE OF STUDY	L	T	P	C
MA211	Special Functions and Statistics	3	0	0	3
EE223	Applied Electrical Engineering	2	0	2	3
EC217	Applied Electronics Engineering	2	0	2	3
PR221	Production Technology – I	3	0	0	3
CE281	Strength of Materials	3	0	0	3
ME203	Engineering Thermodynamics	3	1	0	4
Practical					
CE283	Strength of Materials Lab	0	0	2	1
ME205	Machine Drawing	0	0	6	2
	Total	**16**	**1**	**12**	**22**

SEMESTER IV

CODE	COURSE OF STUDY	L	T	P	C
MA208	Fourier Series and Partial Differential Equations	3	0	0	3
MT252	Engineering Metallurgy	3	0	0	3
PR222	Production Technology – II	3	0	0	3
ME202	Thermal Engineering	3	0	0	3
ME204	Mechanics of Machines – I	3	1	0	4
ME206	Fluid Mechanics	3	1	0	4
Practical					
CE290	Fluid Mechanics Lab	0	0	2	1
MT262	Metallurgy Lab	0	0	2	1
PR232	Production Process Lab	0	0	3	2
ME208	Thermal Engineering Lab – I	0	0	3	2
	Total	**18**	**2**	**10**	**26**

SEMESTER V

CODE	COURSE OF STUDY	L	T	P	C
MA301	Numerical Methods	3	0	0	3
IC 315	Mechatronics	3	0	0	3
ME 301	Compressible Flow and Jet Propulsion	3	0	0	3
ME 303	Heat and Mass Transfer	3	0	0	3
ME 305	Mechanics of Machines – II	3	1	0	4
ME 307	Analysis and Design of Machine Components	3	0	0	3
Practical					
IC 317	Mechatronics Lab	0	0	2	1
ME309	Dynamics Lab	0	0	3	2
ME 311	Production Drawing and Cost Estimation	1	0	2	2
	Total	**19**	**1**	**7**	**24**

SEMESTER VI

CODE	COURSE OF STUDY	L	T	P	C
ME302	Turbomachines	3	0	0	3
ME304	Automobile Engineering	3	0	0	3
ME306	Design of Mechanical Drives	3	0	0	3
ME308	Computer Aided Design and Drafting	3	0	0	3
ME310	Refrigeration and Air Conditioning	3	0	0	3
ME3E1	Elective – I	3	0	0	3
Practical					
ME312	Thermal Engineering Lab II	0	0	3	2
ME314	Automobile Engineering Lab	0	0	3	2
ME316	Computer Aided Design and Drafting Practice	0	0	2	1
	Total	**18**	**0**	**8**	**23**

SEMESTER VII

CODE	COURSE OF STUDY	L	T	P	C
HM401	Industrial Economics	3	0	0	3
ME403	Power Plant Engineering	3	0	0	3
ME405	Metrology and Quality Control	3	0	0	3
ME407	Oil Hydraulics and Pneumatics	3	0	0	3
ME4E2	Elective – II	3	0	0	3
ME4E3	Elective – III	3	0	0	3
Practical					
ME409	Metrology Lab	0	0	2	1
ME411	Comprehensive Viva-voce	0	3	0	3
ME413	Project Work Phase – I	0	1	0	0
	Total	**18**	**4**	**2**	**22**

SEMESTER VIII

CODE	COURSE OF STUDY	L	T	P	C
HM402	Management Principles and Concepts	3	0	0	3
PR472	Resource Management Techniques	3	0	0	3
ME4E4	Elective – IV	3	0	0	3
ME4E5	Elective – V	3	0	0	3
ME410	Project Work Phase – II	0	0	15	6
	Total	**12**	**0**	**15**	**18**

Credits for I Year	- 45
Credits for Mechanical Engineering (III to VIII Semester)	- 135
Total Credits	- 180

LIST OF ELECTIVES

Elective – I:

SEMESTER VI

CODE	COURSE OF STUDY	L	T	P	C
ME352	Finite Element Method	3	0	0	3
ME354	Advanced I.C. Engines	3	0	0	3

Elective – II & III:

SEMESTER VII

CODE	COURSE OF STUDY	L	T	P	C
ME451	Industrial Safety	3	0	0	3
ME453	Optimization in Engineering Design	3	0	0	3
ME455	Computational Fluid Dynamics	3	0	0	3
ME457	Design of Gears and Cams	3	0	0	3
ME 459	MEMS Devices – Design and Fabrication	3	0	0	3
ME461	Welding Engineering	3	0	0	3
HM401	Corporate Communication	3	0	0	3
	(or)				
	Any one Elective from other Departments				

Elective – IV & V:

SEMESTER VIII

CODE	COURSE OF STUDY	L	T	P	C
ME452	Industrial Robotics	3	0	0	3
ME454	Combustion Engineering	3	0	0	3
ME456	Dynamics of Machinery	3	0	0	3
ME458	Renewable Energy	3	0	0	3
ME460	Advanced Machining Processes	3	0	0	3
	(or)				
	Any one Elective from other Departments				

SEMESTER III

MA211 SPECIAL FUNCTIONS AND STATISTICS (3 – 0 – 0) 3

Course Objectives:

1. To impart knowledge on solving ordinary differential equations and partial differential equations using Laplace transform.
2. To acquire knowledge on Bessel's equation, Poisson and Normal distributions, Moment generating function etc and to apply the same in solving the engineering problems.

Laplace Transforms of standard functions – Unit Step function, Dirac delta, function, derivatives and integrals - Inverse Laplace Transform - convolution theorem – Periodic functions - Application to ordinary differential equations and simultaneous equations with constant coefficients and integral equations.

Gamma and Beta functions - Forbenius method of finding series solution of ordinary differential equation.

Bessel's equation – Bessel functions - Recurrence formulae - Orthogonality property-Generating function. Legendre's equation- Legendre polynomials - Rodrigue's formula-Orthogonality property - Generating function - Recurrence relations.

Probability - conditional probability - Bayes' theorem – Random variable – density and distribution functions – Expectation - Binomial, Poisson and Normal distributions.

Moment generating function - Characteristic function – Chebyshev's inequality - Law of large numbers - Central Limit Theorem.

References:

1. Grewal, B.S., *Higher Engineering Mathematics*, Khanna Publishers, 6th ed. 2001.
2. Gupta, S.C., and Kapoor, V.K., *Fundamentals of Mathematical Statistics*, Sultan Chand and Sons, 2002.
3. Venkataraman, M. K., *Higher Mathematics for Engineering and Science*, National Publishing Company, 1997.

Course Outcomes:

On successful completion of the course, the student will be able to,

1. Demonstrate the ability of using Laplace transform in solving the ordinary differential equations and partial differential equations
2. Identify the relationship between gamma and beta functions and apply the various distributions like binomial, Poisson and normal distributions in engineering applications
3. Apply the moment generating function to determine its probability distribution

EE223 APPLIED ELECTRICAL ENGINEERING (2 – 0 – 2) 3

Course Objectives:

1. To understand the basics concepts of electric & magnetic circuits.
2. To learn the principle of operations of electrical machines.
3. To impart knowledge on different type of drives for various applications in industries.

Asynchronous Machines: Three phase induction motors – Principle of operation – Cage and Slip ring rotors.

Torque – Slip Characteristics - Equivalent Circuit – Starting and Speed Control.

Single Phase induction motors – Types – Applications – Universal Motor.

Selection of Drives: Electric drives – Individual and Group drives – Factors governing selection of drives – Motors for domestic uses.

Cranes, Lifts, General Factory, Textile Mill, Paper Mill, Mining Work, Cement Mill, Machine Tools, Belt Conveyors, Ships, Refrigeration and Air Conditioning.

References:

1. Theraja, B.L., *Electrical Technology*, Vol – 2, S. Chand & Company, 1997.
2. Gupta, J.B., *A Course in Electrical Power*, S.K. Kataria & Sons, 1997.
3. Hughes, E., *Electrical Technology*, E.L.B.S. 1996.
4. Partab, H., *Art & Science of utilization of Electrical Energy*, Dhanpat Rai & Sons, 1997.

Course Outcomes:

On completion of the course, the student will will be able to,

1. Differentiate the synchronous motors from the three phase induction motor and their control.
2. Identify various applications of three phase and single phase induction machines.
3. Recognize and select the different type of drives for various applications in industries.

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EC217 APPLIED ELECTRONICS ENGINEERING (2 – 0 – 2) 3

Course Objectives:

1. To impart knowledge on different kinds of amplifiers.
2. To understand the concepts of Digital Circuits, Coupled amplifier, Multiplexers and Demultiplexers.

Amplifier circuits – R.C. Coupled, Transformer Coupled, Direct Coupled; Differential amplifiers.

Concept of negative feed-back; Feed-back amplifiers. Applications of operational amplifiers.

Inverting and non-inverting amplifiers; Differentiator – Multiplier - Divider, Comparator - VI and IV converter.

Digital Circuits – D/A and A/D – Types; Sample and Hold circuit - Multiplexers, Demultiplexers, Decoder and Encoders.

Practice on R.C. Coupled amplifier, OP amp, Multiplexers and Demultiplexers, SCR and Applications, Power supply and Regulator.

References:

1. Sedra, A.S. and Smith, K.C., *Micro Electronic Circuits*, Oxford University Press, 2004.
2. Millman and Halkias, *Integrated Electronics*, Tata McGraw -Hill, 1998.
3. Donald A. Neamen, *Electronic Circuit Analysis and Design*, Tata McGraw- Hill, 2002.

Course Outcomes:

On completion of the course, the student will will be able to,

1. Demonstrate different kind of amplifiers, operational amplifiers and feedback circuits.
2. Recognize the different types of converters and their contributions in various circuits.
3. Construct and analysis of multiplexers, demultiplexers, decoders and encoders.

PR221 PRODUCTION TECHNOLOGY – I (3 – 0 – 0) 3

Course Objectives:

1. To learn the various methods and types of castings, welding processes, sheet metal forming, plastics.
2. To impart knowledge on selection of suitable manufacturing process for the typical component.

Moulding sands - Types and Properties, patterns - types of patterns, selection of patterns - pattern allowances - Classifications of castings - according to mould materials and moulding methods. Special casting techniques - Fettling and finishing of castings - defects in castings.

Classification of welding process: Principle of Gas welding, Arc welding, resistance welding, Solid State Welding, Thermochemical welding and radiant energy welding - Brazing and soldering - thermal cutting of metal/alloys.

Forging: Classification of forging processes - forging processes - forging defects and inspection. Rolling: Classification of rolling processes - rolling mill - rolling of bars and shapes. Extrusion: Classification of extrusion processes - extrusion equipments - examples.

Drawing: Drawing of rods, wires and tubes. Sheet metal forming methods: Shearing, Blanking, Bending, Stretch Forming, deep forming. Spinning: Spinning processes.

High Velocity Forming: Explosive forming, Electro hydraulic forming - magnetic pulse forming - pneumatic - mechanical high velocity forming. Plastics Working: Types of plastics - plastic moulding processes.

References:

1. Jain R.K., *Production Technology*, Khanna Publishers, 2001.
2. Hajra Choudhry, *Elements of Workshop Technology***,** Vol – II Media Promoters & Publishers, 1994.
3. *Production Technology by HMT*, Tata McGraw-Hill, 2002.
4. Chapman, W.A.J., *Workshop Technology***,** Vol - II, Oxford & IBH Publishing Co. Ltd., 1986.

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

1. Recognize the different types of casting process.
2. Select suitable manufacturing process for typical components.
3. Describe the various welding process.
4. Explain the concept of forging, rolling process and drawing.

CE281 STRENGTH OF MATERIALS (3 - 0 - 0) 3

Course Objectives:

1. To develop the theoretical basis about the stress, strain and elastic modulus concepts in various components.
2. To understand the mechanical behavior of materials.
3. To familiarize about finding shear force, bending moment, deflection and slopes in various types of beams with different load conditions
4. To enable students to solve practical problems related to springs and shafts.

Axial and shear stresses and strains – Elasticity, Hook's law – Lateral strain – Poisson's ratio – Volumetric strain – Elastic constants – Stress in composite bars. Strain energy impact and suddenly applied loads.

Thin cylindrical and spherical shells subjected to internal pressure. Principal stresses and their planes. Plane of maximum shear – Mohr's circle of stresses. Thick cylinders – Lame's equation, shrink fit. Compound cylinders.

Shear force and bending moment diagrams for beams subjected to different types of loads – Theory of simple bending and assumptions.

Leaf spring, shear stress. Deflection – The moment area method, Macaulay's method – superposition (statically determinate beams only).

Torsion of solid and hollow circular shafts – Power transmission, strength and stiffness of shafts. Stress and defection in open helical spring.

References:

1. Timoshenko, S.P., Gere, M.J., *Mechanics of Materials*, C.B.S., Publishers, 1980.
2. Ramamurtham, S., *Strength of Materials,*, Dhanpat Rai Publications, 2005.
3. Popov, E.P., *Engineering Mechanics of Solids*, Prentice-Hall, 1999.

Course Outcomes:

On successful completion of the course, the student will be able to,

1. Observe the different types of material behaviour such have elastic, plastic, ductile and brittle to predict the strength of materials.
2. Visualize the concept of moment of inertia for different shapes.
3. Apply shear force and bending moment diagrams to analyse the resistance offered by the beam and able to solve practical problems in real world scenario.

ME203 ENGINEERING THERMODYNAMICS (3-1-0) 4

Course Objectives:

1. To learn the principles of work and energy.
2. To acquire knowledge about the fundamentals of thermodynamic laws, concepts and principles.
3. To understand the principles of various cycles and to apply the thermodynamic concepts in various applications like IC engines and Air conditioning systems

Review of basic concepts of thermodynamics, properties of pure substances - First law applied to control mass, control volumes. First law of thermodynamics steady flow energy equation - applications of SFEE - uniform state, uniform flow.

Second law statements - irreversible processes, Carnot theorem, Clausius Inequality — entropy, entropy change for pure substances – T-S diagram, entropy change applied to control mass, control volume-availability and irreversibility.

Vapour power cycles - Rankine cycle - Effect of pressure and temperature on rankine cycle - Reheat cycle - Regenerative cycle - Air standard power cycles - Assumptions regarding air standard cycles - Otto , Diesel , dual , Stirling and Brayton cycles.

Thermodynamic relations : Partial derivatives - Maxwell relations - Clapeyron equation, entropy of a pure substance - entropy change of an ideal gas - the ideal gas - Behavior of real gases - equations of state. Isothermal and adiabatic compressibility.

Mixture of non-reacting gases - Dalton's and Amalgam's model - calculation of C_p , C_v , R and U , h and s changes for gas mixtures fuels and combustion - combustion chemistry - calculation of air fuel ratio - exhaust gas analysis.

References:

1. Sonntag, R.E., Borgnakke, C., and Van Wylen, G.J., *Fundamentals of Thermodynamics,* 6th ed., John Wiley, 2003.
2. Cengal, Y.A and Boles, M.A, *Thermodynamics: An Engineering Approach,* 5th ed., McGraw-Hill, 2006.
3. Nag, P.K., *Engineering Thermodynamics*, 3rd ed., Tata McGraw-Hill, 2005.

Course Outcomes:

On successful completion of the course, the student will be able to,

1. Define the fundamentals of the first and second laws of thermodynamics and explain their application to a wide range of systems.
2. Analyze the work and heat interactions associated with a prescribed process path and to perform a analysis of a flow system.
3. Evaluate entropy changes in a wide range of processes and determine the reversibility or irreversibility of a process from such calculations.

CE283 STRENGTH OF MATERIALS LAB (0 – 0 – 2) 1

Course Objectives:

1. To understand the procedure of doing different tests like hardness, compression, torsion, tension and impact etc in various materials
2. To impart knowledge about the testing of springs and beams and behavior of materials.

Deflection test on springs, steel bar, cantilever beams, wooden beams.
Torsion test on different grades of steel.
Hardness test.
Impact test.

Course Outcomes:

On successful completion of the course, the student will be able to,

1. Describe the behavior of materials upon normal external loads.
2. Predict the behavior of the material under impact conditions.
3. Recognize the mechanical behavior of materials.

ME205 MACHINE DRAWING (0 - 0 - 6) 2

Course Objectives:

1. To understand and apply national and international standards while drawing machine component.
2. To understand the concept of various tolerances and fits used for component design
3. To familiarize in drawing assembly, orthographic and sectional views of various machine components.

Standardization - Interchangeability - Selective Assembly - Tolerance. Tolerance of form and position - grades of tolerance - fits -Standard tolerances - Machining symbols - surface finish indication - Functional and manufacturing datum.

Shaft Couplings: rigid, flexible: cotter joints , knuckle joints, Hook's joints. Bearings - Journal - Footstep, thrust or Collar bearing; Plummer block ; Pulleys for flat belts, V-belt and rope. Engine parts - Stuffing box, Connecting rod, Atomizer, spark plug, fuel injection pump. Valves - stop valve - safety valve, relief valve and non-return valve. Machine tool components - Drill jig, Tail stock, Toolpost, Tool head for shaping machine, machine vice, screw jack.

References:

1. Dhawan, R.K., *A Text Book of Machine Drawing,* S. Chand & Company, 1996.
2. Ostrowsky, O., *Engineering Drawing with CAD Applications,* ELBS, 1995.
3. Engineering Drawing Practice for Schools and Colleges SP**:** 46- 1988.

Course Outcomes:

On successful completion of the course, the student will be able to,

1. Identify the national and international standards pertaining to machine drawing.
2. Apply limits and tolerances to assemblies and choose appropriate fits.
3. Recognize machining and surface finish symbols.
4. Explain the functional and manufacturing datum.
5. Illustrate various machine components through drawings.

SEMESTER IV

MA208 FOURIER SERIES AND PARTIAL DIFFERENTIAL EQUATIONS

(3 – 0 – 0) 3

Course Objectives:

1. To know to express the periodic functions such as Fourier series, Fourier transform and formation of partial differential equation in solving problems.
2. To understand to solve one dimensional and two dimensional wave and heat equation.

Dirichiet conditions - Expansion of periodic functions into Fourier series - Change of interval-Fourier series for even and odd functions - Half-range expansions- RMS value of a function - Parseval's relation - Fourier series in complex form - Harmonic analysis.

Definition of Fourier Transform (finite and infinite) - Inverse Fourier Transform –Properties - Fourier Sine and Cosine transforms - Inverse Fourier Sine and Cosine transforms – Properties - Convolution theorem for Fourier Transform.

Formation of PDE - Solution of standard types of first order equations - Lagrange's linear equation - Second and higher order homogeneous and non-homogeneous linear equations with constant coefficients.

One-dimensional wave equation and one-dimensional heat flow equation - method of separation of variables - Fourier series solution.

Two-dimensional heat flow equation in steady state - Laplace equation in Cartesian and polar co ordinates - method of separation of variables - Fourier series solution.

References:

1. Grewal, B.S., *Higher Engineering Mathematics*, Khanna Publishers, 2001.
2. Kandasamy, P. Thilagavathy, K. and Gunavathy, K., *Engineering Mathematic*s, Vol. III, S. Chand & Co, 2001.
3. Venkataraman, M. K., *Engineering Mathematics*, Vol.III, National Publishing Company, 1998.

Course Outcomes:

On successful completion of the course, the student will be able to,

1. Apply the fundamental concept of Fourier series and be able to give Fourier expansions of a given function.
2. Solve various first order differential equations with their applications.
3. Illustrate the mathematical aspects that contribute to the solution of heat and wave equations.

MT252 ENGINEERING METALLURGY (3 – 0 – 0) 3

Course Objectives:

1. To impart knowledge on the atomic arrangement and structure of metals and alloys.
2. To acquire sound knowledge on phase diagram and heat treatment of materials.
3. To understand the various material testing methods.

Atomic Arrangement and Phase Diagrams - Structure of metals and alloys: Phase diagram: phase rules.

Phase Diagrams and Ferrous Alloys Fe- FeC diagram, Critical temperature - Plain carbon steel and other steels. .

Heat Treatment of steel, CCT diagrams, austempering, martempering ausforrning. Surface hardening process - non - ferrous alloys.

Testing of Materials I - Properties evaluated by tensile testing procedure, Engineering stress strain curve vs. true stress-strain curve, stress strain curve for typical materials. Hardness testing.

Testing of Materials II - Impact testing, Fracture toughness. Fatigue testing: Creep testing.

References:

1. Avner, S.H., *Introduction to Physical Metallurgy*, 2nd ed., Tata McGraw-Hill, 1997.
2. Dieter, G.E.,*Mechanical Metallurgy*, McGraw-Hill, 1988.
3. Donald S.Clark, and Wilbur R. Varney, *Physical Metallurgy for Engineers*, East-West Press, 1999.
4. Suriyanarayana, A.V.K, *Testing of metallic materials*, Tata McGraw-Hill, 2001.

Course Outcomes:

On successful completion of the course, the student will be able to,

1. Interpret the atomic arrangement and structure of metals and alloys.
2. Describe the iron-carbon equilibrium diagram and phase diagrams.
3. Explain the behavior of material upon heat treatment from iron-carbon equilibrium diagram and predict the behavior of materials upon impact, fracture and creep testing.

PR222 PRODUCTION TECHNOLOGY – II (3 – 0 – 0) 3

Course Objectives:

1. To understand the working of machine tools such as lathe, shaper, planner, slotter, milling, hobbing, and grinding.
2. To know the basic concepts of NC and CNC machine tool programming and computer aided part programming

Lathes, capstan & turret lathe, drilling and boring machine -Classification - principles of working components, work holding & tool holding devices.

Shaper, planner & slotter, machines - Classification - principles of working components, work holding & tool holding devices.

Milling, hobbing, broaching & grinding machines - Classification - principles of working components, work holding & tool holding devices.

NC & CNC machine tools and manual part programming Machining centre, turning centre. NC part programming.

Computer aided part programming - APP: Post processors. APT programming - motion statements, additional apt statements.

References:

1. Khanna, O.P., and Lal, M., *A Text Book of Production Technology*, Vol II , Dhanpat Rai & Sons, 1992.
2. Yoram Koren, *Computer Control of Manufacturing Systems*, McGraw-Hill, 1986.
3. Choudhry, S.K.H., *Elements of Work Shop Technology*, VoL II, Media Promoters & Publishers, 1994.
4. *Production Technology by HMT*, Tata McGraw-Hill, 2002.
5. Kundra, T.K., Rao., P.N., and Tiwari, N.L.K., *Numerical Control and Computer Aided Manufacturing*, Tata McGraw-Hill, 2006.

Course Outcomes:

On successful completion of the course, the student will be able to,

1. Explain the features and applications of lathe, milling, drilling and broaching machines.
2. Discuss features and applications of reciprocating machine tools like shaper, planer and slotting machine.
3. Write the programming to control and operate nc and cnc machines.

ME202 THERMAL ENGINEERING (3 – 0 – 0) 3

Course Objectives:

1. To familiarize with the types of air compressors, working principle of two stroke and four stroke engines
2. To know various ignition systems and testing of IC engines.

Reciprocating air compressors - types - construction - work of compression without clearance - effect of clearance – Multistaging - optimum intermediate pressure for perfect inter cooling - Compressor efficiencies and mean effective pressure.

Working of two and four stroke engines - valve and port timing diagrams - Deviation of engine indicator diagram from air standard cycles - Fuel air cycles and their analysis, Comparison of air standard and fuel air cycles - Losses in actual cycles.

I.C. engines fuels and rating -SI engine air fuel mixture requirements - Performance curve of an automobile carburetor - Diesel injection systems - types - Jerk type pump - Injection pump governors. Types of nozzles - Introduction to petrol injection.

Battery Ignition - magneto ignition and transistorized coil ignition - Combustion in SI engines - Knock in SI engines - effect of engine variable on knock - Combustion in CI engines - knock in CI engines - combustion chambers for SI and CI engines.

I.C. Engine testing - Measurement of friction power - Indicated power - Electronic Indicator- Brake power - dynamometers - Instruments for measuring emission of NOx , CO, Unburnt HC and smoke - engine efficiencies - Heat balance - Scavenging in two stroke engines.

References:

1. Ganesan, V., *Internal Combustion Engines,* Tata McGraw-Hill, 2003.
2. Heywood, J.B., *Fundamentals of Internal Combustion Engines,* McGraw-Hill, 1988.
3. Ballaney, P.L., *Thermal Engineering,* Khanna Publishers, 1996.

Course Outcomes:

On successful completion of the course, the student will be able to,

1. Apply thermodynamics laws in engineering applications.
2. Explain the process of air standard cycles and concept of internal combustion engine and system.
3. Demonstrate knowledge of the operating characteristics of common internal combustion engines.

ME204 MECHANICS OF MACHINES - I (3 - 1 - 0) 4

Course Objectives:

1. To impart knowledge on various types of Mechanisms and synthesis
2. To impart skills to analyse the position, velocity and acceleration of mechanisms
3. To familiarize higher pairs like cams and gears

Kinematics Fundamentals: Types of links, Degrees of freedom- Kinematic chains, mechanisms, Mechines- lower pairs and higher pairs- Mobility-Number Synthesis-isomers-Linkage Transformation-inversions-Grashof conditions- Barker's classification-Rotatability and revolvability of N bar linkages-Compliant Mechanism-MEMS. Introduction to animation software: working model

Graphical Linkage Synthesis: Two position synthesis, rocker output coupler output- three position synthesis- quick return mechanism- coupler curves-symmetrical 4-bar linkage-cognates-introduction to synthesis using coupler curve atlas-limiting conditions, toggle position and transmission angle

Position analysis: translation rotation and complex motion- Euler's theorem and Chasles' theorem-graphical position analysis-algebraic position analysis-vector loop equation for four bar linkages-circuits and branches in linkages

Velocity analysis: definition of velocity-graphical velocity analysis-instant centers of velocity-Kennedy's rule-velocity analysis using instant centers-mechanical advantage-centrodes-analytical velocity analysis of a 4 bar linkage

Acceleration analysis: definition of acceleration-graphical acceleration analysis- analytical acceleration analysis-coriolis acceleration-human tolerance to acceleration

Cams: types of cams and followers-types of motion program-pressure angle and radius of curvatureGears: fundamental law of gearing-involute tooth form-pressure angle –changing center distance-interferrence and under cutting- contacnt ratio-types of gears-simple gear trains- compound gear trains-epicyclic gear trains-Ferguson's paradox

References:

1. Robert L. Norton.," Design of Machinery: an introduction to synthesis and analysis of mechanisms and machines" 5th ed.,McGraw-Hill 2012
2. Uicker,J.J., Jr., Pennock,G.R., and Shigley, J.E., Theory of Machines and Mechanisms ,3rd ed., Oxford Univeristy Press,2003.
3. Robert Norton., "Kinematic s and Dynamics of machinery" 1st ed.,McGraw Hill India., 2009

Course outcomes:

On successful completion of this course the student will be able to,

1. Synthesize and analyze 4 bar mechanisms
2. Use computers for mechanism animation and analysis
3. Understand cams and gears

ME206 FLUID MECHANICS (3-1-0) 4

Course Objectives:

1. To familiarize with the properties of fluids and the applications of fluid mechanics.
2. To formulate and analyze problems related to calculation of forces in fluid structure interaction.
3. To understand the concept of fluid measurement, types of flows and dimensional analysis.

Basic concepts - Fluid properties - Basic hydrostatic equation - Manometry - Submerged and floating bodies.

Pressure at a point - Hydrostatic equations for incompressible and compressible fluids - Manometers - Hydrostatic force on a submerged plane and curved surfaces - Buoyancy and equilibrium of floating bodies - Metacentre - Fluid in rigid motion bodies.

Fluid dynamics; integral and differential formulations - Continuity equation - Navier-Stokes equations.

Laminar and turbulent flows - Some exact solutions of Navier-Stokes equations - Flow through pipes.

Fluid rotation and deformation - Stream function - Condition of irrotationality - Governing equations of potential flow - Laplace equation. Boundary layer concept - Prandtl's equation - Drag on flat plates - Buckingham π-theorem - Dimensionless numbers.

References:

1. Fox, R.W. and Mc Donald, A.T., *Introduction to Fluid Mechanics*, 6^{th} ed., John Wiley, 2003.
2. White, F.M., *Fluid Mechanics*, 5^{th} ed., McGraw-Hill, 2003.

Course Outcomes:

On successful completion of the course, the student will be able to,

1. Identify and obtain the values of fluid properties and relationship between them and understand the principles of continuity, momentum, and energy as applied to fluid motions.
2. Recognize these principles written in form of mathematical equations.
3. Apply dimensional analysis to predict physical parameters that influence the flow in fluid mechanics.

CE 290 FLUID MECHANICS LAB (0 – 0 – 2) 1

Course Objectives:

1. To provide practice in estimating friction losses.
2. To impart training to use various flow measuring devices for making engineering judgments.

Determination of pipe friction.
Calibration of venturimeter, orifice meter and water meter.
Determination of discharge coefficients for notches and weirs.
Determination of minor losses.
Determination of discharge coefficients for mouthpiece and orifice.
Flow through helical coils.
Determination of metacentric height.

Course Outcomes:

On successful completion of the course, the student will be able to,

1. estimate the friction and measure the frictional losses in fluid flow.
2. experiment with flow measurement devices like venturimeter and orifice meter.
3. predict the coefficient of discharge for flow through pipes.

MT 262 METALLURGY LAB (0 – 0 – 2) 1

Course Objectives:

1. To recognize the process of specimen preparation for testing of materials
2. To acquire knowledge on basic elements of materials microstructures
3. To know various testing methods for materials

Preparation of specimen for metallographic observation of white Cast Iron, Gray Cast Iron, Nodular Iron.

Preparation of specimen for metallographic observation of Mild Steel, Low Carbon Steel, Medium Carbon Steel, Hypereutectoid Steel, Hardened Steel, Tempered Steel, Tool Steel and Stainless steel.

Preparation of specimen for metallographic observation of Al – Si Alloys, Al – bronze Alloy, Pb – Tin soldering alloy, Pb – Tin antimony Alloy.

Tensile, Hardness and Creep testing of given metallic materials.

Course Outcomes:

On successful completion of the course, the student will be able to,

1. Prepare specimen for metallographic observation.
2. Identify the microstructure of various metals.
3. Explain the various testing methods for materials.

PR232 PRODUCTION PROCESS LAB (0 – 0 –3) 2

Course Objectives:

1. To impart students with the knowledge of various machine tools and its operations.
2. To familiarize with the selection of suitable production process for the desired component

Lathe – Simple / Step / Taper Turning, Thread Cutting, Drilling and Boring.
Shaping – V – Cutting
Milling – Job requiring Indexing.
Hobbing – Spur Gear Cutting
Grinding – Surface / Cylindrical grinding
CNC Lathe – Simple Turing, Step Turning, Thread Turing
Machining Center – A typical job production.

Course Outcomes:

On successful completion of the course, the student will be able to,

1. Explain the working principle of various machines used in manufacturing.
2. Identify the appropriate production process and machines.
3. Demonstrate the working of common machine tools like lather, shaper, miller, grinder and CNC lathe and machining centre.

ME208 THERMAL ENGINEERING LAB - I (0 - 0 - 3) 2

Course Objectives:

1. To provide knowledge on testing of properties of fuels and lubricating oils
2. To demonstrate and conduct experiments, interpret and analyze data and report results of IC Engine testing

Property determination for fuels and lubrication oil.

Study and performance testing of IC engines.

Study and performance testing of air compressor.

Emission measurements.

Course Outcomes:

On successful completion of the course, the student will be able to,

1. Compute the property of fuels and lubricating oils using suitable tests.
2. Demonstrate the performance of internal combustion engines and air compressors.
3. Interpret the emission characteristics of internal combustion engines.

SEMESTER V

MA 301 NUMERICAL METHODS (3 – 0 – 0) 3

Course Objectives:

1. To develop the basic understanding of numerical techniques for solving linear, non-linear and Ordinary Differential Equations.
2. To provide knowledge on solving Laplace equation and Poisson equation, heat flow and wave equation

Solution of linear system - Gaussian elimination and Gauss-Jordan methods - LU - decomposition methods - Crout's method - Jacobi and Gauss-Seidel iterative methods - sufficient conditions for convergence - Power method to find the dominant eigenvalue and eigenvector.

Solution of nonlinear equation - Bisection method - Secant method - Regula falsi method - Newton-Raphson method for $f(x) = 0$ and for $f(x,y) = 0$, $g(x,y) = 0$ - Order of convergence - Horner's method - Graeffe's method - Bairstow's method.

Newton's forward, backward and divided difference interpolation – Lagrange's interpolation – Numerical Differentiation and Integration – Trapezoidal rule – Simpson's 1/3 and 3/8 rules - Curve fitting - Method of least squares and group averages.

Numerical Solution of Ordinary Differential Equations- Euler's method - Euler's modified method - Taylor's method and Runge-Kutta method for simultaneous equations and 2^{nd} order equations - Multistep methods - Milne's and Adams' methods.

Numerical solution of Laplace equation and Poisson equation by Liebmann's method - solution of one dimensional heat flow equation - Bender - Schmidt recurrence relation - Crank - Nicolson method - Solution of one dimensional wave equation.

References:

1. Gerald, C.F., and Wheatley, P.O., *Applied Numerical Analysis*, Addison Wesley, 1998.
2. Jain, M.K., Iyengar, S.R. and Jain, R.K., *Numerical Methods for Scientific and Engineering Computation*, Wiley Eastern, 1987.
3. Kandasamy, P., Thilagavathy, K., and Gunavathy, S., *Numerical Methods*, S.Chand & Company, 1998.

Course Outcomes:

On successful completion of the course, the student will be able to,

1. Solve linear and non-linear system of equations through numerical techniques.
2. Compute solutions for ordinary differential equations through numerical techniques.
3. Apply various numerical techniques to solve Laplace equation and Poisson equation, heat flow and wave equation.

IC315 MECHATRONICS (3 – 0 – 0) 3

Course Objectives:

1. To provide knowledge on electrical circuits, signal conditioning
2. To make familiar about control system and power electronics in designing Mechatronics system

INTRODUCTION

Introduction to Mechatronics-Systems-Measurement Systems-Control Systems-Mechatronics Approach.

SENSORS AND TRANSDUCERS

Introduction-Performance, Terminology-Displacement, Position and Proximity-Velocity and Motion-Fluid Pressure-Temperature Sensors-Light Sensors-Selection of Sensors-Signal Processing.

8085 MICROPROCESSOR

Introduction-Architecture-Pin Configuration-Instruction set-Programming of Microprocessors using 8085 instructions-Interfacing input and output devices-Interfacing D/A converters and A/D converters-Applications- Temperature control-Stepper motor control-Traffic light controller.

PROGRAMMABLE LOGIC CONTROLLERS

Introduction-Basic structure-Input/output Processing-Programming-Mnemonics-Timers, Internal relays and counters-Data handling-Analog Input/output-Selection of a PLC.

DESIGN AND MECHATRONICS

Stages in Designing mechatronic systems - Traditional and Mechatronic design -Possible design solutions-Case studies of mechatronic systems - Pick and place robot - automatic car park system - engine management system.

References:

1. W.Bolton, Mechatronics,Longman,Second Edition, 1999.
2. Michael B. Histand and David G.Alciatore, " Introduction to Mechatronics and Measurement Systems ", McGraw Hill International Editions, 1999.
3. HMT Ltd., " Mechatronics ", Tata McGraw Hill Publishing Co. Ltd., 1998.
4.Dan Necsulescu, "Mechatronics",Pearson Education Asia,2002(Indian reprint).

Course Outcomes:

On successful completion of the course, the student will be able to,

1. Describe mechatronic systems and overview of control systems & actuators.
2. Differentiate between various sensors, transducers and actuators and their applications.
3. Relate various signal conditioning units, amplifiers, logic gates and their role in programmable logic controllers.

ME301 COMPRESSIBLE FLOW AND JET PROPULSION (3 - 0 - 0) 3

Course Objectives:

1. To study the basic difference between incompressible and compressible flow
2. To study about the phenomenon of shock waves and its effect on flow.
3. To gain some basic knowledge about the jet propulsion Rocket propulsion.

Governing equations for inviscid-compressible flows - static and stagnation properties - speed of sound and Mach number.

Isentropic flow through variable area passage ducts - Choking of flow.
Normal and oblique shocks - Prandtl-Meyer flows.

Fanno flow - Rayleigh flow.

Fundamentals of jet propulsion - Propulsion cycle - Power and efficiency calculations - Turbojet, turbofan, and turboprop engines - Fundamentals of rocket propulsion.

References:

1. Yahya, S.M., *Fundamentals of Compressible Flow with Aircraft and Rocket Propulsion,* 3rd ed., New Age International Publishers, 2003.
2. Oosthuizen, P.H. and Carscallen, W.E., *Compressible Fluid Flow,* McGraw-Hill, 1997.
3. Zucker, R.D. and Biblarz, O., *Fundamentals of Gas Dynamics,* 2nd ed., John Wiley, 2002.

Course Outcomes:

On successful completion of the course, the student will be able to,

1. Interpret governing equations for inviscid-compressible flows.
2. Demonstrate isentropic flow through variable area passage ducts
3. Express Prandtl-Meyer flows, Fanno flow and Rayleigh flow.
4. Explain the fundamentals of jet propulsion, propulsion cycle and rocket propulsion.

ME303 HEAT AND MASS TRANSFER (3-0-0) 3

Course Objectives:

1. To understand the application of various experimental heat transfer correlations in engineering applications.
2. To learn the thermal analysis and sizing of heat exchangers.
3. To understand the basic concepts of mass transfer.

Conduction - General 3-D equation - Heat generation problems - Fins - Unsteady state conduction.

Radiation Laws - Black and Gray bodies - Radiation exchange between surfaces - Radiation shields Green house effect.

Forced Convection - Boundary layer theory - External and internal flows - Free convection - Correlations.

Heat exchangers - Fouling factor, LMTD and NTU methods - Boiling and condensation - Boiling regimes and correlations, Nusselt's theory - Condensation over surfaces. Mass transfer - Fick's law - Similarities between heat and mass transfer

References:

1. Incropera, F.P. and Dewitt, D.P., *Fundamentals of Heat and Mass Transfer, 5th* ed., John Wiley, 2002.
2. Holman, J.P., *Heat Transfer,* 9th ed., Tata McGraw-Hill, 2004.
3. Ozisik, M.N., *Heat Transfer - A Basic Approach,* McGraw-Hill, 1985.
4. Cengel, Y.A., *Heat Transfer - A Practical Approach,* McGraw-Hill, 1998.

Course Outcomes:

On successful completion of the course, the student will be able to,

1. Explain about the real time applications of solid medium heat transfer.
2. Describe the real time applications of fluid medium heat transfer.
3. Express the knowledge of design skills of heat exchangers.
4. Illustrate the real time applications of radiation mode of heat transfer (no media).
5. Relate the skill of mass transfer and its applications.

ME305 MECHANICS OF MACHINES - II (3-1-0) 4

Course objectives:

1. To impart knowledge about dynamic analysis of mechanisms and balancing
2. To familiarize about gyroscopes and flywheels
3. To give understanding various aspects of mechanical vibrations and their control

Static and inertial force analysis of mechanisms

Balancing: rotating masses in single and several planes- reciprocating masses- single and multicylinder engines-Lanchester balancer

Gyroscopes: Gyroscopic effect- gyroscopes and their uses

Flywheel: industrial uses of flywheels- design of a flywheel of IC engines and punch press

Mechanical vibrations: linear and torsional vibrations- two rotor, three rotor and multi rotor systems-damped vibrations- coupled vibrations-forced vibrations- -vibration sensors

Vibration control: philosophy of vibration control-vibration isolations- suspension systems-tuned vibration absorbers- uses of vibration in condition monitoring

References:
1. George H. Martin., "Kinematics and Dynamics of Machines" 2nd ed., Waveland Pr Inc.,2002
2. Morrison.J.L.M., Crossland.B., "An Introduction to the Mechanics of Machines" 1st ed., Longmans ,1964
3 Daniel J. Inman., " Engineering Vibrations" 3rd ed., Pearson Education 2009

Course outcomes:

On successful completion of the course the student will be able to,

1. Perform static and dynamic analysis of mechanisms
2. Understand the issues related to balancing of reciprocating and rotating machinery
3. Know the working of gyroscopes and flywheels
4. Have understanding about the effect of vibration and vibration control

ME307 ANALYSIS AND DESIGN OF MACHINE COMPONENTS (3 - 0 - 0) 3

Course Objectives:

1. To familiarize the various steps involved in the Design Process
2. To understand the principles involved in evaluating the shape and dimensions of a component
3. To satisfy functional and strength requirements.
4. To learn to use standard practices and standard data
5. To learn to use catalogues and standard machine components

Mechanical engineering design - Design considerations - Material selection - Modes of failure - Theories of failure - Endurance limit - Stress concentration - Factor of safety.

Design of shafts and couplings - Design of cotter and knuckle joints.

Helical and leaf springs.

Fasteners and keys - Design of welded joints - Fillet and butt welds - Design of riveted joints.

Design of sliding contact bearings - Selection of rolling contact bearings.

References:

1. Sundararajamoorthy, T.V. and Shanmugam, N., *Machine Design,* Anuradha Agencies, 2003.
2. Shigley, J.E., Charles, R.M. and Richard, G.B., *Mechanical Engineering Design*, 7th ed., McGraw-Hill, 2004.

Course Outcomes:

On successful completion of the course, the student will be able to,

1. Describe the design process, material selection, calculation of stresses and stress concentrations under variable loading.
2. Design the solid, hollow shafts and to finding the critical speeds.
3. Differentiate between rigid and flexible couplings and also the knuckle joints.
4. Analyze bolted joints in eccentric loading.
5. Examine the welded joints for vessels and steel structures also have a design knowledge on sliding and rolling contact bearing.
6. Summarize the knowledge in helical, leaf, disc and torsional springs and also in levers.

IC 317 MECHATRONICS LAB (0 – 0 – 2) 1

Course Objectives:

1. Develop an understanding of the basic elements underlying mechatronic systems: analog electronics, digital electronics, sensors, actuators, microcontrollers, and embedded software.
2. Understand how to interface electromechanical systems to microcontrollers.
3. Gain hands-on experience with commonly used electronic test and measurement instrumentation.
4. Improve written communication skills through laboratory and project reports.
5. Gain practical experience in applying knowledge gained in the course through a hands-on project.

Verification of basic specifications of operation amplifier from data sheet; OP-amp Ck1 amplifier (inverting and Non-inverting)

P-amp Ck2 wave form generation (square wave, triangular wave); OP-amp Ck3 Integrator, Differentiator; OP-amp Ck4 V-I converter & I-V converter.

Study of transducers: RTD + Signal Conditioning Circuit; Study of LVDT with accessory chip; Study of Digital Gates - SOP realization.

Study of Microprocessor instruction set; Simple programs using 8085 microprocessor - Addition, Use of functions, Peripheral chips, Waveform generation.

Usage of interrupts, Stepper motor control, Key board interface, Heater control; Study of PLC; Study of tools such as PSPICE; Usage of simulators (any other microprocessor)

Course Outcomes:

On successful completion of the course, the student will be able to,

1. Analyse the velocity and direction of fluid power circuit with the help of simulation software.
2. Demonstrate the fluid power circuits using PLC.
3. Observe interface between stepper motor and 8051 micro controller.
4. Simulate the basic electric, hydraulic and pneumatic system using simulation software.

ME309 DYNAMICS LAB (0 - 0 - 3) 2

Course Objectives:

1. To equip students with understanding of the fundamental principles and techniques for Identify different types of dynamic systems and classify them by their governing equations.
2. To develop a model of a mechanical system using a free body diagram.
3. To develop equations of motion for translational and rotational mechanical systems.

Measurement of moment of inertia of rigid bodies.
Gyroscope.
Jump speed of a cam.
Mechanical vibrations.
Balancing.

Course Outcomes:

On successful completion of the course, the student will be able to,

1. Compute the moment of inertia of rigid bodies
2. Demonstrate the working principles of gyroscope and cam
3. Experiment with vibrations and balancing.

ME 311 PRODUCTION DRAWING AND COST ESTIMATION (1 – 0 – 2) 2

Course Objectives:

1. To impart the knowledge of engineering drawing rules and manufacturing details.
2. To conduct tolerance analysis of various product assemblies.
3. To estimate manufacturing cost and time.

Conventional Representation of Machine elements - International Standards (ISD) and Indian Standards (IS).

Limits and Fits - IT system of tolerances, deviations and fits.

Geometric Dimensioning and Representation - Tolerancing, Tolerancing of form, orientation, location and run-outs, Datums and Datum Systems.

Surface texture indication on drawing. Welds - Symbolic representing of drawings. Preparation of process - Chart for a given component.

Cost Estimation of setting time and machining time - estimation of material cost, labour cost and overhead cost based on supplied data. Given a sub-assembly /assembly to prepare production drawings of components as per current drawing office practice. At least ten sub-assemblies/assemblies are to be completed on A4 sheets.

References:

1. Indian Standards : 10714,10715,10716,10717,10719, 813,919,2709,8000 , pt.1 to 4 : 10721, 11158 corresponding to ISO's
2. *PSG Design Data Book*, PSG Book Depot, 2005.
3. Khan M.Y. & Jain P.K., *Cost Management*, TMH outline series, 2nd ed., 2000.
4. Engineering Drawing Practice for Schools and Colleges SP**:** 46- 1988.

Course Outcomes:

On successful completion of the course, the student will be able to,

1. Select suitable fits and associated tolerance for machine elements.
2. Recognize the standard notations and use them as per SP 46.
3. Interpret production drawing properly.
4. Compute the manufacturing cost of a component.

SEMESTER VI

ME302 TURBOMACHINES (3 - 0 - 0) 3

Course Objectives:

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1. Provide students with opportunities to apply basic flow equations;
2. How to compare and chose machines for various operations.

Introduction - Classification - Dimensional analysis - Specific speed - Basic laws and equations. Hydraulic turbines; Pelton, Francis, and Kaplan turbines - Turbine efficiencies - Cavitation in turbines.

Centrifugal pumps; theory, components, and characteristics - Cavitation - Axial flow pumps - Pump system matching.

Centrifugal and axial flow compressors; slip, surging and chocking.

Steam turbines; basic cycle, impulse and reaction turbines - Gas turbine; basic cycle and multi-staging - Power and efficiency calculations.

References:

1. Dixon, S.L., *Fluid Mechanics and Thermodynamics of Turbomachines,* 5th ed., Butterworth-Heinemann, 2005.
2. Sayers, A.T., *Hydraulic and Compressible Flow Turbomachines,* CBLS, 2003.
3. Ganesan, V., *Gas Turbines,* 2nd ed., Tata McGraw-Hill, 2003.
4. Lakshminarayana, B., *Fluid Dynamics and Heat Transfer of Turbomachinery,* Wiley-Interscience, 1995.

Course Outcomes:

On successful completion of the course, the student will be able to,

1. Explain basic concepts of turbomachines and visualize dimensional analysis.
2. Describe the working of Pelton, Francis and Kaplan along their performance parameters.
3. Discuss the operation of centrifugal pumps, centrifugal and axial compressors.
4. Associate the effect of cavitation in turbines and pumps.
5. Express the basic cycles and calculations involved in the operation of steam and gas turbines.

ME304 AUTOMOBILE ENGINEERING (3 - 0 - 0) 3

Course Objectives:

1. Introduction to engineering analysis of the automobile and its sub-systems.
2. Application of engineering principles to automotive design.
3. Familiarization with modeling and analysis methods.
4. Familiarization with the automotive industry and its terminology.

General classification of vehicles - Power unit - All components of power unit.

Steering systems - Power steering - Wheel and suspension systems - Transmission system; clutches, couplings, gear boxes, and torque converters.

Axles - Differentials - Mechanical, hydraulic, and pneumatic brakes - Power brakes - Four wheel drive.

Electrical systems; construction, operation, and maintenance of batteries - Starter motors.

Lighting and electrical accessories - Panel board instruments - Automobile air conditioning - Troubleshooting.

References:

1. Heitner, J. *Automotive Mechanics Principle and Practice,* 2nd ed., Affiliated East-West Press Ltd., 1974.
2. Newton, K., Steeds, W., and Garrett, T.K., *The Motor Vehicle,* Butterworths, 1989.
3. Kirpal Singh, *Automotive Engineering,* Vol. I & II**,** Standard Publishers, New Delhi, 2002.

Course Outcomes:

On successful completion of the course, the student will be able to,

1. Demonstrate the vehicle construction, chassis, lubrication system and cooling system in automobile, 3-way catalytic converter.
2. Describe the principle and working of Carburettors, CRDI, MPFI, electronic fuel injection system and Ignition system.
3. Differentiate between clutch, gear box, rear axle drives, fluid flywheel, and torque converter.
4. Identify the wheels, tyres, steering gear box, suspension system-telescopic, and leaf spring.
5. Appraise the recent trends in alternate fuels and automobile safety system.

ME306 DESIGN OF MECHANICAL DRIVES (3 - 0 - 0) 3

Course Objectives:

1. To teach students how to formulate the design and manufacturing problem for simple systems and mechanical components
2. To teach students how to apply the general mechanical engineering sciences in analyses specific to the design of mechanical components and systems
3. To teach students in a laboratory setting how to generate concepts, conduct analyses to size components, construct and assemble a prototype of a system and test its function
4. To reinforce students team skills through team projects, including problem formulation, problem solutions and written and oral reporting of results
5. To reinforce students visualization and hands-on skills through project virtual prototyping and/or physical construction exercises

Introduction to transmission elements - Positive and friction based drives.

Design of spur and helical gears based on contact and beam strength. Design of bevel and worm gears.

Importance of friction based drives - Design of flat and V-belts - Design of rope and chain drives.

Design of brakes; drum- shoe and band brakes - Design of positive and friction based clutches; single plate, multi-plate and cone clutches.

Design of multi-speed gearbox - Preparation of ray diagram and kinematic arrangement diagram for multi-speed gearbox.

References:

1. Sundararajamoorthy, T.V. and Shanmugam, N., *Machine Design,* Anuradha Agencies, 2003.
2. Shigley, J.E., *Mechanical Engineering Design,* 5th ed., McGraw-Hill, 1989.

Course Outcomes:

On successful completion of the course, the student will be able to,

1. Recognize the need for friction drives and positive drives.
2. Apply BIS standards and catalogues in design and selection of belts and chain for requirement.
3. Select suitable drive combination based on requirement.
4. Explain failure modes in gears.
5. Establish suitability of a given drive elements whether to meet the requirement.

ME308 COMPUTER AIDED DESIGN AND DRAFTING (3 - 0 - 0) 3

Course Objectives:

1. To introduce the student to the basic tools of computer-aided design (CAD) and computer-aided manufacturing (CAM).
2. To expose the student to contemporary computer design tools for aerospace and mechanical engineers.
3. To prepare the student to be an effective user of a CAD/CAM system.

CAD hardware - Product cycle - CAD tools, CAD systems; system evaluation, CAD specific I/O devices.

CAD software - Graphic standards – Modes of graphics operation, Software Modules.

Geometric modeling – Types and mathematical representation and manipulation of curves and surfaces.

Solid modeling- fundamentals, feature based modeling manipulations of solid models.

Transformation of Geometric models and visual realism - Animation.

References:

1. Zeid, I., *CAD/CAM Theory and Practice,* Tata McGraw-Hill, 2008.
2. Rogers, D.E and Adams, J.A., *Mathematical Elements for Computer Graphics, 2nd* ed., McGraw-Hill, 1990.

Course Outcomes:

On successful completion of the course, the student will be able to,

1. Explain lifecycle of a product and the role of computer-aided design (CAD) in product development.
2. Describe the concepts of geometric and solid modelling.
3. Visualize geometric models through animation and transform them into real world systems.

ME310 REFRIGERATION AND AIR CONDITIONING (3 - 0 - 0) 3

Course Objectives:

1. To understand the principles of refrigeration and air conditioning.
2. To calculate the cooling load for different applications.
3. To select the right equipment for a particular application.
4. To design and implement refrigeration and air conditioning systems using standards.
5. Energy Conservation and Management.

Introduction about Refrigeration – Definitions of various terms. Methods of refrigeration. Air refrigeration system. Bell – Coleman cycle. Introduction about Air craft Air-Conditioning.

Analysis of Vapour compression cycle, Modifications to basic cycle. Multi pressure systems. Multi-evaporator system and Cascade systems. Properties of refrigerants. Selection of refrigerants.

Discussion of components of V.C system, Servicing. Vacuumizing and charging of refrigerant. Introduction to cryogenics.

Psychrometry – Definitions for properties. Introduction to cooling load calculations. Comfort conditions. Effective temperature concept.

Air-conditioning systems – discussion about the central plant with direct evaporator and chiller applications, Ice plant, refrigerators. Food preservation, IQF technique and freeze drying etc. Cold storage and thermal insulation.

References:

1. Manohar Prasad, *Refrigeration and Air Conditioning*, New Age International, 2004.
2. Dossat R.D., *Principle of Refrigeration,* 4th ed., Prentice-Hall, 1997.
3. Arora, C.P., *Refrigeration and Air Conditioning,* 2nd ed., Tata McGraw-Hill, 2000.

Course Outcomes:

On successful completion of the course, the student will be able to,

1. Illustrate the basic concepts of refrigeration system.
2. Analyze the vapour compression cycle and interpret the usage of refrigerants.
3. Explain the components of vapour compression system.
4. Demonstrate the use of psychrometry in analyzing refrigeration systems.
5. Discuss the theory and concept of air-conditioning systems.

ME312 THERMAL ENGINEERING LAB - II (0 - 0 - 3) 2

Course Objectives:

1. To expose the students to the basic knowledge of thermal equipments and help them to develop experimental skills.
2. To study the concepts, applications of the thermal engineering laboratory.

Study and performance tests on refrigeration.
Study and performance tests on air conditioning test rig.
Heat transfer experiments based on conduction and convection.
Heat transfer experiments based on radiation.

Course Outcomes:

On successful completion of the course, the student will be able to,

1. Demonstrate conduction, convection and radiation heat transfer through experiments.
2. Interpret heat transfer enhancement mechanisms.
3. Estimate the size and type of heat exchangers.
4. Calculate the cooling load of air conditioning systems and cooling towers.

ME314 AUTOMOBILE ENGINEERING LAB (0 - 0 - 3) 2

Course Objectives:

1. To make the student understand about the various components of petrol engine and diesel engine by dismantling and assembling the parts like carburetor, alternator, water pump etc and we have the multi cylinder diesel and petrol engines for easy learning.
2. To make the student understand about the various electrical components of an automobile and the wiring circuits and to test the starter motor, ignition system, batteries etc.

Study on engine components.
Fuel systems.
Ignition systems - Transmission systems - Steering systems.
Suspension and braking systems.
Layout of electrical wiring - Light and heavy vehicles.

Course Outcomes:

On successful completion of the course, the student will be able to,

1. Describe, explain and demonstrate the various aspects of automobile components and system which include engine components, fuel and ignition systems, transmission systems and steering systems, suspension and braking systems and electrical and electronics system.

ME316 COMPUTER AIDED DESIGN AND DRAFTING PRACTICE (0 - 0 - 2) 1

Course Objectives:

1. To introduce the student to the basic tools of computer-aided design (CAD) and computer-aided manufacturing (CAM).
2. To expose the student to contemporary computer design tools for aerospace and mechanical engineers.
3. To prepare the student to be an effective user of a CAD/CAM system.

Components drawing with dimensioning
Assembly drawing using modeling software package
Shaft coupling
Bearings
Automobile parts
Machine tool parts

Course Outcomes:

On successful completion of the course, the student will be able to,

1. Sketch, construct and simulate the mechanical engineering parts and components which include shaft coupling, bearings, automobile parts, machine tool parts along with their assembly drawing in a CAD package.

SEMESTER VII

HM 401 INDUSTRIAL ECONOMICS (3 – 0 – 0) 3

Course Objectives:

1. Give a simple yet thorough introduction into the main methods of economic analysis of industry structure and firm behaviour under various conditions of technology, competition, and organization.
2. Elaborate students' skills and abilities to use modern theoretical and empirical tools to formulate and solve economic problems.
3. Explore in details how economists approach and answer specific empirical questions.

Demand and Supply – Forecasting techniques – Cost and Revenues.

Competitive nature of the firms – Keynesian economics – National income.

Trade cycle – Inflation – Index numbers – Capital budgeting – Cash flow analysis – Balance sheet.

Risk and Decision Making – Technological Change in Global Economy – Locating the Firm in a global economy – Taxes and Decision Making.

Exchange Rate determination – Marketing – Product life cycle – Marketing research – Branding – Personality – Motivation – Leadership – Working in Teams.

References:

1. Adhikary Manab, *Business Economics*, Excel Books, 2004.
2. Dwivedi, D.N., *Macro Economics Theory & Policy*, Tata Mc Graw-Hill, 2005.
3. Aczel D. Amir, Soundarapandian Jayavel, *Complete Business Statistics*, Tata Mc Graw-Hill, 2005.
4. Robins P. Stephen, *Organizational Behaviour*, Prentice-Hall, 2002.

Course Outcomes:

On successful completion of the course, the student will be able to,

1. Analyze the risk of decision making in a firm.
2. Describe and explain the determinants of the size and structure of firms.
3. Give an overview of trade cycle, inflation, cash flow analysis and Balance sheet.
4. Explain the marketing research, product life cycle, motivation and leadership.
5. Describe the competitive nature of the firm and team working.

ME403 POWER PLANT ENGINEERING (3 - 0 - 0) 3

Course Objectives:

1. Describe sources of energy and types of power plants
2. Analyze different types of steam cycles and estimate efficiencies in a steam power plant
3. Describe basic working principles of gas turbine and diesel engine power plants. Define the performance characteristics and components of such power plants
4. List the principal components and types of nuclear reactors.
5. Evaluate cycle efficiency and performance of a gas cooled reactor power plant
6. Classify different types of coupled vapor cycles and list the advantages of combined cycles power plant

Layout - various components and functions of thermal power plants.
Nuclear power plants and gas turbine.
Hydro power plants.
Diesel power plants.
Power plant economics and environmental hazards.

References:

1. Culp Jr., A.W., *Principles of Energy Conversion*, *M*cGraw-Hill, 1985.
2. Arora, S.C. and Domkundwar, S., *A Course in Power Plant Engineering*, Dhanpat Rai & Sons, 2001.
3. El Wakil, M.M., *Power Plant Technology*, Tata McGraw-Hill, 1985.
4. Nag. P.K., *Power Plant Engineering*, 2nd ed., Tata McGraw-Hill, 2002.

Course Outcomes:

On successful completion of the course, the student will be able to,

1. Summarize the layout and components in a power plant.
2. Enumerate and classify the types of power plants available.
3. Recognize the steam cycles on pressure - volume and temperature diagram.
4. Outline the scenario of entire business of power plants along with performance parameters, load curves and tariff calculations.
5. Relate and couple the different thermodynamic cycles to improve efficiency and to reduce pollution.
6. Extend their knowledge to power plant economics and environmental hazards

ME405 METROLOGY AND QUALITY CONTROL (3 - 0 - 0) 3

Course Objectives:

1. Describe the evolution of quality standards and metrology
2. Describe key points and timelines for the evolution of the quality system as we know it today
3. Define what a quality system is and why it is utilized, Identify and provide the uses for various quality tools such as checksheets, pareto charts, flowchart, cause and effect diagrams, histogram, scatter diagram and control charts

Standards - Errors in measurements - Calibration - Length measurements. Angle measurements. Limits and tolerances.

Surface finish; terminology and measurements - Optical measuring instruments.

Measurement of screw thread and gear elements - Acceptance test for machines.

Statistical Quality Control - Control charts - Sampling plans.

References:

1. Gupta, I.C., *Engineering Metrology*, Dhanpat Rai & Sons, 2004.
2. Grant, E.L., *Statistical Quality Control*, Mc Graw-Hill, 2004.
3. Doeblin E.O., *Measurement Systems*, Mc Graw-Hill, 2004.

Course Outcomes:

1. Demonstrate different measurement techniques.
2. Reproduce the fundamental knowledge on metrology techniques.
3. Apply statistical process control and acceptance sampling procedures in a manufacturing environment to improve quality of processes / products.
4. Identify suitable metrological methods for measuring the components.
5. Explain the acceptance test for machines.
6. Outline the working of various optical measuring instruments.

ME407 OIL HYDRAULICS AND PNEUMATICS (3 - 0 - 0) 3

Course Objectives:

1. The cognitive objective of this course is for each student to comprehend foundational knowledge needed to perform stated entry-level industry competencies.

2. The performance objective of this course is for each student to apply foundational knowledge to hydraulic and pneumatic problems and exercises encountered in class.

Basic concepts of fluid power system design - Hydraulic oils and fluid properties – Seals and Seal materials - Filters and Filtration.

Hydraulic pumps, cylinders, and motors - Construction, sizing, and selection.

Control valves; pressure, flow, and direction - Servo-valves.

Basic hydraulic circuits, hydrostatic transmission - Cartridge valve
circuits.

Control of hydraulic circuits - Electrical, electronics, and PLC - Pneumatic components and basic circuits.

References:

1. Esposito. A., *Fluid Power with Applications,* 5th ed., Pearson Education, 2003.
2. *Industrial Hydraulics,* Vickers - Sperry Manual, 2002.

Course Outcomes:

On successful completion of the course, the student will be able to,

1. Recall various fluid properties and identify the appropriate fluid power system for particular application.
2. Recognize the suitable pump and actuators for particular application.
3. Select various control valves such as pressure control, flow control, direction control valves and use them in hydraulic and pneumatic circuit development.
4. Analyze the hydraulic and pneumatic circuit for energy efficiency.
5. Select the appropriate control system like electrical, electronics, and PLC to control the fluid power system.
6. Trouble-shoot and identify maintenance problems associated with fluid power system.

ME409 METROLOGY LAB (0 - 0 - 2) 1

Course Objectives:

1. Identify the uncertainties in dimensional metrology and the define the measurement standards; describe the fundamentals of dimensional and geometrical tolerances;
2. Measure length and angles using line-graduated instruments, i. e. vernier callipers, micrometers, bevel protractor, sine bar and surface plates;
3. Use comparative length-measuring instruments, i.e. dial indicator, to measure variations in the distance between two or more surfaces;

Measurements on precision instruments; sine bar, CMM - Universal measuring microscope, Profile projector - Electronic comparator, optical flat, surface roughness - Gear tooth thickness - MAAG gear tester - Calibration of LVDT - Statistical Quality Control charts.

Course Outcomes:

On successful completion of the course, the student will be able to,

1. Illustrate on different metrological tools and perform measurements in quality impulsion.
2. Describe and explain the working of precision instruments.
3. Outline of electronic comparator, optical flat, surface roughness, gear thickness measuring instruments.
4. Demonstrate the statistical quality control chart.
5. Distinguish with the different instruments that are available for linear, angular, roundness and roughness measurements.
6. Locate appropriate measuring instrument according to a specific requirement.

ME411 COMPREHENSIVE VIVO-VOCE (0 - 3 - 0) 3

On successful completion of the course, the student will be able to,

1. Recall, recognize, visualize, illustrate, demonstrate, criticize and appraise the aspects of mechanical engineering systems and the interaction among them.

ME413 PROJECT WORK - PHASE I (0 - 1 - 0) 0

On successful completion of the course, the student will be able to,

1. Identify real world problems of mechanical engineering and related systems.
2. Interpret the working of mechanical engineering systems.
3. Apply the principles of mechanical engineering in real world systems.
4. Criticize and experiment to arrive at solutions for real world mechanical engineering problems.
5. Analyse and evaluate to obtain solution for problems in mechanical engineering systems.

SEMESTER VIII

HM402 MANAGEMENT PRINCIPLES AND CONCEPTS (3 – 0 – 0) 3

Course Objectives:

1. Define the concept of management and discuss why organizations are needed, why managers are necessary, and why management is a challenge.
2. Describe the communications process; discuss barriers to communication and suggest remedies to overcome communications difficulties.
3. Explain why planning is needed in organizations and why long-term objectives are necessary for successful planning.
4. Identify and differentiate between the various tools and processes used in planning; compare the advantages and disadvantages of the participatory approach to planning.

Introduction to management –Evolution of scientific management, modern management, Principles-Elements of management planning, organizing, staffing, directing, coordinating, reporting, budgeting.

Financial management, objectives, scope, Techniques of investment analysis, Payback period, sources of financing, technology management, product design, and plant layout.

Inventory management, project management, PERT, CPM- Applications.

Significance of Human resources management, HR Planning, Job evaluation, recruitment and selection.

Placement and induction, training, Performance appraisal, compensation, Industrial relations.

References:

1. Prasad, L.M., *Principles and practice of Management*, Sultan Chand & Sons, 2006.
2. Gupta, R.N., *Principles of Management*, Sultan Chand & Co, 2001.

Course Outcomes:

On successful completion of the course, the student will be able to,

1. Illustrate the principle of modern management and budgeting.
2. Infer the techniques of investment analysis and finance sourcing.
3. Review inventory and analyse project management using PERT and CPM.
4. Explain the significance of human resource management.
5. Prepare performance appraisal and compensation.

PR472 RESOURCE MANAGEMENT TECHNIQUES (3 – 0 – 0) 3

Course Objectives:

1. To introduce the students how to use variables for formulating complex mathematical models in management science, industrial engineering and transportation science.
2. To provide the students with opportunity of using various software package for solving linear programming and integer programming models
3. To introduce the students to the use of basic methodology for the solution of linear programs and integer programs.

Linear programming, graphical method - simplex method - big M method - Two-phase method - introduction to duality theory

Transportation & assignment models -Mathematical model for Transportation problem –balanced and unbalanced problem –Assignment problem.

Queuing theory & sequencing - applications of queuing model -single and multi server model.

Decision theory and replacement analysis.

Project scheduling -project network - determination of critical path, project duration and slack time calculation - Cost considerations in project scheduling.

References:

1. Gupta and Hira, *Problems on operations research*, S.Chand & Company, New Delhi, 1991.
2. Taha H.A., *Operations research*, Prentice – Hall of India, New Delhi, 2001.
3. Panneerselvam, R, *Operations Research*, Prentice – Hall of India, New Delhi, 2002

Course Outcomes:

On successful completion of the course, the student will be able to,

1. Solve linear programming problems using graphical and simplex algorithm.
2. Explain the need for duality theorem and its use in solving linear programming problems.
3. Formulate and solve transportation and assignment problems.
4. Describe the procedure for solving sequencing problems.
5. Solve problems on replacement and decision theory.
6. Identify the project scheduling and project network problems.

LIST OF ELECTIVES

SEMESTER VI

Elective I

ME352 FINITE ELEMENT METHOD (3 - 0 - 0) 3

Course Objectives:

1. The objective of the course is to apprise the students about the basics of the Finite Element Technique, a numerical tool for the solution of different classes of problems in solid mechanics.
2. Different application areas will be dealt with after introducing the basic aspects of the method.
3. The analysis methodologies for 1-D, 2-D and 3-D problems with the advantages and disadvantages clearly spelt out.
4. It is expected that once the students are exposed to the course, they will be in a position to develop computer codes for any physical problem using Finite Element technique.

Introduction - Illustration using spring systems and simple problems - Weighted residual methods - Galerkin's method - Variational approach - Rayleigh-Ritz method.

One-dimensional finite element analysis; bar element, beam element, frame element - Heat transfer problems.

Two-dimensional finite element analysis; types of elements, shape functions, natural coordinate systems.

Applications to structural mechanics - Numerical integration - Solution of finite element equations.

Fluid flow problems - Dynamic problems.

References:

1. Seshu, P., *Textbook of Finite Element Analysis*, Prentice-Hall, India, 2003.
2. Segerlind, L.J., *Applied Finite Element Analysis*, John Wiley, 1987.

Course Outcomes:

On successful completion of the course, the student will be able to,

1. Illustrate the basic concepts of finite element systems through spring systems and by solving problems.
2. Interpret one-dimensional and two-dimensional finite element analysis with examples.
3. Apply finite element methods to real world problems and obtain solutions.

ME354 ADVANCED IC ENGINES (3 - 0 - 0) 3

Course Objectives:

1. Learn to classify different types of internal combustion engines and their applications.
2. Apply principles of thermodynamics, fluid mechanics, and heat transfer to the design and analysis of engines and engine components.
3. Become aware of the relevance of environmental and social issues on the design process of internal combustion engines.
4. Develop mathematical methods for designing components and systems
5. Apply numerical methods to perform design calculations.
6. Advance proficiency in professional communications and interactions.

Engine design parameters, properties of working fluids.

Analysis of engine cycles, fuel intake systems.

Combustion in SI and CI engines.

Pollutant formation and control in IC engines.

Engine performance and modeling.

References:

1. Heywood, J.B., *Internal Combustion Engine Fundamentals,* McGraw-Hill, 1988.
2. Taylor, C.P., *The Internal Combustion Engines in Theory and Practice,* Vol. II, MIT Press, 1985.
3. Ganesan, V., *Internal Combustion Engines,* 2nd ed., Tata McGraw-Hill, 2003.

Course Outcomes:

On successful completion of the course, the student will be able to,

1. Differentiate the internal combustion engines based on the classification parameters.
2. Analyze the internal combustion engine cycles and performance parameters.
3. Explain the combustion characteristics of internal combustion engines and identify the abnormalities in combustion.
4. Identify the exhaust pollutants.
5. illustrate the measuring instruments appropriately while working on internal combustion engines.

SEMESTER VII

Elective – II & III:

ME451 INDUSTRIAL SAFETY (3 - 0 - 0) 3

Course Objectives:

1. To Understand and apply the principles of science, technology, engineering, and maths to solve industry-related problems.
2. Contribute to the profitable growth of industrial economic sectors by using IE analytical tools, effective computational approaches, and systems thinking methodologies.

Evolution of modern safety concept- safety policy - Safety Organization - Safety Committee - budgeting for safety.
Safety training – creating awareness, awards, celebrations, safety posters, safety displays, safety pledge, safety incentive scheme, safety campaign

Concept of an accident, reportable and non reportable accidents, reporting to statutory authorities – principles of accident prevention – accident investigation and analysis – records for accidents, departmental accident reports, documentation of accidents – unsafe act and condition – domino sequence – supervisory role – cost of accident.

Machine Guarding, Guarding of hazards, Machine Guarding types and its application – Safety in welding and Gas cutting – Safety in Manual and Mechanical material handling- Safety in use of electricity

Toxicity- TLV- Types of Chemical Hazards-Occupational diseases caused by dust, fumes, gases, smoke and solvent hazards- control measures
Fire triangle- Types of fire - first aid firefighting equipment – flammability limit- LPG safety

Overview of factories act 1948 – OHSAS-18000

References:

1. Accident Prevention Manual for Industrial Operations", N.S.C.Chicago, 1982
2. Blake R.B., "Industrial Safety" Prentice Hall, Inc., New Jersey, 1973
3. Heinrich H.W. "Industrial Accident Prevention" McGraw-Hill Company, New York, 1980.
4. Krishnan N.V. "Safety Management in Industry" Jaico Publishing House, Bombay, 1997.
5. John Ridley, "Safety at Work", Butterworth & Co., London, 1983.

Course Outcomes:

On successful completion of the course, the student will be able to,

1. Enumerate the importance of industrial safety.
2. Indicate unsafe acts and conditions causing accidents.
3. Outline accident investigation and analysis.
4. Identify risk accompanying chemical hazards, fire hazards and electrical hazards.
5. Recognize the various occupational diseases and their causes.
6. Interpret hazards associated with manufacturing processes and material handling operations.

ME453 OPTIMIZATION IN ENGINEERING DESIGN (3 – 0 – 0) 3

Course Objectives:

1. Earn how MSDO can support the product development process of complex, multidisciplinary engineered systems
2. Learn how to rationalize and quantify a system architecture or product design problem by selecting appropriate objective functions, design parameters and constraints
3. Subdivide a complex system into smaller disciplinary models, manage their interfaces and reintegrate them into an overall system model

Introduction - Optimization techniques. Single and multi variable optimization. Constrained optimization.
Specialized algorithms - Integer, geometric.

Nontraditional algorithms.

References:

1. Deb, Kalyanmoy, *Optimization for Engineering Design,* Prentice - Hall, 1995.
2. Rao. S.S., *Optimization Theory and Applications,* Wiley Eastern Ltd., 1998.

Course Outcomes:

On successful completion of the course, the student will be able to,

1 Enumerate the necessity of optimization in engineering design.
2 Identify the various optimization techniques pertaining to design oriented problems.
3 Solve problems with single and multi – variable.
4 Formulate constrained optimization problems.
5 Distinguish between integer and geometric specialized algorithm.
6 Apply non-traditional algorithms for optimization of typical problems requiring their application.

ME455 COMPUTATIONAL FLUID DYNAMICS (3 - 0 - 0) 3

Course Objectives:

1. To introduce numerical modeling and its role in the field of heat transfer and fluid flow.
2. To enable the students to understand the various discretization methods and solving methodologies.
3. To create confidence to solve complex problems in the field of heat transfer and fluid dynamics by using high speed computers

Classification of partial differential equations - Discretization methods; finite difference and finite volume formulations.

Numerical solution of elliptical equations - Linear system of algebraic equations.

Numerical solution of parabolic equations - Stability analysis.

Numerical solution of hyperbolic equations - Burgers equation.

Incompressible Navier-Stokes equations and algorithms - Basics of grid generation.

References:

1. Tannehill, J.E., Anderson, D.A., and Pletcher, R.H., *Computational Fluid Mechanics and Heat Transfer*, 2nd ed., Taylor & Francis, 1997.
2. Hoffmann, K.A. and Chiang, S.T., *Computational Fluid Dynamics for Engineers*, Engineering Education Systems, 2000.
3. Andeson J.D., Computational Fluid Dynamics – The basics with applications, Mc Graw-Hill, 1995.
4. Versteeg, H.K. and Malalasekera, W., *An Introduction to Computational Fluid Dynamics – The finite volume method*, Longman Scientific & Technical, 1995.
5. Patankar, S.V., *Numerical Heat Transfer & Fluid Flow*, Hemisphere, 1980.

Course Outcomes:

On successful completion of the course, the student will be able to,

1. Express numerical modeling and its role in the field of fluid flow and heat transfer.
2. Apply the various discretization methods, solution procedures and turbulence modeling to solve flow and heat transfer problems.
3. Interpret the knowledge, capability of analyzing and solving any concept or problem associated with heat energy dynamics and utilization.
4. Illustrate the working concepts of thermal engineering.

ME457 DESIGN OF GEARS AND CAMS (3 - 0 - 0) 3

Course Objectives:

1. Identify the basic relative kinematics relations of two moving point
2. Identify individual links
3. Identify and categorize the type of the connection of the links (joints)
4. Develop analytical equations describing the relative position, velocity and acceleration of all moving links
5. Identify all reaction and inertia forces on the links
6. Apply the fundamentals of part I to specific link and joint combinations such as cams and gear systems,
7. Demonstrate familiarity with standards in gear and cam machine components,

Design of gears - spur, helical. bevel and worm & worm wheel.

BIS standards for gear design.

Force analysis.

Design of cams - Tangential and Polynomial cams.

References:

1. BIS Standards.
2. Maitra, G.L., *Hand Book of Gear Design,* 2nd ed., Tata McGraw-Hill, 2005.
3. Merritt, H.E., *Gear Engineering,* A. H. Wheeler & Co. Pvt. Ltd., 1984.

Course Outcomes:

On successful completion of the course, the student will be able to,

1. Explain the basic principles of gears and cams.
2. Demonstrate the design process of commonly used gears and cams.
3. Recognize the standards used in design of gears.
4. Analyze the force acting on the gears.

ME459 MEMS DEVICES - DESIGN AND FABRICATION (3 – 0 – 0) 3

Course Objectives:

1. To think in an unified way about interdisciplinary Microsystems
2. Understand the operation of a wide range of sensors and actuators appropriate for microscale systems encompassing different energy domains represent microsystems as generalized networks.
3. To design, analysis and simulation master techniques for combining a structured top-down system design approach with bottom-up constraints propagation design and simulate microsystems using behavioral modeling languages and finite element analysis.

An overview of microelectromechanical devices and technologies, and an introduction to design and modeling

Standard microelectronic fabrication technologies; bulk micromachining, surface micromachining, bonding technologies, related fabrication methods, and creating process flows.

Mechanical, thermal, electrical, magnetic, optical, and chemical properties of materials

Introduction to lumped modeling of systems and transducers; an overview of system dynamics

MEMS examples, energy methods, the thermal energy domain; modeling dissipative processes, *Fluids and Transport*

Text Book

1. Tai – Ran Hsu, "MEMS& Microsystems Design and Manufacturing", Tata McGraw-hill Edition, 2006

References

1. Mohamed Gad-el-Hak, "MEMS: Design and Fabrication (Mechanical Engineering)", CRC; 1 edition, 2005.
2. Marc J. Madou, "Fundamentals of Microfabrication, the science of Miniaturization", CRC Press Second Edition, 2002.
3. Sami Franssila, "Introduction to Microfabrication", John Wiley; 1 edition, 2004.
4. John A. Pelesko, David H. Bernstein, "Modeling MEMS and NEMS", CRC; 1 edition, 2002.

Course Outcomes:

On successful completion of the course, the student will be able to,

1. Illustrate on the design and modeling of MEMS components.
2. Explain the various MEMS fabrication technologies.
3. Describe the mechanical, thermal, electrical, magnetic and chemical properties of material.
4. Discuss the lumped modeling of systems and transducers.
5. Interpret the micro system dynamics.
6. Identify the modeling dissipative processes.

ME461-WELDING ENGINEERING (3 – 0 – 0) 3

Course Objectives:

1. Occupational skills in welding construction.
2. Emphasis is placed on four position welding techniques (flat, vertical, horizontal and overhead) utilizing Oxy-Acetylene welding (OAW), Shielded Metal-Arc Welding (SMAW), Gas Tungsten-Arc Welding (GTAW) and Gas Metal-Arc Welding (GMAW) processes.

Welding Processes - 1 - Gas welding, manual, submerged arc, TIG, MIG welding, plasma arc. Electroslag, electro-gas welding, pressure welding processes - cold and hot pressure welding. resistance, friction and explosive welding. Plastic and ceramic welding.

Welding Processes - 2 Radiant energy and solid phase welding processes and equipment - Beam power control. Laser beam cutting, under water welding. Diffusion welding.

Allied Processes Brazing, Soldering, Cutting, Surfacing Methods - Need, Flame Spraying. Plasma Spraying.

Welding metallurgy - weld thermal cycles and their effects - structural changes in different materials, effect of pre and post heat treatment. Weldability.

Testing And Design of Weldment - Design and quality control of welds. Edge preparation-types of joints, weld symbols. Stresses in butt and fillet welds - weld size calculations. Design for fatigue. Testing - tensile, bend hardness. Impact, notch and fatigue tests. Visual examination - liquid penetration test, magnetic particle examination. Radio graphs, ultrasonic testing. Life assessment of weldments.

References:

1. Jackson, M.D., *Welding Methods and Metallurgy*, Charles Griffin & Company, London, 1967.
2. AWS, American Welding Society, Volume I to V, Miami, 1982.
3. George E. Linnert, *Welding Metallurgy*, GML Publications, South Carolina, U.S.A., 1994.
4. Little LR, *Welding and Welding Technology*. Tata McGraw-Hill, New Delhi, 1980.

Course Outcomes:

On successful completion of the course, the student will be able to,

1. Illustrate the various welding techniques including plastic and ceramic welding.
2. Explain radiant energy and solid phase welding processes.
3. Extend the concept of welding to other allied processes such as brazing and soldering.
4. Analyze the welding metallurgy and effect of pre and post heat treatment.
5. Infer the testing and design of weldments for quality control of welds.
6. Review the life assessments of weldments.

HM401 CORPORATE COMMUNICATIONS (3 – 0 – 0) 3

Course Objectives:

1. This course focuses on how corporations communicate with their key audiences, both internal and external to the corporation. Through readings, case study analysis, discussions and screenings, the course introduces students to the practices that allow companies to reach a variety of stakeholders, including customers, investors, employees, media, government agencies and communities.

Communication in the corporate world – Communication process – Networks and Channels of communication

Technology for communication – Role of psychology – Motivation - Speech mechanics – Mental process of speaking

Extempore speech practice – Group dynamics – Seminar & Presentation skills and interview strategies

Listening skills & practice – Familiarity to accents and tones – Varieties of Styles & Registers – Mechanics of technical writing – Report & Executive summary

Abstracts, Circulars & Notices – Proposals, Agenda & Minutes – Papers for Presentation – Marketing Language.

References:

1. Simon Sweeney, *English for Business Communication,* Cambridge University Press, 1997.
2. Shiv Khera, *You Can Win,* Macmillan, 1998.
3. June A. Valladares, *The craft of Copywriting,* Response Books, 1998.
4. Matthukutty M. Monippally, *Business Communication Strategies,* Tata McGraw-Hill, 2001.
5. Raymond V.Lesikar & Marie E. Flatley, *Basic Business Communication,* Tata Mc Graw-Hill, 2005.

Course Outcomes:

On successful completion of the course, the student will be able to,

1. Communicate and will find sources for networks and channels for communication.
2. Explain the role of psychology and motivation in communication.
3. Outline the necessity of group dynamics that relate with presentation and interview strategies.
4. Infer the listening skills and familiarize to accent and tone.
5. Revise writing of abstract, circular and notice.
6. Demonstrate his/her language in marketing language.

SEMESTER VIII

Elective IV & V:

ME452 INDUSTRIAL ROBOTICS (3 - 0 - 0) 3

Course Objectives:

1. To introduce the basic concepts, parts of robots and types of robots
2. To make the students familiar with the various drive systems for robot, sensors and their applications in robots, programming of robots
3. To discuss about the various applications of robots, justification, implementation and safety of robot.

Classification and characteristics

Principles and problems in robot design and control

Transmission system.

Vision system.

Programming and languages.

References:

1. Mair, G.M., *Industrial Robotics,* Prentice-Hall, 1988.
2. Considine, D.M. and Considine, G.D., *Standard Hand Book of industrial Automation,* Chapman and Hall, 1986.
3. Groover, M.P., Weiss, M., Nagel, R.N., and Odrey, N.G., *Industrial Robotics, Technology, Programming, and Applications*, McGraw-Hill, 1995.

Course Outcomes:

On successful completion of the course, the student will be able to,

1. Classify and characterize the robots based on the configuration and work volume.
2. Explain and solve the problems related to robot design and control.
3. Illustrate the working of the transmission system in a robot.
4. Discuss the concept of vision system and image processing.
5. Write programs for automatic functioning of a robot.
6. Design a working model of a robot using the concepts and principles learnt.

ME454 COMBUSTION ENGINEERING (3 - 0 - 0) 3

Course Objectives:

1. This course starts with a review of chemical thermodynamics, statistical mechanics, equilibrium chemistry, chemical kinetics, and conservation equations.
2. Then the following subjects are covered: chemical and dynamic structure of laminar premixed, diffusion, and partially premixed flames; turbulent premixed combustion; turbulent diffusive combustion in one and two-phase flows;
3. Aerodynamics and stabilization of flames; ignition, extinction and combustion instabilities; non-intrusive combustion diagnostics and flame spectroscopy.

Combustion of fuels - Combustion equations and air-fuel ratio calculations.

Thermodynamics of combustion - Thermochemistry - Kinetics of combustion.

Laminar and turbulent flames - Quenching, flammability, ignition and flame stabilization. Combustion in SI and CI engines.

Emission and control methods.

References:

1. Turns, S.R., *An Introduction to Combustion, 2nd* ed., McGraw-Hill, 2000.
2. Glassman, I**.,** *Combustion,* 3rd ed., Academic Press, 1996.
3. Heywood, J.B., *Internal Combustion Engine Fundamentals,* McGraw-Hill, 1988.
4. Mukunda, H.S., *Understanding Combustion*, Macmillan, 1992.

Course Outcomes:

On successful completion of the course, the student will be able to,

1. Formulate combustion equations to determine A/F, adiabatic flame temperature and pollutant concentration.
2. Relate the thermo chemistry and kinetics of combustion to evolve mathematical models for combustion.
3. Identify factors responsible for laminar and turbulent flame propagation.
4. Apply the different principles of flame stabilization and ignition to design combustor.
5. Summarize emission associated with combustion and identify their control techniques.

ME456 DYNAMICS OF MACHINERY (3 - 0 - 0) 3

Course Objectives:

1. To understand the force-motion relationship in components subjected to External Forces
2. To analyse the force-motion characteristics of standard mechanisms
3. To study the undesirable effects of unbalances resulting from prescribed motions in mechanism.

Single degree of freedom systems - Periodic excitations - Impulse response - Virtual work.

Forced vibrations.

Two degree of freedom systems - coupled vibrations.

Vibration of continuous systems.

Wave and Euler equations - Vibration of plates.

References:

1. Rao, J.S. and Gupta, K., *Introductory Course on Theory and Practice of Mechanical Vibration,* New Age International Pvt. Ltd., 2004.
2. Thomson, W.T., *Theory of Vibration with Applications,* CBS Publishers, New Delhi, 1990.

Course Outcomes:

On successful completion of the course, the student will be able to,

1. State the single degree of freedom systems.
2. Sketch the impulse response for a periodic excited virtual work.
3. Examine the concept of forced vibration.
4. Extend the concept to two degree of freedom systems.
5. Manipulate the vibration of continuous systems.
6. Solve problems using wave and euler equations.

ME458 RENEWABLE ENERGY (3 - 0 - 0) 3

Course Objectives:

1. To enable the students to understand the principle of working and the components of different non-conventional sources of energy and their utilization.
2. To get an exposure on the power plants working with non conventional energy

Solar energy - Solar radiation - Heat transfer equations.

Solar thermal energy conversion - Efficiencies - Solar photo voltaic energy.

Bio energy - Conversion - bio degradation - Biogas generation - Fuel properties - Biomass gasifier.

Wind energy - Data and energy estimation, Conversion - Wind mill - Performance, applications - Geothermal.

Tidal energy - Magneto hydrodynamic - Thermionic - Fuel cell.

References:

1. Sukhatme, S.P., *Solar Energy: Principle of Thermal Collection and Storage,* 2nd ed., Tata Mc-Graw Hill, 2000.
2. Rao, S. and Parulekar, R.B., *Energy Technology - Nonconventional, Renewable and Conventional*, Khanna Publishers, 1995.
3. Rai, G.D., *Nonconventional Energy Sources,* Khanna Publishers, 1999.
4. Le Gourieres, D., *Wind Power Plant - Theory and Design,* Pergaman Press, 1982.

Course Outcomes:

On successful completion of the course, the student will be able to,

1. Explain solar radiation and heat transfer equations.
2. Analyze the properties of bio energy.
3. Compute wind energy potential and predict performance of wind turbines.
4. Point out the advantages of geothermal energy.
5. Describe the harvesting of tidal energy.
6. Distinguish the various form of energies such as magneto hydrodynamic, thermionic and fuel cell.

ME460 ADVANCED MACHINING PROCESSES (3 – 0 – 0) 3

Course Objectives:

1. To understand the basic concepts of nontraditional machining techniques
2. To know the factors influencing the processes and their applications

Non-traditional machining processes – classification.

Chemical and electrochemical processes - material removal - maskants and etchants - types of chemical material removal - application and limitations - Electrochemical material removal.

Thermoelectrial processes - types - electrical discharging machining, electron beam machining, ion beam machining and plasma arc machining.

Mechanical processes - ultrasonic machining abrasive jet machining - abrasive flow machining - water jet cutting.

Special Machining Processes - polygonal turning and drilling deep hole drilling and trepanning - shaped tube electrolytic machining - thread rolling - roller burnishing - electrical discharge wire cutting - thermal deburring - orbital grinding micromachining - Numerical control and automated processes.

References:

1. *Production Technology by HMT*, Tata McGraw Hill, 2002.
2. Wellar, P.C., *Non-Traditional Machining Processes*, SME, Michigan, 1984.
3. Pandey, P.C., *Modern Machining Processes*, Tata McGraw Hill Company, 2004.
4. Serope Kalpakjian, *Manufacturing Processes for Engineering Materials*, 3rd ed.., Addison Wesicy Publishing Company, 1997.

Course Outcomes:

On successful completion of the course, the student will be able to,

1. Classify the various non-traditional machining processes.
2. Explain the working of chemical and electro chemical processes.
3. Identify important process parameters associated with various non – traditional machining processes.
4. Explain the effect of process parameters on the metal removal rate and surface finish / surface intensity.