

Mechanical Engineering Curriculum

<u>E1 Sem1 Courses and Syllabus</u>		
Course Code: MA1101	Course Name: Mathematics I	No. of Credits: 4
Detailed Syllabus: Linear Algebra: Rank and inverse of a matrix, Eigen values and Eigen vectors, Hermitian and skew Hermitian matrices, Numerical solution of system of linear equations. Differential calculus: Limit, continuity and differentiability of functions of several variables, partial derivatives and their geometrical interpretation, Differentials, Derivatives of composite and implicit functions, Maxima and minima of functions of several variables- Lagrange's method of multipliers. Integral Calculus: differentiation under integral sign, differential of integrals with variable limits,- Leibnitz rule. Rectification, double and triple integrals, computations of surface and volumes. Vector Calculus: Scalar and vector fields, level surfaces, directional derivative, Gradient, Curl, Divergence, Laplacian, Line and surface integrals, theorems of Green, Gauss and Stokes. Complex variables: Limit, continuity, differentiability and analyticity of functions, Cauchy-Riemann equations, Line integrals in complex plane, Cauchy's integral theorem, independence of paths, Existence of indefinite integral, Cauchy's integral formula, Derivatives of analytic functions, Taylor's series, Laurent's series, Zeros and singularities, Residue theorem, Evaluation of real integrals. Reference books: 1. Advanced Engineering Mathematics by R K Jain and S.R.K. Iyenger, Narosa publishing house, New Delhi. 2. E. Kreyszig Advanced Engineering Mathematics, 9th Edition, John Wiley & sons.		
Course Code: ME1101	Course Name: Engineering Mechanics	No. of Credits: 4
Detailed Syllabus: Force systems: Introduction, Forces acting at a point, Moment of a force about a point and about an axis; couple moment; reduction of a force system to a force and a couple. Equilibrium : Free body diagram; equations of equilibrium; problems in two and three dimensions; plane frames and trusses. Friction : Laws of Coulomb friction., problems involving large and small contact surfaces; square threaded screws; belt friction; rolling resistance. Kinematics and Kinetics of particles: Particle dynamics in rectangular coordinates cylindrical coordinates and in terms of path variables; central force motion. Properties of areas : Centroid and Centre of gravity, Moments of inertia and product of inertia		

of areas, polar moment of inertia, principal axes and principal moments of inertia.

Concept of stress and strain : Normal stress, shear stress, state of stress at a point, ultimate strength, allowable stress, factor of safety; normal strain, shear strain, Poissons ratio, generalized Hook's law; analysis of axially loaded members.

Torsion : Torsion of cylindrical bars, torsional stress, modulus of rigidity and deformation.

Flexural loading : Shear and moment in beams; load, shear and moment relationship; shear and moment diagrams; flexure formula; shear stress in beams; differential equation of the elastic curve, deflection of beams.

Transformation of stress and strain : Transformation of stress and strain, principal stresses, principal strains, Mohr's circle for stress and strain.

Combined loading: Axial and torsional; axial and bending; axial, torsional and bending.

Books related to mechanics:

1. Vector mechanics for Engineers by P. Beer and Russel Johnson,
2. Solid mechanics by Popov

Course Code: CS1701

Course Name: Programming and Data structures

No. of Credits: 4

Detailed Syllabus: Theory Component :

Introduction to Programming ;

Variables, Assignment; Expressions;

Input/Output;

Conditionals and Branching;

Iteration;

Functions and Recursinons;

Arrays;

Introduction to Pointers; Structures;

Introduction to Data-Procedure Encapsulation; Dynamic allocation;

Introduction to Data Structure ;Stacks and Queues; Linked structures; Searching, Sorting and Search Trees; Time and space requirements.		
Course Code: CE1201	Course Name: Engineering Drawing and Computer Drafting	No. of Credits: 4
Detailed Syllabus: Introduction to IS code of drawing; Conics and Engineering Curves - ellipse, parabola, hyperbola, cycloid, trochoid, involute; Projection of lines - traces, true length;Projection of planes and solids; Solid objects - cube, prism, pyramid, cylinder, cone and sphere; Projection on Auxiliary planes; Isometric projection, isometric scale; Section of solids - true shape of section; Introduction of Development and Intersection of surfaces. Introduction to CAD tools - basics and use;		
Course Code: ME1102	Course Name: Workshop	No. of Credits: 3
Detailed Syllabus: <u>Introduction to Manufacturing Processes</u> Theory Component: Basic concepts and principles of manufacturing Performing processes: Casting forging, rolling, drawing,extrusion,press tool work, plaastic moulding powder metallurgy. Joining Processes: Welding,brazing and crimping Semi-finishing and finishing process: Machining (Turning,shaping,drilling,Milling and grinding). Non-traditional processes: Abrasive jet machining, Ultrasonic machining, Electro-discharge machining Electrochemical machining and laser beam machining Product Quality: Possible defects and their detection, assessment and remedy.		
Course Code: CS1201	Course Name: Programming and Data structures Lab	No. of Credits: 2
Detailed Syllabus: 1. Familiarization of computer and environment and execution of sample programs. 2. Expression evaluation 3. Conditionals and branching 4. Iterations 5. Functions 6. Recursions 7. Arrays		

8. Structures
9. Linked lists
10. Data structure

E1 Sem2 Courses and Syllabus

Course Code: MA1202

Course Name: Mathematics II

No. of Credits:4

Detailed Syllabus:

Laplace transform: Definition of Laplace transform, Linearity property, Condition for existence of Laplace transform, First and second shifting properties, Laplace transform of derivatives and integral, Unit step function, Dirac delta function, Differentiation and integration of transforms, Convolution theorem, Inversion, Periodic functions, Evaluation of integrals by L.T., Solution of boundary value problems.

Fourier series: Periodic functions, Fourier series representation of a function, half range series, Sine and Cosine series, Fourier integral formula, Parseval's identity.

Partial differential equation: Introduction to partial differential equations, Linear and quasi-linear equations of first order, classification of integrals, Lagrange's method of solution and its geometrical interpretation, compatibility conditions, Charpit's method, special types of first order equations, second order partial differential equations with constant and variable coefficients.

Numerical Analysis: Trapezoidal and Simpson's $1/3^{\text{rd}}$ rule for numerical integration, solution of polynomials and Newton-Raphson method, single and multi step methods for differential equations.

Probability and statistics: Definition of probability and sampling theorems, Definition of conditional probability, mean, mode, median and standard deviation, Random variables, Poisson, normal and binomial distributions.

Reference books:

1. Advanced Engineering Mathematics by R K Jain and S.R.K. Iyenger, Narosa publishing house, New Delhi.
2. E. Kreyszig Advanced Engineering Mathematics, 9th Edition, John Wiley & sons.
3. A Papoulis: Probability, Random variables and stochastic processes.

Course Code: EE1101

Course Name: Basic Electrical Engineering

No. of Credits: 4

Detailed Syllabus:

Sources of energy; General structure of electrical power systems, Power transmission and distribution via overhead lines and underground cables, Steam, Hydel, Gas and Nuclear power generation.

DC Networks:

Kirchoff's laws, node voltage and mesh current methods, Delta-star and star-delta conversion, Superposition principle, Thevenin's and Norton's theorems.

Single phase AC Circuits:

Single phase EMF generation, average and effective values of sinusoids, solution of R,L,C series circuits, the j operator, complex representation of impedances, phase diagram, power factor, power in complex notation, solution of parallel and series- parallel circuits.

Three phase AC Circuits :

Three phase EMF generation, delta and Y connections, line and phase quantities, solution of three phase circuits, balanced supply voltage and balanced load, phasor diagram, easurement of power in three phase circuits, Three phase four wire circuits.

Magnetic Circuits :

Ampere's circuital law, B- H curve, solution of magnetic circuits, hysteresis and eddy current losses, relays, an application of magnetic force, basic principles of stepper motor.

Transformers :

Construction, EMF equation, ratings, phasor diagram on no load and full load, equivalent circuit, regulation and efficiency calculations, open and short circuit tests, auto-transformers.

Induction Motor :

The revolving magnetic field, principle of orientation, ratings, equivalent circuit, Torque-speed characteristics, starters for cage and wound rotor type induction motors.

DC Machines :

Construction, EMF and Torque equations, Characteristics of DC generators and motors, speed control of DC motors and DC motor starters.

Electrical Measuring Instruments :

DC PMMC instruments, shunt and multipliers, multimeters, Moving iron ammeters and voltmeters, dynamometer, wattmeter, AC wathour meter, extension of instrument ranges.

Course Code: ME2103

Course Name: Mechanics of Materials

No. of Credits: 4

Detailed Syllabus:

Introduction of theory of elasticity- Hooke's law and tension test; Elastic material properties; Analysis of Stress and Strain, Stress equation of equilibrium, Compatibility equations, Stress- Strain Relations, Solution of elasticity equations-stress function approach; Energy methods and Lagrange's equations; Virtual Work, Shape functions for displacement and solution by energy methods; Bending of beams, Axially loaded structures, torsional load and bending of beams; Combined axial and bending, torsional and bending; Yield criteria. Finite element methods of one dimensional structures; axial, torsional and bending elements and stiffness matrices; Various structural elements and examples such as curved beams, Axisymmetric problems, Thick walled cylinders, Stresses in composite tubes-Shrink fits, Rotating discs with uniform and variable thickness, Rotating shafts and cylinders. Columns and struts- Euler's Buckling load, Different end conditions, Beam columns

Computer aided stress analysis with cases dealt in the class and visualize the stress and strain distribution in the structures

Reference Books:

A. C. Ugural and S. K. Fenster, *Advanced Strength and Applied Elasticity*.
A. P. Boresi, R. J. Schmidt and O. M. Sidebottom, *Advanced Mechanics of Materials*.
S. P. Timoshenko and J. N. Goodier, *Theory of Elasticity*.
I.S. Sokolnikoff, *Mathematical Theory of Elasticity*.
Y.C. Fung, *Foundations of Solid Mechanics*.

Course Code: ME2102

Course Name: Thermodynamics

No. of Credits: 4

Detailed Syllabus:

Introduction

Fundamental Concepts: definitions of system and surrounding, concept of control volume, thermodynamic state, concepts of simple compressible substances, pure substance and phase, thermodynamic processes and thermodynamic equilibrium; Temperature and Zeroth law; Thermodynamic properties and use of tables of thermodynamic properties; Idea of a generalized chart and the law of corresponding states; Concept of ideal gases and their equations of state; Thermodynamic concept of energy; Modes of work and heat transfer.

First Law of Thermodynamics

The first law referred to cyclic and non-cyclic processes, concept of internal energy of a system, conservation of energy for simple compressible closed systems; Definitions of enthalpy and specific heats; Conservation of energy for an open system or control volume, steady & transient processes.

Second Law of Thermodynamics

The directional constraints on natural processes; Formal statements; Concept of reversibility; Carnot principle; Absolute thermodynamic temperature scale; Clausius Inequality, entropy, change in entropy in various thermodynamic processes, Tds relations, entropy balance for closed and open systems, Principle of increase-in-Entropy, entropy generation. Exergy: Concept of reversible work & irreversibility; Second law efficiency;

Thermodynamic Property Relations

Maxwell relations; Clausius-Clapeyron equation; Difference in heat capacities; Ratio of heat capacities; Joule-Thompson coefficient.

Introduction to Properties of Mixtures and Phases

Amagat's and Dalton's model, Equation of state and properties of ideal gas mixtures, Change in entropy on mixing; introduction to real-gas mixtures; Gibbs phase rule;

Reference Books:

Johnes, James B and George A Hawkins, *Engineering Thermodynamics*.

J Van Wylen and Sonntag, *Fundamentals of Classical Thermodynamics*.

G F C Rogers and Y R Mayhew, *Engineering Thermodynamics Work and Heat Transfer*.

Course Code: ME 3101

Course Name: Material Science and Metallurgy

No. of Credits: 4

Detailed Syllabus: Introduction: why study properties of materials, classification of materials, advanced material, future and modern materials.

Atomic structure and bonding in solids, crystal structures, crystalline and non-crystalline materials, miller indices. Imperfections in solids like point, line and interfacial defects

Phase Diagrams, Equilibrium of phase diagrams, particle strengthening by precipitation, precipitation reactions, kinetics of nucleation and growth, Iron-carbon system, phase transformation, transformation rate effects and TTT diagrams, microstructure and property changes in iron-carbon diagrams.

Heat treatment of steel: Annealing, Normalizing, Hardening, Tempering, Austempering and Martempering of steels. Surface hardening of steels. Carburizing, Nitriding, Cyaniding, Flame and induction hardening methods.

Diffusion mechanisms: Steady and non-steady state diffusion, factors influencing diffusion, non-equilibrium transformation and microstructure. Dislocation and plastic deformation, mechanisms of strengthening in metals, recovery, recrystallization and grain growth.

Introduction and applications of composite materials, plastic, ceramics etc.

Course Code: EE1701

Course Name: Basic Electrical Engineering Lab

No. of Credits: 2

Detailed Syllabus:

1. Characteristics of Fluorescent and Incandescent Lamp
2. Verification of Network Theorems
3. R-L-C Series Circuit
4. Three phase power measurement by two Wattmeter method.
5. Single Phase Energy Meter
6. OC and SC Test of Single Phase Transformer
7. D.C Shunt Motor
8. OCC of separately excited DC Shunt Generator
9. Load test of Three Phase Induction Motor

Course Code: ME 2701	Course Name: Mechanics of Materials Lab	No. of Credits: 2
Detailed Syllabus: - To carry out tension shear test of material supplied - To carry out charpy test, Tension impact test, Izod test. - To study the stress strain tension characteristics of metals by using UTM - To study the stress strain compression characteristics of metals by using UTM - To find out the modulus of elasticity of the specimen supplied and to verify the Maxwells theorem - To determine the hardness using different hardness testing machines: Brinnels, Vickers and Rockwell's. - To calibrate the given proving ring by applying compressive force by U.T.M - Deflection test on beams using U.T.M		
<u>E2 Sem1 Courses and Syllabus</u>		
Course Code: EC2101	Course Name: Basic Electronics	No. of Credits: 4
Detailed Syllabus: Introduction to electronics and electronic systems, Semiconductor and devices like diodes, BJT, FET, MOSFET, Rectifier and Filters, Transistor biasing. Small signal transistor amplifiers, Operational amplifiers, Feedback and Oscillators, Digital circuit and combinational logic, Sequential logic and flip-flops, ADC & DAC, Data acquisition systems, Memory systems, Case studies of electronic systems like microprocessors, radio & TV broadcasting, Mobile & cellular telephones, fiber optics & networking.		
Course Code: ME2101	Course Name: Kinematics of Machines	No. of Credits: 4
Detailed Syllabus: Beginnings of Theory of Machines, Planar Mechanisms, Basic Kinematic Concepts, Elementary Mechanisms, Grübler's Criterion Four Link Chains, Kinematic Inversion; Kinematic Analysis of Mechanisms, Velocities by Centro Method, Relative Velocity Equation, Relative Acceleration Equation, Acceleration Analysis of Reciprocating Engine Mechanism, Analytical Determination of Velocity and Acceleration of the Piston; Straight Line Motion and Universal Coupling, Condition for Exact Straight Line Motion, Exact Straight Line Motion Mechanisms, Approximate Straight Line Motion Mechanisms, Steering Gear Mechanism, Hooke's (Cardan, Universal) Joint; Cams, Types of Cams and Followers, Displacement Diagrams, Disk Cam with Knife-Edge Follower, Translating Roller Follower, Translating Flat Follower, Oscillating Flat Follower, Cams of Specified Contour; Gears, Classification of Gears, Types of Motion, Gear Nomenclature, Law of Gear Tooth Action, Involute as a Gear Tooth Profile, Layout of an Involute Gear Set, Producing Gear Teeth, Meshing Gears and Line of Contact, Interference of Involute Gears, Minimum Number of Teeth to Avoid Interference, Contact Ratio, Cycloidal Tooth Profiles, Cycloidal and Involute Tooth Forms;		

Helical, Spiral, Worm and Bevel Gears, Involute Helicoid, Helical Gear Tooth Relations, Contact of Helical Gear Teeth, Helical Gear Calculations, Spiral [Crossed Helical] Gears, Worm Gearing, Bevel Gears, Formation of Bevel Gears;

Gear Trains, Classification of Gear Trains, Simple Gear Trains, Compound Gear Trains, Synthesis of Gear Trains, Gear Train Applications to Machine Tools, Epicyclic Trains, Inversions of Epicyclic Trains, Differential Trains, Torque Distribution in Epicyclic Trains, Example of an Epicyclic Train, Coupled Epicyclic Trains, Wilson Four Speed Automobile Gear Box.

Computer aided kinematic analysis with cases dealt in the class and visualize the Mechanisms and kinematic solutions.

Course Code: ME2202

Course Name: Fluid Mechanics

No. of Credits: 4

Detailed Syllabus:

Introduction - properties of fluids, concept of continuum.

Fluid statics - pressure variation in a static fluid, force on submerged surfaces, stability of floating bodies.

Kinematics – Lagrangian and Eulerian description, streamline, streakline and pathline, acceleration of a fluid element, continuity equation, stream function, rotation and angular deformation, irrotational flow, velocity potential.

Inviscid flow - Euler equation, Bernoulli's equation and its applications Reynolds transport theorem - conservation of mass, linear and angular momentum Stokes law of viscosity and Navier-Stokes equations.

Dimensional analysis and similarity - Buckingham Pi theorem. Finite Volume method for CFD solutions; Mach number and subsonic and supersonic cases; shock;

Internal flows - pipe flow, friction factor, Moody diagram, minor and major losses, pipe networks, hydraulic diameter.

External flows - boundary layer approximation, momentum integral method, flow over a flat plate, flow separation.

Turbulence - Reynolds experiment, Reynolds decomposition, time averaged Navier-Stokes equation, eddy viscosity.

Fluid Machinery - similarity, Euler equation for turbomachines, centrifugal pump, hydraulic turbines, cavitation.

Computer aided CFD analysis with cases dealt in the class and visualizing the flow parameters pressure, velocity, density, temperature.

Course Code:ME3101	Course Name: Manufacturing Processes	No. of Credits: 4
Detailed Syllabus: Casting process: Types of foundries, steps in making a casting; cast metals; types, materials and allowances of patterns; moulding processes and their characteristics; moulding materials; gating and riser design; melting furnaces; casting defects. Welding Welding processes, welding energy sources and their characteristics; fluxes and coatings; weldability and welding of various metals and alloys; metallurgical characteristics of welded joints; weld testing and inspection. Forming Classification of metal forming processes; basic metal working concepts and plasticity; yield criterion; slip line fields; estimation of force and energy requirements; technology of bulk and sheet metal forming processes; precision forming processes; various features of different types of metal forming dies; principles of powder forming.		
Course Code: ME2801	Course Name: Machine Drawing	No. of Credits: 4
Detailed Syllabus: Screw threads and Screw Fastenings using standard Empirical formulae, Riveted joints, Keys, Cotter-joints, Pin-joints, Shaft couplings: Box and split muff couplings, Flanged, Flexible, Universal and Oldham couplings, shaft bearings, Brackets and Hangers, Pipe joints, Orthogonal views and Sectional views of machine parts, Assembly drawing of various engine components and machine tool components, Specifications like fits and tolerances, surface finish, welding symbols, production methods, Introduction to functional design. Reference Books: 1. N.D. Bhatt, <i>Machine Drawing</i>. 2. N. Sidheswar, P. Kanniah and V.V.S. Sastry, <i>Machine Drawing</i>.		
Course Code: EC2701	Course Name: Basic Electronics Lab	No. of Credits: 2
Detailed Syllabus: 1. Familiarization with electronic components and usage of multimeter (measurement of resistance, classification of capacitors, diode testing) 2. Familiarization with Oscilloscope, signal generator and further usage of multimeters 3. Frequency response and square wave resting of R-C, C-R and R-L networks 4. Half-wave and full-wave rectifiers, rectification with capacitive filters, zenar diode and IC regulation 5. Studies on CE amplifiers 6. Studies on Analog Circuits using OP-AMP 7. Studies on logic gates		

Course Code: ME2702	Course Name: Kinematics of Machines Lab	No. of Credits: 2
Detailed Syllabus: 1. Practice of Kinematic chains and their inversion by Auto desk software 2. Graphical methods of velocity and acceleration analysis		
Course Code: ME2802	Course Name: Fluid Mechanics Lab	No. of Credits: 2
Detailed Syllabus: 1. Bernoulli's theorem 2. Orifice-meter 3. Venturimeter 4. Static pitot tube 5. Calibration of v-notch 6. Pipe friction apparatus 7. Rotameter 8. Free and forced vortex 9. Orifice and free jet flow		
<u>E2 Sem2 Courses and Syllabus</u>		
Course Code: ME2201	Course Name: Dynamics of Machinery	No. of Credits: 4
Detailed Syllabus: Static Force Analysis; Reciprocating Engine Mechanism, Quick Return Mechanism, Four Link Mechanism, Six Link Mechanism Analysis, Friction in Linkages, Slider in Equilibrium under the Action of Concurrent Forces, Slider in Equilibrium under the Action of Nonconcurrent Forces, Inertia Forces of A Reciprocating Engine Mechanism, Four Link Mechanism, Quick Return Mechanism, More Details of Reciprocating Engine Mechanism; Combined Static and Inertia Force Analysis, Twin Cylinder Engine Example, Dynamics of Reciprocating Engine Mechanism, Correction Torque, Bearing Loads of A Reciprocating Engine Example, Turning Moment Diagram and Flywheel, Turning Moment Diagram and Crankshaft Speed Fluctuation, Fly Wheel, Flywheel of An Internal Combustion Engine, Flywheel of A Punch Press, Analytical Expressions for the Turning Moment, Flywheel for Reciprocating Machinery; Balancing of rotating components; Unbalance in one Plane, Unbalance in Several Planes, Balancing Machines Balancing of Linkages; Inertia Force of A Reciprocating Mass, Balancing of Multicylinder In-Line Engine, Firing Order, Balancing of Radial Engines, Balancing of V-Type Engine, Balancing of Four-Bar Linkages [Shaking Forces], Balancing of Four-Bar Linkages [Shaking Moments], Complete Balancing of Four-Bar Linkages Gear and Cam Forces; Spur Gears, Helical Gears, Worm Gears, Bevel Gears, Cam Forces;		

Mechanisms for Control: Governors and Gyroscopes; Illustration Of Mechanisms In Control, Governors, Watt Governor, Porter Governor, Proell Governor, Performance Parameters, Spring Controlled Fly-Ball [Hartnell] Governor, Spring Controlled Governor With Auxiliary Spring [Wilson-Hartnell Governor], Spring Controlled Governor with Bell Crank attached to the Sleeve, Hartung Governor, Pickering Governor, Governor Effort and Power, Controlling Force, Friction and Insensitiveness, Centrifugal Effect of the Revolving Arms; Gyroscopes, Gyroscopic Forces and Couple, Thin Rod Rotating About Its Centroidal Axis, Gyroscopic Stabilization, Stability of A Four Wheel Vehicle Moving on A Curved Path, Stability of A Two Wheel Vehicle

Reference Books:

1. J. E. Shigley and J.J. Uicker, *Theory of Machines and Mechanisms*
2. A. K. Mallik, A. Ghosh, G. Dittrich, *Kinematic analysis and synthesis of Mechanisms.*
3. J. S. Rao and R. V. Dukupati, *Mechanism and Machine Theory.*
4. S. S. Rattan, *Theory of Machines.*

Course Code: ME2203

Course Name: Hydraulics and Hydraulic Machinery

No. of Credits: 4

Detailed Syllabus:

Impact of jet, Velocity diagrams for impulse and reaction turbines, axial, radial and mixed flow turbines. Fundamentals of hydraulic turbine theory; Turbine performance characteristics and selection of turbines; Design of radial flow and axial flow turbines and Pelton turbines; Fundamentals of Rotodynamic pumps; Centrifugal and axial flow pumps; special duty pumps; cavitations in hydraulic machines. Applications : hydraulic jack, lift etc.

Axial flow compressors: flow through cascades, cascade terminology, flow separation, radial equilibrium theory, actuator disc theory, effect of tip clearance, secondary flow, performance characteristics, surging and stalling.

Axial flow turbine: vortex theory, blade design, cooling of turbine blades, performance characteristics. profile loss, secondary flow loss, annulus loss, tip clearance loss. limiting factors in turbine design.

Course Code: ME3102

Course Name: Metal Cutting and Machine Tools

No. of Credits: 4

Detailed Syllabus:

Tool geometry, mechanism of chip formation. Mechanics of machining. Cutting temperature causes, effects, estimation, measurement and control. Cutting fluid applications. Failure modes, wear and life of cutting tools. Cutting tool materials. Role of geometrical and process parameters and cutting fluid on machinability. Mechanics of grinding. Economy of machining and grinding. PRINCIPLES OF zigs and fixture, work holding devices, industrial automation, basics of CNC and DNC.

Machine tools: Concept and definition of machining and machine tools. History of developments of machine tools. Concept of producing geometrical surfaces by generatrix and directrix. Kinematic systems and structures of conventional machine tools. Electromechanical and hydraulic

drives and control of machine tools		
Course Code: ME3103	Course Name: Heat Transfer	No. of Credits: 4
Detailed Syllabus: Introduction, Modes of heat transfer, thermal conductivity, combined modes of heat transfer, concept of thermal contact resistance. Derivation of heat conduction equation, steady state one-dimensional heat conduction with and without generation of heat in simple geometries : plane wall, cylindrical and spherical walls, critical thickness of insulation, heat transfer from extended surfaces, 2D steady state heat conduction Unsteady conduction: lumped heatcapacity system, transient heat conduction in infinite and semi-infinite walls, concept of Heisler chart, heat conduction from a moving heat source. Introduction to concepts of Finite difference approach for solving conduction problems. Forced convection: Derivation of energy equation, concept of thermal boundary layer and derivation of thermal boundary layer equation, flat plate in parallel flow (solution by energy integral method), cylinder in cross flow, internal flows: concept of thermally fully developed flow and its corollaries, fully developed pipe flow, fully developed channel flow with constant wall heat flux, turbulent flow in pipes, Reynolds analogy. Free convection: Vertical plate at constant temperature â derivation of governing equation, recognition of dimensionless terms, and solution by integral method. Condensation and Boiling: laminar film condensation over a vertical plate and horizontal circular tube. regimes of boiling heat transfer, correlations for critical heat flux in boiling. Finite element methods for one dimensional heat transfer; Heat exchangers: classification of heat exchangers, overall heat transfer coefficient, concept of fouling factor, LMTD and NTU methods. Thermal radiation: Radiation properties, blackbody radiation, Planck's law, Stefan- Boltzman law, Kirchoff's law, radiation exchange between black surfaces, concept of view factor, radiation exchange between non-black surfaces, two surface enclosure, three surface enclosure, concept of radiation shield. Computer aided heat transfer analysis with cases dealt in the class and visualize temperature distribution Reference Books: 1. F.P. Incropera and D.P. Dewitt, <i>Fundamentals of Heat and Mass Transfer</i>. 2. J.P. Holman, <i>Heat Transfer</i>. 3. P.K. Nag, <i>Heat and Mass transfer</i>.		
Course Code: ME3202	Course Name: Applied Thermodynamics	No. of Credits: 4
Detailed Syllabus:		

I C Engines: Otto, Diesel, Dual & Stirling Cycles, Comparison of cycles. Classification of Engines. Testing and performance Characteristics Heat balance, Indicators and Indicator Diagrams, Fuels and Fuel ratings, Fuel feed systems-Carburetor, Fuel injection systems, Fuel pump and injector. Ignition Systems Battery and Magneto. Governing of I C Engines, Normal and abnormal combustion in S I and C I Engines, Design and operating Parameters affecting engine power, Economy and emissions. Air Pollution, Rotary Engines, Supercharging, Cooling, Lubrication and wear

Refrigeration: Mechanical vapor compression refrigeration cycles - RC cycle , single stage saturation cycle, effects of sub-cooling and superheating, optimum suction stage. Properties of refrigerants. Reciprocating compressor- volumetric efficiency and work requirement, rotary, centrifugal and screw compressors. Multistage, multi-evaporator and cascade refrigeration cycles. Gas cycle refrigeration, thermoelectric refrigeration, vortex tube and steam jet refrigeration. Absorption refrigeration cycle- use of h-x diagram and Platen-Munter's refrigeration system. Expansion valves, evaporators, and condensers.

Air-conditioning: Principles of psychrometry and psychrometry processes. Comfort chart and effective temperature. Solar radiation, design conditions and cooling load calculation. Summer and Winter air-conditioning. Duct design

Reference Books:

1. V Ganesan, *Internal Combustion Engines*.
2. M. L. Mathur & R. P. Sharma, *Internal combustion engines*.

Course Code: ME2803

Course Name: Hydraulics and Hydraulic Machinery Lab

No. of Credits: 2

Detailed Syllabus:

1. Centrifugal pump apparatus
2. Impact of water jet
3. Pipe surge
4. Water hammer
5. Pelton turbine
6. Francis turbine

Course Code: ME3701

Course Name: Metal Cutting and Machine Tools Lab

No. of Credits: 2

Detailed Syllabus:

List of experiments in Machining:

1. Milling of Spur gear
2. Effect of process parameter and machining involvement on chip formation in turning
3. Effect of process parameters in turning on cutting forces & temperatures
4. Regrinding of single point cutting tool

List of experiments in Casting:

1. Study on moulding properties like permeability, Green hardness, Dry tensile & compression strength, Green tensile & compression strength, Moisture measurement.
2. Study on riser design & shieve analysis.

List of experiments in Welding:

1. Study the characteristics of MIG welding with movable work table
2. Study of arc welding characteristics using automatic moving torch.
3. Demo of TIG and Resistance spot welding

List of experiments in Forming

1. Disc compression & Ring compression test
2. Extrusion & deep drawing

Course Code: ME4701

Course Name: Heat Transfer Lab

No. of Credits: 2

Detailed Syllabus:

1. Burnout heat flux in pool boiling
2. Measurement of emissivity
3. Forced convection heat transfer
4. Parallel flow and counter flow heat exchanger
5. Heat transfer through slab guarded hot plates
6. Heat transfer through natural convection
7. Heat transfer from Pin fin apparatus
8. Flame propagation and stability
9. Performance of centrifugal fan
10. Compressive flow in Nozzle

Course Code: ME3802

Course Name: Applied Thermodynamics Lab

No. of Credits: 2

Detailed Syllabus:

1. Test rig of a vapour compression refrigeration system
2. Air conditioning laboratory unit
3. Absorption refrigeration system

List of experiments for I.C. Engines:

1. Load test on multi cylinder diesel engine
2. Load test on single cylinder diesel engine
3. Load test on single cylinder petrol engine
4. Morse test

5. Pollution test (smoke and particulate material)

E3 Sem1 Courses and Syllabus

Course Code: ME3105

Course Name: Elementary Machine Design

No. of Credits: 4

Detailed Syllabus:

General considerations & procedure of Machine Design: General Principle of Machine Design; Common engineering materials & their mechanical properties, factor of safety, strength, rigidity, fracture, wear, creep, fatigue, stress concentration; Design principle of machine elements: Rivets, welded joint, cotter joint, knuckle joint etc., design of power screw, Design of Shaft, keys and Couplings, spring design.

Reference Books:

1. J. E. Shigley, *Mechanical Engineering Design*.
2. M. F. Spotts, *Design of Machine Elements*.
3. A. H. Burr and J. B. Cheatham, *Mechanical Analysis and Design*.

Course Code: ME3201

Course Name: Mechanical Measurements and Metrology

No. of Credits: 4

Detailed Syllabus:

Metrology: Introduction, Precision, Accuracy, repeatability. Types of errors in measurement. Simple measurement tools like height gauges, micrometers, depth gauges, slip gauges, sine bar etc. Limits, Fits & Tolerances. Inspection gauges. Surface roughness: sources of surface irregularities in manufactures, different element of surface roughness, surface roughness parameters. Measurement instruments, profilometers, analysis of roughness signal in frequency domain. Coordinate measuring machine CMMs, application, types, construction, probing, hard probing and soft probing.

Course Code: ME3204

Course Name: CAD and CAM

No. of Credits: 3

Detailed Syllabus:

PRINCIPLES OF COMPUTER GRAPHICS : Introduction, graphic primitives, point plotting, lines, Bresenham's circle algorithm, ellipse, transformation in graphics, coordinate systems, view port, 2D and 3D transformation, hidden surface removal, reflection, shading and generation of characters.

CAD TOOLS: Definition of CAD Tools, Types of system, CAD/CAM system evaluation criteria, brief treatment of input and output devices. Graphics standard, functional areas of CAD, Modeling and viewing, software documentation, efficient use of CAD software. GEOMETRICMODELLING: Types of mathematical representation of curves, wire frame models wire frame entities parametric representation of synthetic curves her mite cubic splines Bezier curves B-splines rational curves.

SURFACE MODELING: Mathematical representation surfaces, Surface model, Surface entities surface representation, Parametric representation of surfaces, plane surface, rule surface, surface of revolution, Tabulated Cylinder.

PARAMETRIC REPRESENTATION OF SYNTHETIC SURFACES: Hermite Bicubic surface, Bezier surface, B- Spline surface, COONS surface, Blending surface Sculptured surface, Surface manipulation — Displaying,

Segmentation, Trimming, Intersection, Transformations (both 2D and 3D).		
Introduction, classification, design features and control features of CNC machines; Programming : G & M Code programming, Offline (APT-like) programming; Free form surface machining : Isoparametric, Isoplanar and Isoscallop machining strategies.		
Course Code: ME3106	Course Name: Instrumentation and Control	No. of Credits: 4
Detailed Syllabus: Control Feedback systems, mathematical modeling of physical systems; Laplace transforms, block diagrams; Time domain analysis: performance specifications, steady state error, transient response of first and second order systems; Stability analysis: Routh-Hurwitz stability criterion, relative stability; proportional, integral, PI, PD, and PID controllers; Lead, lag, and lag-lead compensators; Root-locus method: analysis, design; Frequency response method: Bode plots, Nyquist stability criterion, performance specifications.		
Course Code: ME4101	Course Name: Thermal Power Engineering	No. of Credits: 4
Detailed Syllabus: Analysis of steam cycles, optimization of reheat pressure and degree of regeneration, coupled cycles and combined plants, process heat and power. Fuels and their properties, stoichiometric and actual air requirements, flue gas analysis, boiler energy balance, draft system. Different types of furnaces for burning coal, fuel oil and gas. Circulation theory, down-comers and risers, economizers and super-heaters, air pre-heater, drum and its internals. Different types of boilers, boiler mountings, feed water treatment, boiler loading and manner of operation through super boilers Steam turbines; convergent and convergent-divergent nozzles - theory and design. Impulse and reaction turbines, compounding of turbines, optimum velocity ratio, reheat factor and condition line, parallel exhaust, losses in steam turbines, steam turbine governing. Theory and design of condensers, air ejector and cooling tower. Gas turbines: cycles, cooling		
Course Code: ME3702	Course Name: Mechanical Measurements and Metrology Lab	No. of Credits: 2
Detailed Syllabus: 1. Study of DCC - coordinate measuring machine 2. Micrometer calibration and tool maker microscope 3. Measurement of angles 4. Calibration of measuring instruments like Mechanical comparator, dial gauge, screw gauge. 5. Measurement of profiles using software		

6. Strain measurement
7. Pressure/force measurement
8. Displacement/velocity measurement
9. Air flow measurement

Course Code: ME3804	Course Name: CAD and CAM Lab	No. of Credits: 2
Detailed Syllabus: Solid Modeling: Data structures and Boolean operations. Computer Graphics Display Interface: Modeling transformations, Viewing transformations, Projections, Clipping, Hidden line/surface elimination, shading and light sources, Double buffering, Hardware graphics engines. Computer aided drafting, Parametric drafting, Design visualization, Integration with NC machines and manufacturing. Scientific Visualization: Animation, physical principles. Graphics Standards: 2D and 3D standards and graphics portability Graphics output devices, Rasterization, scan conversion. Raster scan Graphics: Algorithms for rasterization of straight lines and circles. Display Generation Techniques: Real time scan conversion, Run-length encoding, Cell organization, Frame buffer memory. Curves and Surfaces: Splines, parametric curves, Bezier and B-spline curves and surfaces, ruled surfaces and surfaces of revolution. Solids and their properties: Surfaces and curves in solids, Intrinsic and global properties, Characteristic tests and Intersections.		
<u>E3 Sem2 Courses are Electives and Syllabus</u>		
Course Code: ME3205	Course Name: Advanced Machine Design	No. of Credits: 4
Detailed Syllabus: Design of Clutches, Brakes, Design of sliding contact bearing, design of rolling contact bearing, Bearing Selection, Fly Wheel, Belt drive, Chain Drive, spur Gears, helical gear, bevel gears, worm gear, Gear Train and Gear units, Non-metallic machine elements, flexible mechanical elements, design of power transmission system, introduction to analysis tools. 1. J. E. Shigley, <i>Mechanical Engineering Design</i>. 2. M. F. Spotts, <i>Design of Machine Elements</i>. 3. A. H. Burr and J. B. Cheatham, <i>Mechanical Analysis and Design</i>.		
Course Code: ME3104	Course Name: Mechanical Vibrations	No. of Credits: 4
Detailed Syllabus: Vibration Vibration Characteristics of Simple Systems; Natural Frequency, Equivalent Systems, Energy Method, Response to Initial Disturbance, Single Degree Of Freedom System With Viscous Damping, Logarithmic Decrement, Forced Vibrations, Support Motion - Absolute Response, Support Motion - Relative Motion Response, Vibration Isolation Critical Speeds, Bending Critical Speeds of Simple Shafts, Bending Critical Speeds of Multimass		

Systems, Holzer Method for Torsional Systems

Reference Books:

1. W.T. Thomson, Theory of vibration with application
2. K Ogata, *Modern Control Engineering*.
3. B C Kuo and F. Golnaraghi, *Automatic Control Systems*.

Course Code: ME4422

Course Name: Air conditioning (Elective)

No. of Credits: 4

Detailed Syllabus:

Brief history of air conditioning. Principles of psychrometry, psychrometry of airconditioning processes, comfort chart, indoor and outdoor design conditions. Solar time, solar angles, direct beam and diffuse solar radiation, sol-air temperature. Equivalent temperature difference and time lag- decrement factor methods of cooling load calculations and psychrometric applications. Transmission and distribution of air, airconditioning apparatus and control.

Course Code: ME4508

Course Name: NON TRADITIONAL
MANUFACTURING(Elective)

No. of Credits: 4

Detailed Syllabus:

Needs of manufacturing industries and the concept of surface integrity. The role of newer & innovative processes for the solutions. Impact erosion and the evaluation for impregnation of foreign bodies. Theory and application of Abrasive Jet, Water Jet, Abrasive Flow, Ultrasonic, Total Form Machining and Low stress Grinding. Theory and applications of Chemical Processing: Chemical Machining, etching of semiconductors, coating and Electroless forming and CVD. Theory and applications of Electrochemical machining and grinding including, Electrochemical sharpening, polishing, honing and deburring, surface treatment, coating and Electroforming. Thermal energy methods of material processing (machining, welding, cladding, alloying and heat-treatment): Electro-discharge, Laser, Electron beam, Plasma arc, Plasma spray, Ion beam and PVD. Hybridization of processes for improving process capability and surface integrity. Explanation of some processes like ECDG, ultrasonic and Laser assisted processing, LIGA & SLIGA etc.; Generic manufacturing and introduction to rapid prototyping. Pcomponent: Experiments on EDM, ECM, laser etc

Course Code:

Course Name: Project

No. of Credits: 4

Detailed Syllabus:

E3 Summer Semester

Course Code: ME3300

Course Name: Summer internship

No. of Credits: 6

E4 Sem1 and Sem2 Courses are Electives and Syllabus

Course Code: ME4700

Course Name: Project-I

No. of Credits: 4

Course Code: ME4421	Course Name: Advanced fluid mechanics (Elective-I)	No. of Credits: 4
Detailed Syllabus: Concept of continuum and definition of a fluid. Body and surface forces, stress tensor. Scalar and vector fields, Eulerian and Lagrangian description of flow. Motion of fluid element - translation, rotation and vorticity; strain rate tensor, continuity equation, stream function and velocity potential. Transport theorems, Constitutive equations, derivation of Navier-Stokes equations. Exact solutions of Navier-Stokes equations: plane Poiseuille flow and Couette flow, Hagen-Poiseuille flow, flow between two concentric rotating cylinders, Stoke's first and second problem, Hiemenz flow, flow near a rotating disk, flow in convergent-divergent channels. Slow viscous flow: Stokes and Oseen's approximation, theory of hydrodynamic lubrication. Boundary layer: derivation, exact solutions, Blasius, Falkner Skan, series solution and numerical solutions. Approximate methods. momentum integral method. Two dimensional and axisymmetric jets. Description of turbulent flow, velocity correlations, Reynold's stresses, Prandtl's Mixing Length Theory, Karman's velocity defect law, universal velocity distribution. Concepts of closure model and wall function, K-e model of turbulence.		
Course Code: ME4502	Course Name: Technology of surface coating (Elective-II)	No. of Credits: 4
Detailed Syllabus: Significance of surface engineered materials in modern engineering applications. Role of surface coating and surface modification technologies in obtaining required surface characteristics of a product. Different surface coating technologies : chemical vapour deposition, physical vapour deposition, electro deposition, electroless deposition, thermal spray processes, coating deposition by wetting. Principle of various coating processes. Various process parameters controlling the yield of coating and various surface properties of the coating. Criteria for selection of a surface coating technology. Product oriented surface coating technology. Different coating systems and function of various elements of coating systems. Substrate technology and its significance in obtaining high performance coating. Physical and mechanical characterization of coating. Various methods for evaluating the performance of the coating.		
Course Code:ME4504	Course Name: Non- destructive evaluation and imaging (Elective-III)	No. of Credits: 4
Detailed Syllabus: Scope of non-destructive evaluation; Liquid-penetrant and magnetic particle inspection techniques; X-ray and gamma-ray radiography; Ultrasonic inspection:- principle of wave propagation through solids, surface waves, pulse echo technique, A,B,C scan; Eddy current testing;		

Image sensing through welding arc; Thermal imaging; Image reconstruction; Inspection of typical components:- castings, forgings, welded components, brazed and adhesive bonded assemblies.		
Course Code: ME4505	Course Name: Robots and computer controlled machines (Elective-IV)	No. of Credits: 4
Detailed Syllabus: Drive systems of robots, Electrical and hydraulic systems, AC and DC drives, Servo drives using voltage control, current control and direct torque control, PID control systems and performance issues. Feedback systems. Single loop and multi-loop, DSP based motion control systems, Sensors for industrial robots, encoders, resolvers, hall-effect sensors, acoustic sensors, ultrasonic and optical/infrared sensors, Elements of robot vision, Integration using PLCs. Digital motion planning systems. Introduction, classification, design features and control features of CNC machines; Programming : G & M Code programming, Offline (APT-like) programming; Free form surface machining : Isoparametric, Isoplanar and Isoscallop machining strategies		
Course Code: ME4800	Course Name: Project-II	No. of Credits: 4
Course Code: ME4506	Course Name: Quantity production methods (Elective-I)	No. of Credits: 4
Detailed Syllabus: Classification of production. Industrial and economical aspects of production in large quantity. Various methods of quantity production of common engineering objects like rods, bars, rails, tubes, threaded objects, gears, bearings, cams, cutting tools etc.. Purpose, design and use of jigs and fixtures. Role of automation in quantity production. Scheduling, tool layout and cam layout for semi-automatic and automatic machine tools. Large quantity production by special purpose and transfer machines. Quantity production of small items like washers, seals, laminates, cups, strong and soft tubes, coins etc. by shearing, forming and embossing in press tools. Industrial methods of manufacturing of pins, needles, wires, rims and similar products. Large scale production of various objects made of polymer, ceramics and composites. Quantity production by processes like spinning, bulging, hydro forming, magneto forming and explosion forming. Group technology. Selection of processes, tools and systems and process planning for feasible and economic production. Flexible automation and computer control in manufacturing. Assessment and control of productivity, quality and economy in quantity production.		
Course Code: ME4443	Course Name: TRIBOLOGY (Elective-II)	No. of Credits: 4

Detailed Syllabus: Definition of Tribology. Economic aspects of Tribology (Lubrication, Friction and Wear). Basic equations of the theory of lubrication, its solution for idealized and finite bearings. Calculations of the flow rate. Thermal equilibrium. Bearing design. Design and selection of anti friction bearings. Theories of friction, wear and their measurement.		
Course Code: ME4523	Course Name: AUTOMOBILE ENGINEERING (Elective-III)	No. of Credits: 4
Detailed Syllabus: Introduction to Automobiles, Basics of Otto and Diesel cycle, Elements of Petrol and Diesel Engine, Engine Performance curves, Vehicle Performance Characteristics and Requirements, Power-train, Transmission and Drive units, Exhaust System, Steering and Suspension System, Chassis and Body Design, Brake systems, Electrical and Lighting Systems, Safety and Comfort Features, Wheel and Tyre, NVH Considerations in Vehicle Design, Vehicle Ride and Handling Evaluation. Air pollution due to exhaust emissions, control measures and Euro-norms.		
Course Code: ME4527	Course Name: Energy conservation and waste heat recovery (Elective-IV)	No. of Credits: 4
Detailed Syllabus: Patterns of energy use, potential for energy conservation, optimum use of energy resources, total energy approach. Coupled cycles, combined plants and cogeneration systems. Need for energy storage, thermal electrical, magnetic and chemical energy storage systems. Utilization of industrial waster heat; gas-to-liquid and liquid-to-liquid heat recovery systems; Recuperators and regenerators, heat pipes; waster heat boilers; fluidized bed heat recovery; shell and tube heat exchangers. Prime mover exhausts; incineration plants; heat pump systems; thermoelectric devices. Utilization of low grade reject heat from power plants. Thermal insulation; energy economics.		
List of Electives will be offered during E4Sem1 and Sem2		
Course Code: ME4529	Elective1: Computational fluid dynamics	No. of Credits: 4
Detailed Syllabus: Patterns of energy use, potential for energy conservation, optimum use of energy resources, total energy approach. Coupled cycles, combined plants and co-generation systems. Need for energy storage, thermal electrical, magnetic and chemical energy storage systems. Utilization of industrial waster heat; gas-to-gas, gas-to-liquid and liquid-to-liquid heat recovery systems; Recuperators and regenerators, heat pipes; waste heat boilers; fluidised bed heat recovery; shell and tube heat exchangers. Prime mover exhausts; incineration plants; heat pump systems; thermoelectric devices. Utilization of low grade rejected heat from power plants.		
Course Code: ME4542	Elective2: Finite element method in engineering	No. of Credits: 4
Detailed Syllabus: Introduction-Basic Concept of FEM, Methods of weighted residual techniques-Weak Formulation, Galerkin FE formulation, Rayleigh & Ritz FEM,FEM analysis of One-dimensional problems:-Second		

order boundary value problem, Applications in Solid, Fluid and Heat Transfer, Bending of Beams, Euler-Bernoulli Beam, Truss/Frame analysis, Eigenvalue and Time dependent problems, MATLAB Application, Numerical Integration and Computer Implementation-Natural Co-ordinates, Interpolation Functions, Numerical Integration, Isoparametric Formulation, Computer Implementation, Applications in two-dimensional problems-Plane Stress and plane Strain, Three Dimensional Solid, Axi-symmetric Solid, Plate and Shell structures, Flow of Viscous Fluid, MATLAB Application, Special Topics, Stationary Singular elements, Quarter-Point Singular Elements, Moving singular elements, Semi-infinite elements, Buckling analysis, Non-linear analysis

Course Code: ME4421	Elective3: ADVANCE FLUID MECHANICS	No. of Credits: 4
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Detailed Syllabus:

Concept of continuum and definition of a fluid. Body and surface forces, stress tensor. Scalar and vector fields, Eulerian and Lagrangian description of flow. Motion of fluid element - translation, rotation and vorticity; strain rate tensor, continuity equation, stream function and velocity potential. Transport theorems, Constitutive equations, derivation of Navier-Stokes equations. Exact solutions of Navier-Stokes equations: plane Poiseuille flow and Couette flow, Hagen-Poiseuille flow, flow between two concentric rotating cylinders, Stoke's first and second problem, Hiemenz flow, flow near a rotating disk, flow in convergent-divergent channels. Slow viscous flow: Stokes and

Oseen's approximation, theory of hydrodynamic lubrication. Boundary layer: derivation, exact solutions, Blasius, Falkner Skan, series solution and numerical solutions. Approximate methods. momentum integral method. Two dimensional and axisymmetric jets. Description of turbulent flow, velocity correlations, Reynold's stresses, Prandtl's Mixing Length Theory, Karman's velocity defect law, universal velocity distribution. Concepts of closure model and wall function, K-e model of turbulence.

Course Code: ME4502	Elective4: TECHNOLOGY OF SURFACE COATING	No. of Credits: 4
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Detailed Syllabus:

Significance of surface engineered materials in modern engineering applications.

Role of surface coating and surface modification technologies in obtaining required surface characteristics of a product. Different surface coating technologies : chemical vapour deposition, physical vapour deposition, electro deposition, electroless deposition, thermal spray processes, coating deposition by wetting. Principle of various coating processes. Various process parameters controlling the yield of coating and various surface properties of the coating. Criteria for selection of a surface coating technology. Product oriented surface coating technology. Different coating systems and function of various elements of coating systems. Substrate technology and its significance in obtaining high performance coating. Physical and mechanical characterization of coating. Various methods for evaluating the performance of the coating.

Course Code: ME4504	Elective5: NON-DESTRUCTIVE EVALUATION AND IMAGING	No. of Credits: 4
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Detailed Syllabus:

Scope of non-destructive evaluation; Liquid-penetrant and magnetic particle inspection techniques; X-ray and gamma-ray radiography; Ultrasonic inspection:- principle of wave propagation through solids, surface waves, pulse echo technique, A,B,C scan; Eddy current testing; Image sensing through welding arc; Thermal imaging; Image reconstruction; Inspection of typical components:- castings, forgings, welded components, brazed and adhesive bonded assemblies.		
Course Code: ME4505	Elective6: ROBOTS AND COMPUTER CONTROLLED MACHINES	No. of Credits: 4
Detailed Syllabus: Drive systems of robots, Electrical and hydraulic systems, AC and DC drives, Servo drives using voltage control, current control and direct torque control, PID control systems and performance issues. Feedback systems. Single loop and multi-loop, DSP based motion control systems, Sensors for industrial robots, encoders, resolvers, hall-effect sensors, acoustic sensors, ultrasonic and optical/infrared sensors, Elements of robot vision, Integration using PLCs. Digital motion planning systems. Introduction, classification, design features and control features of CNC machines; Programming : G & M Code programming, Offline (APT-like) programming; Free form surface machining : Isoparametric, Isoplanar and Isoscallop machining strategies		
Course Code: ME4506	Elective7: QUANTITY PRODUCTION METHODS	No. of Credits: 4
Detailed Syllabus: Classification of production. Industrial and economical aspects of production in large quantity. Various methods of quantity production of common engineering objects like rods, bars, rails, tubes, threaded objects, gears, bearings, cams, cutting tools etc.. Purpose, design and use of jigs and fixtures. Role of automation in quantity production. Scheduling, tool layout and cam layout for semi-automatic and automatic machine tools. Large quantity production by special purpose and transfer machines. Quantity production of small items like washers, seals, laminates, cups, strong and soft tubes, coins etc. by shearing, forming and embossing in press tools. Industrial methods of manufacturing of pins, needles, wires, rims and similar products. Large scale production of various objects made of polymer, ceramics and composites. Quantity production by processes like spinning, bulging, hydro forming, magneto forming and explosion forming. Group technology. Selection of processes, tools and systems and process planning for feasible and economic production. Flexible automation and computer control in manufacturing. Assessment and control of productivity, quality and economy in quantity production.		
Course Code: ME4443	Elective8: TRIBOLOGY	No. of Credits: 4
Detailed Syllabus: Definition of Tribology. Economic aspects of Tribology (Lubrication, Friction and Wear). Basic equations of the theory of lubrication, its solution for idealized and finite bearings. Calculations of the flow rate. Thermal equilibrium. Bearing design. Design and selection of anti friction bearings. Theories of friction, wear and their measurement.		

Course Code: ME4523	Elective9: AUTOMOBILE ENGINEERING	No. of Credits: 4
Detailed Syllabus: Introduction to Automobiles, Basics of Otto and Diesel cycle, Elements of Petrol and Diesel Engine, Engine Performance curves, Vehicle Performance Characteristics and Requirements, Power-train, Transmission and Drive units, Exhaust System, Steering and Suspension System, Chassis and Body Design, Brake systems, Electrical and Lighting Systems, Safety and Comfort Features, Wheel and Tyre, NVH Considerations in Vehicle Design, Vehicle Ride and Handling Evaluation. Air pollution due to exhaust emissions, control measures and Euro-norms.		
Course Code: ME4527	Elective10: ENERGY CONSERVATION AND WASTE HEAT RECOVERY	No. of Credits: 4
Detailed Syllabus: Patterns of energy use, potential for energy conservation, optimum use of energy resources, total energy approach. Coupled cycles, combined plants and cogeneration systems. Need for energy storage, thermal electrical, magnetic and chemical energy storage systems. Utilization of industrial waste heat; gas-to-liquid and liquid-to-liquid heat recovery systems; Recuperators and regenerators, heat pipes; waste heat boilers; fluidized bed heat recovery; shell and tube heat exchangers. Prime mover exhausts; incineration plants; heat pump systems; thermoelectric devices. Utilization of low grade reject heat from power plants. Thermal insulation; energy economics.		
Course Code: ME4402	Elective11: COMPOSITE MATERIALS	No. of Credits: 4
Detailed Syllabus: Introduction: materials, fiber reinforcement, matrix materials; Manufacturing processes: hand lay-up, prepreg lay-up, bag molding, autoclave processing, compression molding, resin transfer molding, pultrusion, filament winding, micro-mechanics: strength of materials approach, continuum approach; Ply mechanics: co-ordinate systems, off-axis stiffness; Macro-mechanics: description of laminates, laminate moduli, computation of stresses in laminates, types of joints. Failure criteria, Smart composites : active fiber composites, introduction to smart composite structures.		
Course Code: ME4401	Elective12: SOFT COMPUTING	No. of Credits: 4
Detailed Syllabus: Introduction, Optimization and Some Traditional Methods, Introduction to Genetic Algorithms, Some Specialized Genetic Algorithms, Introduction to Fuzzy Sets, Fuzzy Reasoning and Clustering, Fundamentals of Neural Networks, Some Examples of Neural Networks, Combined Genetic Algorithms: Fuzzy Logic, Combined Genetic Algorithms: Neural Networks, Combined Neural Networks: Fuzzy Logic.		
Course Code: ME4403	Elective13: MECHANICAL SYSTEMS AND EQUIPMENTS	No. of Credits: 4
Detailed Syllabus: Introduction to various Mechanical Handling Systems and Equipment for handling unit load and		

bulk materials, namely Pulley blocks, Winches, Electric Hoists, EOT Cranes, Belt Conveyor, Bucket Elevator, Screw conveyor and Pneumatic Conveyor etc. Dynamic analysis ,design procedures of their components, common mechanisms involved. and their industrial applications. Programmable and Flexible load handling devices.		
Course Code: ME4441	Elective14: DESIGN OPTIMIZATION	No. of Credits: 4
Detailed Syllabus: Basic Concepts ; Functions of One variable : Polynomial Approximations, Golden Section Method, Finding Bounds on the Solution ; Constrained Functions of One Variable : Direct and Indirect Approaches ; Unconstrained Functions of Many Variables : Zero-order, First-order and Second-order Methods, Scaling of Variables and Constraints, Convergence Criteria ; Constrained Functions of Many Variables : Linear Programming, Sequential Unconstrained Minimization Techniques, Direct Methods ; Approximation Techniques ; Duality ; General Design Applications.		
Course Code: ME4442	Elective15: SIMULATION OF MECHANICAL SYSTEMS	No. of Credits: 4
Detailed Syllabus: Energy Methods and variational principles. Euler-Lagranges equation for discrete and continuous systems. Hamiltons principle. Analysis of constraints - non-holonomic systems. Integration of system equations. Modelling in multi-energy domain through bond graphs. Modelling of a system of rigid bodies, structural systems, Hydraulic systems, Thermal systems, electronic and mechatronic systems. Modelling systems for control strategies and design of control strategies in physical domain. Numerical prototyping as modelling for design and synthesis using computational tools like SYMBOLS, MATLAB, ADAMS, etc.		
Course Code: ME4501	Elective16: METAL CASTING TECHNOLOGY	No. of Credits: 4
Detailed Syllabus: Advanced and precision moulding and casting processes- shell and investment moulding, centrifugal casting, full mould process, die casting, squeeze casting, continuous casting; solidification of castings; typical application of gating and risering principles; melting technology; molten metal treatments for ferrous and non-ferrous alloys; automation in foundry; sand conditioning and reclamation systems; pollution control; energy audit.		
Course Code: ME4503	Elective17: WELDING TECHNOLOGY	No. of Credits: 4
Detailed Syllabus: Characteristics of welding arc, machine characteristics, their mutual interaction; synergic and pulsed welding techniques; resistance welding-monitoring and control; study and analysis of heat flow, cooling rates, residual stresses and distortion in welding; weldability and microstructure characterization and procedure selection based on it; welding codes; non-destructive inspection; solid phase and high energy density welding processes; special applications.		
Course Code: ME4507	Elective18: MACHINE TOOL ENGINEERING	No. of Credits: 4
Detailed Syllabus: Major techno-economical aspects of machine tools. Kinematic structure, working principle and		

application of semi-automatic and automatic lathes, gear teeth cutting machines and copying machines. Design principles of special purpose machine tools. Design of machine tool gear boxes, spindles and beds of machine tools. Slides and guides and selection of bearings for machine tools. Rigidity, system compliance and process capability of machine tools. Machine tool vibration and chatter. Foundation and installation of machine tools. Machine tool inspection, testing and maintenance. Flexible automation and robot application in manufacturing by machine tools. Constructional features, operational characteristics and part programming of flexibly automatic machine tools; CNC machining center and FMS and their advantageous applications

Course Code: ME4524

Elective19: ADVANCED ENGINEERING THERMODYNAMICS

No. of Credits: 4

Detailed Syllabus:

Review of laws of thermodynamics. Energy concepts for closed and open systems. Minimization of entropy generation principle and thermodynamic optimization. Exergy analysis of thermal systems and plants. Thermo-economic applications. Phase transition. Equations of state. Multi-component and multiphase system. Reactive systems. Kinetic theory of gases. Distribution of molecular velocities and energy, transport properties of gases. Principles of irreversible thermodynamics and applications

Course Code: ME4525

Elective20: THEORY OF COMUSTIONS AND EMISSIONS

No. of Credits: 4

Detailed Syllabus:

Principles of Combustion, combustion chemistry. Thermodynamics of reactive systems. Reaction kinetics. Theory of premixed laminar and turbulent flames. Concepts of ignition and quenching, Burner systems. Gaseous diffusion flame, atomization of liquid fuel, stability and propagation of flames, droplet and spray combustion. Coal combustion : fixed bed combustion, pulverized coal and fluidized bed combustion. Mechanism and kinetics of coal combustion. Volatile and char combustion. Flames related to industrial applications.

Combustion generated pollutants : various sources, modelling of emissions, industrial furnace emissions.

Course Code: ME4526

Elective21: TURBULENT FLOWS

No. of Credits: 4

Detailed Syllabus:

Turbulent Flows Introduction to stability of laminar flows. Linearized stability analysis using Orr Sommerfeld equations for inviscid and viscous flows. Stability with flexible compliant boundaries, for free convection flows and under centrifugal forces. Transition to turbulence. General properties of turbulence: instability and non linearity, statistical nature, vortex stretching, turbulence scales and cascade, mixing and enhanced diffusivity, energy spectrum. Introduction to mathematical analysis of turbulent flows. The closure problem. Reynolds averaged Navier Stokes equations. Equations for Reynolds stresses, turbulence kinetic energy and energy of mean flow convection, production and dissipation of turbulence, re-distribution, turbulent diffusion. Turbulence modeling. Eddy viscosity/mixing-length models, application to free shear flows and

wall-bounded flows. Two-equation models of turbulence: standard k and k model. Turbulent free shear flows. Turbulent wallbounded flows, Law of the wall, velocity defect law, law of the wake.

Course Code: ME4531

Elective22: Solar energy technology

No. of Credits: 4

Detailed Syllabus:

Current alternate energy sources-thermodynamic view point and conversion methods. Components of solar energy systems, collector performance. Radiation and meteorological data processing, long term conversion factors. System configurations and system performance prediction. Simulations, design methods. System design and optimization. Solar thermal systems applications to power generation, heating and cooling. Solar passive devices : solar stills, ponds, greenhouse, dryers. Trombe wall, overhangs and winged walls. Wind energy conversion systems. Economics of solar and wind energy systems.

Course Code: ME4533

**Elective23: NUCLEAR POWER GENERATION
AND SAFETY**

No. of Credits: 4

Detailed Syllabus:

Basic concepts of reactor physics, radioactivity. Neutron Scattering. Thermal and fast reactors. Nuclear cross-sections. Neutron flux and reaction rates. Moderator criteria. Reactor core design. Conversion and breeding. Types of reactors. Characteristics of boiling water, pressurized water, pressurized heavy water, gas cooled and liquid metal cooled reactors. Future trends in reactor design and operation. Thermal hydraulics of reactors. Heavy water management. Containment system for nuclear reactor. Reactor safety radiation shields. Waste management. Indian nuclear power program.