M.TECH - MECHANICAL
THERMAL POWER ENGINEERING,
SYLLABUS

ENGINEERING MATHEMATICS

Sub Code :16MTP101 **Credits** :04
Hours/Week :4+0+0 **CIE Marks** :50
Total Hours : 48 **SEE marks** :50
Exam Hours :03 **Course Type** : Program Core

Course Outcomes:
Students studying this course will be able to :
1. Identify the importance of evaluating Eigen values and eigenvectors of matrices required frequently in numerical solution of field analysis problems. Recall the basic elements of Linear Solvers and its widespread applications in numerical solution of field problems or optimization problems
2. Solve Heat equation, Wave equation and Laplace equations using finite difference technique.
3. Recognize and employ special methods of solving algebraic & transcendental equations. Analyze the capabilities and limitations of numerical procedures for differentiation and integration of functions
4. Understand the concepts, importance and applications of vector calculus
5. Understand concepts and applications of probability, distributions and sampling

UNIT 1

Linear Algebra: System of linear algebraic equations –Direct Elimination methods -Cramer's rule, Gauss Elimination, LU Decomposition, Cholesky Method, and Iterative Methods like Point
Jacobi, Gauss Seidel, Eigen values and Eigenvectors for Matrices – Jacobi method,, Givens

UNIT 2

ODE: Initial and Boundary value problems, Single step method, Taylors series method and RungeKutta method (R-K method 4th order, for system of equations and higher order systems)
PDE: Classification of second order PDEs, Parabolic- 1D heat diffusion equation – explicit, fully implicit, Crank Nicolson, Hyperbolic equations - Wave equation, Elliptic equations- Laplace and Poisson solvers. 10 hours

UNIT 3

Numerical Methods Roots of Transcendental equations using Bisection method, Regula-Falsi
method, Newton- Raphson method. Handling Multiple roots, Roots of a polynomial - Graeffe's
Roots Squaring Method, Interpolation and Approximations – Cubic Spline, Finite Difference, Numerical Differentiation and Integration: Newton– Cotes and Gauss Quadrature Integration formulae, Simpson and Trapezoidal Rules of integration, 10 hours

UNIT 4

Vectors and Tensors: Definition of Tensor, Vector and scalar - Inner and Outer Product, Gradient, Divergence and Curl of vectors, directional derivatives, Line, Surface and Volume Integrals, Gauss's and Green's Theorems. 08 hours

UNIT 5

Probability and Statistics: Definitions of Probability, Conditional Probability; Mean, Median,
Mode and Standard Deviation; Binomial, Poisson and Standard Normal distributions, Sampling
distribution -Tests of Significance based on the T and Chi-square distribution, Testing of Hypothesis – Confidence Interval and Significance level. 10 hours

Text Books :

1.Introduction to Linear Algebra, bv Gilbert Strang 4th Edition Fourth International Edition,2009
2 Numerical Methods for Engineering Applications, J.H.Ferziger, John Wiley & Sons, 2nd Edition,1998 3 Mathematical Statistics by J.N.Kapur and H.C.Saxena, S. Chand Publishing 20th Edition, 2007.

Reference Book:

1.Numerical methods for Scientific & Engg Comp., M.K Jain, S.R.Iyengar, R.K.Jain,New Age
Int. 2003 2.Fundamentals of Engineering Numerical Analysis by Pervez Moin, Cambridge, 2010

Assessment Method:

CIE:

1. Three internals tests (each 30 marks) are conducted, average of best two tests marks will be considered.
2. Assignments will be evaluated by minimum two and Average of two will be considered - for 10 marks.
3. Two written surprise quiz tests conducted and evaluated for 10 marks. Average of these two will be considered.

SEE:

1. Two Questions are to be set from each unit, carrying 20 Marks each.
2. Students have to answer 5 questions selecting one full question from each unit.

ADVANCED FLUID DYNAMICS

Sub Code :16MTP102 **Credits :**05
Hours/Week :4-0-2 **CIE Marks :**50
Total Hours :**48+0+24** **SEE marks :**50
Exam Hours :03 **Course Type** : Program Core

Course Outcomes :
Students studying this course will be able to :
1. Recall the concept of Continuum and the Eulerian and Lagrangian description of fluid motion
2. Identify the flow regimes and derive the equations for irrotational, inviscid and viscous flow,distinguish clearly between laminar and turbulent flow
3. Recollect the concept of Boundary Layer in viscous flows – no slip condition & solutions tothe relevant equations explaining physical phenomenon of Flow Separation in boundary layers
4. Compute practical problems of fluid flow – both internal flow inside ducts and external flowpast different objects of given shape solving the governing equations
5. Identify the effect of compressibility in high speed flow, Shock Waves - interaction with theflow field.

UNIT 1

Concept of continuum and definition of a fluid.Body and Surface Forces, Stress and Strain RateTensor, Eulerian and Lagrangian description of flow. Compressibility, Viscosity, motion of fluidelement with concept of local and substantial acceleration - translation, rotation & shear, vorticityvector, Inviscid and Irrotational Flow, Continuity equation, Stream Function and VelocityPotential, Potential Flow Equation, Euler Equation, Bernoulli’s Equation

UNIT 2

Constitutive Relationship, Derivation of Navier Stokes equations for viscous compressible flow,Exact solutions of Navier Stokes equations: Poiseuille flow and Couette flow, Hagen-Poiseuilleflow- Blasius solution, Stoke's first and second problem

UNIT 3

Boundary Layer for a viscous fluid, – definition of displacement, momentum and energy thickness, Laminar Flow over a flat plate - Approximate methods – Von Karman Momentum integral equation for laminar boundary layer, Plane Two dimensional and Axisymmetric Jets asFree Shear Layers. Local and Mean Drag coefficients for laminar boundary layer on a smoothFlat Plate.

UNIT 4

Concept of Turbulence – role of disturbance and viscosity, Reynolds-averaged NS Equations, Turbulent flow, Closure problem, length and time scale, Reynold's Stresses, Prandtl'sMixing Length Theory, Karman's velocity defect law, Van Driest model – Boundary layer Separation,Form Drag and Viscous Drag, Karman Vortex Street, Lift on circular Cylinder, Flow on Roughsurface, Moody’s diagram. Flow past a circular cylinder and a sphere; Lift and drag on airfoilsand also for surface vehicles.

UNIT 5

Compressible Flow – Equations of Continuity and Momentum components – Role of velocity ofsound in compressible flows, Fanno (flow with friction) and Rayleigh Lines (flow with heataddition), Normal Compression Shock, Oblique Shock, Supersonic Wave Drag

Text Book :

1. Viscous Fluid Flow, White.F.M.,McGraw Hill
2. Gas Dynamics, Rathakrishnan E., Prentice Hall India

References:

1. Gas Dynamics Zuckrow.M.J. &Hoffman.D.H., McGraw Hill
2. Advanced Engineering Fluid Mechanics Muralidhar K. &Biswas .G, ,Narosa Publishing House.

Assessment Method:

CIE:

1. Three internals tests (each 30 marks) are conducted, average of best two tests marks will be considered.
2. Project/Assignments will be evaluated by minimum two and Average of two will be considered - for 10 marks.
3. Laboratory experiments will conducted and evaluated for 10 marks.

SEE:

1. Two Questions are to be set from each unit, carrying 20 Marks each.
2. Students have to answer 5 questions selecting one full question from each unit.

ENGINEERING THERMODYNAMICS

Sub Code :16MTP103 **Credits :**05
Hours/Week :4+0+2 **CIE Marks :**50
Total Hours :**48+0+24** **SEE marks :**50
Exam Hours :03 **Course Type** : Program Core

COURSE OUTCOMES:
Students studying this course will be able to :
1. Distinguish between System and Surrounding, Intrinsic and Extrinsic physical properties leading to the concept of thermodynamic equilibrium - its practical importance in converting Heatto Work and vice-versa
2. Explain and illustrate the Laws of Thermodynamics – First Law as the simple energy conservation and the Second Law as limitation to the convertibility from heat to work, the ideasof irreversibility, unavailability and exergy in a thermodynamic system
3. Pronounce the thermodynamic properties of an Ideal gas, a Real Gas or liquid-vapour mixturein steam
4. Distinguish between Physically Controlled Diffusion Flames and Chemical Kinetically controlled Pre-mixed Flames; explain the concept of Burning Velocity, Flame Stability, Atomization and Ignition in combustion processes, chemical potential and phase equilibrium.
5. Apply the concept of thermodynamic cycles in power generation, refrigeration systems and direct energy conversion.

UNIT - I

Review of Thermodynamic Laws and Corollaries: Zeroth, First and Second Law of Thermodynamics, steady and unsteady flows with energy transaction, Entropy, Availability andUnavailability, Maxwell Relations, Specific Heat Relations, Evaluation of thermodynamicproperties of working substance. 10 hours

UNIT- II

Equation of state for Ideal and Real Gas, Van der Waal's equation, Compressibility Factor. Energy properties of real gases, Properties of pure substances, properties of gases and gas mixtures, Vapour pressure, Throttling, Joule-Thompson coefficient. Non-reactive mixtures of perfect gases, Governing laws, Evaluation of properties, Psychometric mixture properties and psychometric chart, Air Conditioning processes, Cooling Towers. Real Gas mixture, combinedfirstandsecondlawsofthermodynamics. 10 hours

UNIT-III

Combustion Reactions, Heat of Reaction, Adiabatic Flame Temperature, Enthalpies, Chemicalequilibrium of ideal gases, Effect of non reacting gases equilibrium in multiple reactions, TheVent Hoff's equation. The chemical potential and phase equilibrium - Gibbs Phase Rule.Combustion and Flame velocities, laminar and turbulent flames, premixed and diffusion flames,their properties and structures, Theories of flame propagation, comprehensive theories, Flamestability, Flashback and Blow off. Combustion of solid, liquid and gaseous fuels, Combustion offuel droplets and sprays. 10 hours

UNIT-IV

Power Cycles: Review Binary Vapour cycle, Co-generation and combined cycles, Second LawAnalysts of Cycles, Refrigeration Cycles, Thermodynamics of irreversible processes -

Phenomenological laws, Onsager Reciprocity relation, Applicability of the Phenomenological relations, Heat flux and entropy production, Thermodynamic phenomena, Thermoelectric Circuits. 10 hours

UNIT-V

Direct Energy Conversion - Introduction: Fuel Cells, Thermoelectric Energy, Thermoionic PowerGeneration, Thermodynamic devices, Magnetohydrodynamic Generations, Photovoltaic Cells. 08 hours

Text Books :

1. Engineering Thermodynamics, P.K.Nag. Tata McGraw Hill
2. Thermodynamics, Holman J.P., McGraw Hill.

References :

1. Fundamentals of Classical Thermodynamics/Sonnatag& Van Wylen / John Wiley & Sons
2.Energy, Combustion and Environment - N.A. Chigier, McGraw-Hill, 1981.

Assessment Method:

CIE:

1. Three internals tests (each 30 marks) are conducted, average of best two tests marks will be considered.
2. Project/Assignments will be evaluated by minimum two and Average of two will be considered - for 10 marks.
3. Laboratory experiments will conducted and evaluated for 10 marks.

SEE:

1. Two Questions are to be set from each unit, carrying 20 Marks each.
2. Students have to answer 5 questions selecting one full question from each unit.

IC ENGINES : THEORY AND PRACTICE

Sub Code :16MTP104 **Credits :**05
Hours/Week :4+0+2 **CIE Marks :**50
Total Hours :48+0+24 **SEE marks :**50
Exam Hours :03 **Course Type** : Program Core

Course Outcomes

Students studying this course will be able to:

1. Evaluate the performance of thermodynamic cycles for IC engines and also distinguish between combustion processes in Spark Ignition and Compression Ignition engines
2. Recognize the function of major components of conventional and modern engines
3. Perform evaluation tests concluding with relative assessment of thermal performance of engines and advise on different methods for improving engine performance
4. Evaluate engine emission tests and check the conformity to International Standards on Pollution Control and implement the same
5. Recognize the system modifications required for the use of Alternate Fuels and evaluate therelevant thermal performance

UNIT 1

Engine Design and Operating Parameters - geometrical properties of reciprocating engines, brake torque, indicated work, road load power, M.E.P., S.F.C. and efficiency, specific emissions and emission index, – Thermo-chemistry of Fuel Air mixtures- properties of working fluids. Ideal model of engine cycles – cycle analysis with constant specific heats – volumetric efficiency – Supercharging and Turbo charging - Fuel intake systems and combustion in SI and CI engines – Carburetor and Multifuel Injection systems10Hours

UNIT 2

S.I. Engine mixture requirements, carburetors, fundamentals and design, fuel injection systems, feed back systems, flow past throttle plate, flow in in-take manifold. Combustion in SI Engines – Flame front propagation, flame speed, rate of pressure rise, knock in SI engines; Combustion in CI engines – ignition delay period, rapid and controlled combustion, factors affecting delay period, knock in CI engines, - Pollutant formation and control in IC engines - Types of Diesel combustion system – Fuel spray behavior – Ignition delay10Hours

UNIT 3

Engine performance parameters, Effect of spark-timing, Mixture composition, load, speed and compression ratio on engine performance, efficiency and emissions, SI engine combustion chamber design and optimization strategy, Testing of SI engine, Engine friction and lubrication – measurement of friction – fluid mechanics based multidimensional models – Engine operating characteristics. 10Hours

UNIT 4

Pressure measurement in engines, recording pressure and crank angle diagram, measurement of pollutants. Engine emissions and their control: Air pollution due to IC engines, Euro norms I & II, engine emissions, emission control methods – thermal converters, catalytic converters, particulate traps, Ammonia injection systems, Exhaust gas recirculation10Hours

UNIT 5

Alternate fuels for I.C engines: Vegetable Oils, Alcohol, LPG, CNG, Fuel Air ratio, Emission characteristics 08 Hours

Text Books:

2. Ganesan, V., Internal Combustion Engines, 2nd ed., Tata McGraw-Hill, 2003
3. Mathur and Sharma,

References:

1. Heywood, J.B., Internal Combustion Engine Fundamentals, Mc Graw-Hill, 1988
2. Taylor, C.P., The Internal Combustion Engines in Theory and Practice, Vol-2, MIT Press, 1985

Assessment Method:

CIE:

1. Three internals tests (each 30 marks) are conducted, average of best two tests marks will be considered.
2. Project/Assignments will be evaluated by minimum two and Average of two will be considered - for 10 marks.
3. Laboratory experiments will conducted and evaluated for 10 marks.

SEE:

1. Two Questions are to be set from each unit, carrying 20 Marks each.
2. Students have to answer 5 questions selecting one full question from each unit.

FINITE ELEMENT ANALYSIS OF HEAT TRANSFER PROBLEMS

Sub Code :16MTP105E1 **Credits :**04
Hours/Week :4+0+0 **CIE Marks :**50
Total Hours : 48 **SEE marks :**50
Exam Hours :04 **Course Type** : Program Elective

Course Outcomes:
Students studying this course will be able to :
1. Recall partial differential equations governing Mechanical and Thermal Stress, Heat Transfer and Fluid Flow to be discretised in both Space and Time.
2. Apply the concept of Shape Functions and relevant procedures to discretize multidimensional field problems into strongly coupled quasilinear equation system.
3. Analyze 1D and 2D heat diffusion problems using suitable finite element procedures.
4. Apply appropriate FEM solvers for multidimensional heat diffusion problems with or without phase change under transient conditions.
5. Evaluate 1D & 2D Convection-Diffusion problems using appropriate shape functions.

UNIT 1
Introduction, Weighted Residual Methods, Shape functions, Coordinate systems, Numerical Integration. 08 Hours

UNIT 2
Modeling of Heat Conduction, Variational Formulation, Galerkin's Approach for one dimensional and two dimensional problems Introduction – One dimensional problem solved using a single element – Linear element, Quadratic element, the use of numerical integration and an assembly of elements. 08 Hours

UNIT 3
Time stepping methods for Heat Transfer – Galerkin's approach in Non-linear transient heat conduction problems. Introduction, Basic Equations, Galerkin's Methods for steady Convection – Diffusion problems. 08 Hours

UNIT 4
Upwind Finite Elements in One Dimension, Heat Transfer and fluid flow between Parallel Planes, Convection and Diffusion problem of Melting and Solidification processes.08 Hours

UNIT 5
Practice for some Basic problems in Heat Transfer Analysis using ANSYS Software 1D, 2D and 3D Conduction Problems, Convective Heat Transfer Problems, Convection on Melting & Solidification. 08 Hours

Reference Books:
1. H. R. Thomas, K. N. Seetharamu, Ken Morgan, R. W. Lewis, "The Finite Element Method in Heat Transfer Analysis", John Wiley & Sons Inc, 1996.
2. Roland W. Lewis, PerumalNithiarasu and K.N. Seetharamu, "Fundamentals of the Finite Element Method for Heat and Fluid Flow", Wiley; 1 edition, 2004.

Reference Books:

1. J.N. Reddy and D.K. Gartling, “The Finite Element Method in Heat Transfer and Fluid Dynamics”, CRC; 2ndEdition, 2000.

Assessment Method:

CIE:

1. Three internals tests (each 30 marks) are conducted, average of best two tests marks will be considered.
2. Assignment test and Surprise tests are conducted for 10 Marks each

SEE:

1. Two Questions are to be set from each unit, carrying 20 Marks each.
2. Students have to answer 5 questions selecting one full question from each unit.

REFRIGERATION AND AIR CONDITIONING

Sub Code :16MTP105E2 **Credits :**04
Hours/Week :4+0+0 **CIE Marks :**50
Total Hours : 48 **SEE marks :**50
Exam Hours :03 **Course Type** : Program Elective

Course Outcomes:
Students studying this course will be able to :
1. Understand the basic thermodynamic principles of various refrigeration systems.
2. Apply the principles of Psychrometry and procedures for calculating cooling load for a givensystem.
3. Analyze the operating principles mainly the thermodynamic and heat transfer aspects of different components of a refrigeration system.
4. Achieve expertise in the science of air conditioning and load prediction for a given space using the principles of Heating Ventilation and Air Conditioning (HVAC).
5. Specify different components of a given air conditioning or refrigeration plant with suitablematching operating characteristics.

UNIT 1

Method of Refrigeration and Non-conventional refrigeration system: Ice refrigeration, Evaporative
refrigeration, refrigeration by expansion of air, refrigeration by throttling of gas, Vapor refrigerationsystem, steam jet refrigeration system, refrigeration by using liquid using liquid gases, dry icerefrigeration, types of refrigerants, properties of refrigerants, thermoelectric refrigeration, vortexrefrigeration, cooling by adiabatic demagnetization, pulse tube refrigeration. 08 Hours

UNIT 2

Air refrigeration system: Necessity of cooling the aeroplane, Bell Coleman air refrigerator, Advantages and disadvantages of air refrigeration system, factors considered in selecting the refrigeration system for aero plane, simple cooling with simple evaporative type aero plane airconditioning, boot strap and boot strap evaporative type, regenerative type, reduced ambient type,comparison of different systems, actual air conditioning system with control, limitations, merits andcomparisons. 08Hours

UNIT 3

Vapor compression refrigeration system: Simple vapor refrigeration system, T-s, h-s, p-h diagramsfor vapor compression refrigeration system, wet versus dry compression, vapor compressionrefrigeration systems with multiple evaporators and compressors, Absorption Refrigeration system:Basic- Absorption system, actual ammonia absorption system, Electrolux Refrigeration system,Lithium Bromide Absorption refrigeration system, comparison of Compression and Absorptionrefrigeration system. 08 Hours

UNIT 4

Psychometry and psychometric properties, psychometric relations, psychometric chart, psychometricprocesses, requirements of comfort air conditioning, comfort chart, design consideration, summer airconditioning system, winter air conditioning. 08 Hours

UNIT 5

Cooling load calculations and design of air conditioning system: Different heat sources, Conductionheat load, Radiation load of the Sun, occupants load, equipment load, infiltration air load,miscellaneous heat sources, fresh air load, design of air conditioning system, bypass factorconsideration, effective sensible heat factor, cooling coils and dehumidifying air washers. 08 Hours

Text Books:

1. Arora, C.P., Refrigeration and Air Conditioning, 2nd ed., Tata McGraw-Hill, 2004.
2. Stoeker, W.P. and Jones, J.W., Refrigeration and Air Conditioning, 2nd ed., Tata McGraw-Hill, 1982.

Reference Books:

1. Manohar Prasad, Refrigeration and Air Conditioning, New Age International, 1996.
2. Gosney, W.B., Principles of Refrigeration, Cambridge Uni. Press, 1982.

Assessment Method:

CIE:

1. Three internals tests (each 30 marks) are conducted, average of best two tests marks will be considered.
2. Assignment test and Surprise tests are conducted for 10 Marks each

SEE:

1. Two Questions are to be set from each unit, carrying 20 Marks each.
2. Students have to answer 5 questions selecting one full question from each unit.

THERMAL MEASUREMENTS AND PROCESS CONTROL

Sub Code :16MTP105E3 **Credits :**04
Hours/Week :4+0+0 **CIE Marks :**50
Total Hours : 48 **SEE marks :**50
Exam Hours :03 **Course Type** : Program Elective

Course Outcomes:
Students studying this course will be able to
1. Comprehend a good knowledge of instrumentation for measurements in thermal system – systembehavior, measurement and error analysis
2. Explain the working of flow measuring instruments and their calibration.
3. understand the use and applications of temperature measuring instruments
4. Interpret the experimental methods used in level measurement.
5. Understand the concept of process control systems and process control evaluation.

UNIT-I
General concepts: Fundamental elements of a measuring instrument. Static and dynamic characteristics – errors in instruments – Different methods of measurement and their analysis –
Sensing elements and Transducers. Measurement of pressure – principles of pressure measurement,
static and dynamic pressure, vacuum and high pressure measuring – Measurement of low pressure,
Manometers, Calibration methods, Dynamic characteristics- design principles. 08 Hours

UNIT II
Measurement of flow: Obstruction meters, Variable area meters, Pressure probes Compressible fluid
flow measuring instruments, Thermal anemometers, Calibration of flow measuring instruments.
Introduction to design of flow measuring instruments. 08 Hours

UNIT-III
Temperature Measurement: Different principles of Temperature Measurement, use of bimetallic
thermometers – Mercury thermometers, Vapor Pressure thermometers, Thermo-positive elements,
thermocouples in series & parallel, pyrometer, measurement of heat flux, calibration of temperature
measuring instruments. Design of temperature measuring instruments. 08 Hours

UNIT-IV
Level Measurement: Direct & indirect methods, manometric methods, float level meters, electricalconductivity, Capacitive, Ultrasonic, and Nucleonic Methods. Measurement of density –
Hydrometer, Continuous weight method, Gamma rays, Gas impulse wheel. Velocity Measurement –
Coefficient of viscosity, Ostesld method, Free fall of piston under gravity,torque method.

Measurement of moisture content and humidity, Measurement of thermal conductivity of solids,
liquids and gases. 08 Hours

UNIT-V

Process Control: Introduction and need for process control principles, transfer functions, block
diagrams, signal flow graphs, open and closed loop control systems – Analysis of First & Second
order systems with examples of mechanical and thermal systems. Control System Evaluation –
Stability, Steady state regulations, Transient regulations. 08 Hours

Text Books:

1. Mechanical and Industrial Measurements – R.K. Jain – Khanna Publishers
2. Control Systems, Principles & Design, 2nd Edition – M. Gopal – Tata McGraw Hill

Reference Books:

1. Measurement System, Application & Design – E.O. Doeblin..
2. Mechanical Measurements – Buck & Beckwith – Pearson.

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Assessment Method:

CIE:

1. Three internal tests each with 30 Marks are conducted, average of best two tests marks will be considered.
2. Assignment test and Surprise tests are conducted for 10 Marks each

SEE:

1. The SEE question paper consists of FIVE units each consisting of TWO main questions. In each main questions there shall be maximum of four subdivisions.
2. The student has to answer any one full question from each unit, which amounts to 100 Marks.

NON CONVENTIONAL ENERGY RESOURCES

Sub Code :16MTP105E4 **Credits :**04
Hours/Week :4+0+0 **CIE Marks :**50
Total Hours : 48 **SEE marks :**50
Exam Hours :03 **Course Type** : Program Elective

Course Outcomes:
Students studying this course will be able to :
1. Identify the need of non - conventional energy sources to manage the present crisis of fossil
fuel depletion.
2. Familiarize with solar radiation collectors, measurement of solar angles and various other devices used for measurement.
3. Explain the conversion process of solar energy into other forms of energy and their real time
applications.
4. Recognize the role of Biomass for production of solid, liquid and gaseous fuels.
5. Evaluate the performance and efficiency of energy generation from Wind Turbines, Mini &
Micro Hydro power, Wave Energy, Ocean Thermal Energy,, Geothermal and Nuclear Fusion Reaction.

UNIT 1

Man and Energy: World's Production and reserves of commercial energy sources, India's production
and reserves, Energy alternatives, Different forms of non-conventional energy source, Limitation of
conventional and non-conventional sources of energy 08 Hours

UNIT 2

Solar Energy: Solar radiation geometry, Estimation and measurement of solar energy. Photovoltaic
application: Types and characteristics (I.V) of Photovoltaic cells, Solar cell arrays, balance of system
(BOS) Thermal Application: Water heating, Drying, Cooking, Desalination, Solar refrigeration,
Solar ponds (Basic concepts). 08 Hours

UNIT 3

Biomass Energy Sources: Thermo-chemical and Biochemical routes to Biomass Utilization. Wind
Energy: Betz theory for wind energy conversion, Estimation of wind energy potential, Characteristics of wind turbines (HAWT and VAWT), Aerofoil Blades, Water pumping and power
generation using wind turbines. Wave energy: Wave energy conversion machine & recent advances.
08 Hours

UNIT 4

Mini and Micro Hydro Power Generation: Basic concepts, Types of turbines, Hydrological analysis.
Geothermal Energy Conversion: Forms of geothermal energy sources, geothermal electric power
plants. 08 Hours

UNIT 5

OTEC: Principle of operation, Open and Closed OTEC cycles. Tidal Energy: Single Basin and
Double Basin Tidal systems, Nuclear Fusion Energy.
08 Hours

Text Books:

1. Non Conventional Energy Sources - G.D. Rai, Khanna Publishers, New Delhi.
2. Renewable Energy Source and Conversion Technology, N.K.Bansal, Tata McGraw Hill, 1989

Reference Books:

1. Solar Energy Principle of Thermal Collection and Storage S.P.Sukhatme, Tata McGraw Hill,
1990. Wind Energy Systems, G.L. Johnson Prentice Hall Inc. New Jersey.
2. Solar Engineering of Thermal Processes, J.A. Duffie, and W.A. Beckman Wiley & Sons, 1990.

Assessment Method:

CIE:

1. Three internal tests each with 30 Marks are conducted, average of best two tests marks will be considered.
2. Assignment test and Surprise tests are conducted for 10 Marks each

SEE:

1. The SEE question paper consists of FIVE units each consisting of TWO main questions. In each main questions there shall be maximum of four subdivisions.
2. The student has to answer any one full question from each unit, which amounts to 100 Marks

ADVANCED HEAT TRANSFER

Sub Code :16MTP201 **Credits :**05
Hours/Week :4+0+2 **CIE Marks :**50
Total Hours :48+0+24 **SEE marks :**50
Exam Hours :03 **Course Type** : Program Core

Course Outcomes

Students studying this course will be able to :

1. Reproduce the principles and equations for three modes of heat transfer – Conduction, Convection and Radiation.
2. Analyze the steady and unsteady heat diffusion through composite slabs, tubes, spheres and also the heat transfer augmentation through extended surfaces (Fins) solving governing equations of steady and unsteady heat diffusion.
3. Compute convective heat transfer rates using numerical methods for both internal (ducts) and external flow (plates, cylinders, spheres) situations and heat transfer processes in parallel, counter- and cross-flow heat exchangers.
4. Explain and estimate Radiative Heat Transfer rates as propagation of Electromagnetic waves & employing the concepts of emissivity, absorptivity and shape factor for black and grey surfaces.
5. Analyze and evaluate heat transfer rates for problems involving phase transformation like condensation, evaporation and boiling.

UNIT I

Brief introduction to different modes of heat transfer, General heat conduction equation - initial and boundary conditions. Steady and Transient heat conduction: Lumped system analysis - Heisler charts - semi infinite solid-use of shape factors in conduction- Finite difference methods for 1D and 2D transient heat conduction-problems - Use of Heisler chart; Fins as extended surfaces - steady state analysis and optimization-Radial fins of rectangular and hyperbolic profiles- longitudinal fin of rectangular profile radiating to free space 10 Hours

UNIT 2

Finite Difference methods for 1D and 2D steady state and simple transient heat conduction problems using Explicit, Implicit and Crank Nicolson methods using both Cartesian and Cylindrical Polar coordinate system – emphasis on numerical problems using specified surface temperature or heat flux given on boundaries. 10 Hours

UNIT 3

Forced Convection: Conservation Equations of fluid flow for mass, momentum and energy -

External flows: Laminar and Turbulent Flow over a flat plate - Empirical relations for flow and heat
transfer coefficient - dimensional analysis. Approximate method - integral analysis, Thermal boundary layers - Momentum and Energy equations - Forced Convection for cylinders, spheres and
bank of tubes. Internal flows: Fully developed flow: Analysis for laminar heat transfer coefficientconstant
wall temperature & constant heat flux boundary conditions. 10 Hours

UNIT 4

Natural Convection: Approximate analysis of laminar free convective heat transfer-Boussinesque
approximation-different geometries-combined free and forced convection. Heat transfer with phase
change-Boiling Heat Transfer and Condensation: Effect of non-condensable gases in condensing
equipments, Boiling Curve-correlations- Nusselts theory of film condensation on a vertical plateassumptions
& correlations for different geometries. 08 Hours

UNIT-5

Radiation Heat Transfer: Radiant heat exchange in grey, non-grey bodies, absorbing media, specular
surfaces, gas radiation-radiation from flames. Radiative exchange in furnaces- Radiation

characteristics of particle systems, Thermal radiation of a luminous fuel oil or gas flame-formation
of soot - overall heat transfer in furnaces. 10 Hours

Text Books:

1. Heat Transfer P.K.Nag TMH
2. Fundamentals of Heat and Mass Transfer, Incropera, P.P. and Dewitt, D.P. 5th ed., John

References:

1. Heat Transfer - A Basic Approach, Ozisik, M.N., McGraw-Hill, 1987.
2. Heat Transfer RK Rajput /S.Chand
3. Engg. Heat & Mass Transfer Sarit K. Das DhanpatRai

Assessment Method:

CIE:

1. Three internals tests (each 30 marks) are conducted, average of best two tests marks will be considered.
2. Project/Assignments will be evaluated by minimum two and Average of two will be considered - for
10 marks.
3. Laboratory experiments will conducted and evaluated for 10 marks.

SEE:

1. Two Questions are to be set from each unit, carrying 20 Marks each.
2. Students have to answer 5 questions selecting one full question from each unit.

ADVANCED POWER PLANT CYCLES

Sub Code :16MTP202 **Credits :**04
Hours/Week :4 **CIE Marks :**50
Total Hours :48+0+24 **SEE marks :**50
Exam Hours :03 **Course Type** : Program Core

Course Outcomes
Students studying this course will be able to :
1. Analyze and evaluate the performance of single & combined Rankine cycle & efficiency enhancement techniques
2. Recall the thermo-chemistry explaining the mechanism of combustion for different fuels
3. Explain the working principles of various components of steam generators, condensers and feed water system in a thermal power plant
4. Understand the mechanism of nuclear fission reaction and working principles of various Nuclear Power Plants
5. Explain the working principles of Hydroelectric Power Plant with calculation regarding the energy conversion in water turbines.

UNIT 1

Analysis of Steam cycles: Rankine cycle, Carnot cycle, effect of variation of steam condition on
plant thermal efficiency, reheating of steam, regeneration, regenerative feed water heating, Carnotization of Rankine cycle, optimum degree of regeneration, Supercritical pressure cycle,
Deaerator, typical layout and efficiencies of a steam power plant, Cogeneration of Power and Process Heat, Numerical Problems.**Combined cycle power generation:** Flaws of steam as working
fluid in Power Cycle, Characteristics of ideal working fluid, Binary vapor cycles, combined cycle
plants, gas turbine-steam turbine power plant, MHD-steam power plant, Thermionic-Steam power
plant
10 Hours

UNIT 2

Fuels and combustion : Coal, oil, natural and petroleum gas, emulsion firing, coal – oil and coal
– water mixtures, synthetic fuels, biomass, combustion reactions, heat and enthalpy of combustion,
theoretical flame temperature, free energy of formation, equilibrium constant, effect of dissociation,
Numerical problems.**Combustion Mechanisms :**Kinetics of combustion, mechanisms of solid fuel
combustion, kinetic and diffusion control, mechanisms of pulverized coal combustion and , fuel-bed
combustion, fluidized bed combustion, coal gasifiers, combustion of fuel oil or gas or combined gas
fuel oil burners 10 Hours
.

UNIT 3

Steam Generators: Basic type of steam generators, fire tube/water tube boilers.economizers, superheaters, reheaters, steam generator control, air preheater, fluidized bed boilers, electrostatic
precipitator, fabric filters and bag houses, ash handling system, feed water treatment, deaeration,
evaporation, internal treatment, boiler blow down, steam purity. **Condenser, feed water and circulating water systems:** Need of condenser, direct contact condensers, feed water heaters, circulating water system, cooling towers, calculations, Numerical Problems. 10 Hours

UNIT 4

Nuclear Power Plants: Chemical and Nuclear reactions, nuclear stability and binding energy,
radioactive decay and half life, nuclear fission, chain reaction, neutron energies. Neutron flux and
reaction rates, moderating power and moderating ratio, variation of neutron cross sections with
neutron energy, neutron life cycle. Reflectors, Types of Reactor, PWR, BWR, gas cooled reactors.
Liquid metal fast breeder reactor, heavy water reactors, Fusion Power reactors, Numerical problems. 10 Hours

UNIT 5

Hydro Electric Power Plant: Introduction, advantages and disadvantages of water power, optimization of hydro – thermal mix, hydrological cycles, storage and pondage, essential elements of
hydro electric power plant, classification, hydraulic turbines – Pelton wheel, Francis turbine, Propeller and Kaplan turbines, Deriaz turbine, Bulb Turbine, Comparisons of Turbines, Selection of
Turbines, Numerical Problems. 08 Hours

Text Books:

1. Power Plant Engineering - P.K. Nag, Tata McGraw-Hill Publications.
Power Plant Engineering **-** M.M. EI-Wakil, McGraw- Hill Publications.

Reference Books:

1. Power plant Engineering RK Rajput S.Chand Publications
2.

Assessment Method:

CIE:

1. Three internals tests (each 30 marks) are conducted, average of best two tests marks will be considered.
2. Assignments will be evaluated by minimum two and Average of two will be considered - for 10 marks.
3. Two written surprise quiz tests conducted and evaluated for 10 marks. Average of these two will be considered.

SEE:

1. Two Questions are to be set from each unit, carrying 20 Marks each.
2. Students have to answer 5 questions selecting one full question from each unit

EQUIPMENT DESIGN FOR THERMAL SYSTEMS

Sub Code :16MTP203 **Credits :**04
Hours/Week :4+0+2 **CIE Marks :**50
Total Hours :48+0+24 **SEE marks :**50
Exam Hours :03 **Course Type** : Program Core

Course Outcomes

Students studying this course will be able to :

1. Design and Construct various types of Heat Exchangers and analyze the performances for different industrial applications.
2. Design and Develop a Boiler Furnace and analyze the same for Heat Transfer and Pressure Drop using appropriate methods
3. Analyze and Design a Super heater and a Repeater and estimate the flow and pressure drop factors in each element of the deign assembly
4. Design and Develop a Steam Condenser and analyze the effect of various factors like flow velocity, pressure drop and shell diameter on the thermal performance of the condenser
5. Correlate the results obtained in performance analysis of different Oil Heaters and Cooling Towers respectively

UNIT - 1

Classification of Heat Exchangers: Introduction, Recuperation & Regeneration, Tubular Heat Exchangers, Double pipe, Shell & tube heat exchanger, Plate heat Exchangers, Gasketed plate heat exchanger. Spiral plate heat exchanger, Extended surface heat exchanger, Plate fin and Tabular fin.

Basic Design Methods of Heat Exchanger: Introduction, Basic equations in design, Overall heattransfer coefficient, LMTD method for heat exchanger analysis, Parallel flow, Counter flow.

Multipass, Cross flow heat exchanger design calculations. 10 Hours

UNIT-2

Double pipe Heat Exchangers: Film coefficient for fluids in annulus, fouling factors, Calculation of double pipe exchanger in series parallel arrangements. Shell & Tube: Tube layouts for exchangers,

Baffle heat exchangers, Shell side film coefficients, equivalent diameter, The true temperature difference in a 1-2 heat exchanger. Influence of approach temperature on correction factor. Shell side and Tube side pressure drop, Analysis of performance of 1-2 heat exchanger and design , Flow arrangements for increased heat recovery, the calculation of 2-4 exchangers. 10 Hours

UNIT- 3

Condensation of single vapours: Calculation of horizontal condenser, Vertical condenser, De-Super heater condenser, Vertical condenser-sub-Cooler, Horizontal Condenser-Sub cooler, Vertical reflux type condenser. Condensation of steam. 10 Hours

UNIT- 4

Vaporizers, Evaporators and Reboilers: Vaporizing processes, Forced circulation vaporizing exchanger, Natural circulation vaporizing exchangers, Calculations of a reboiler. Extended Surfaces:
Longitudinal fins. Weighted fin efficiency curve, Calculation of a Double pipe fin efficiency curve.
Calculation of a double pipe finned exchanger, Calculation of a longitudinal fin shell and tube
exchanger. 10 Hours

UNIT-5

Direct contact heat exchangers: Cooling towers, relation between wet bulb & dew point temperatures, The Lewis number and Classification of cooling towers, Cooling tower internals and
the role of fill, Heat Balance. Heat Transfer by simultaneous diffusion and convection, Analysis of
cooling tower requirements, Deign of cooling towers, Determination of the number of diffusion
units, Calculation of cooling tower performance. 08 Hours

Text Books:

1. Process Heat Transfer, D.Q.Kern, Tata McGrew HillsH
2. Heat Exchanger Design, A.P.Fraas and M.N.Ozisicj/ John Wiely& sons, New York.

Reference Books:

1. Cooling Towers, J.D.Gurney and I.A. Cotter/ Maclaren

Assessment Method:

CIE:

1. Three internals tests (each 30 marks) are conducted, average of best two tests marks will be considered.
2. Project/Assignments will be evaluated by minimum two and Average of two will be considered - for
10 marks.

3. Laboratory experiments will conducted and evaluated for 10 marks.

SEE:

1. Two Questions are to be set from each unit, carrying 20 Marks each.
2. Students have to answer 5 questions selecting one full question from each unit.

COMPUTATIONAL FLUID DYNAMICS

Sub Code :16MTP204 **Credits :**04
Hours/Week :4+0+2 **CIE Marks :**50
Total Hours :48+0+24 **SEE marks :**50
Exam Hours :03 **Course Type** : Program Core

Course Outcomes

Students studying this course will be able to :

1. Recall the knowledge and mathematical description of Fluid Mechanics and recognize how todiscretize the conservation equations for mass, momentum and energy and define the truncation,round-off and discretization errors
2. Recognize and use different Grid Generation procedures for discretization of space around complex configuration to be analyzed; distinguish between differential and algebraic procedures ofgrid generation
3. Analyze Finite Difference and Finite Volume schemes to solve non-linear fluid-flow problemsusing appropriate numerical discretization of the relevant mass, momentum and energy fluxes;emphasize on the concept and merit of Upwind Differencing of different accuracy levels to discretize convective fluxes for problems of engineering interest
4. Explain and employ Turbulence Models of different levels of accuracy for computing differentreal life fluid flow and heat transfer problems
5. Compute flow situations of simple geometry using the current best practice for selection of numerical grid, turbulence model and flux discretization scheme, followed by validation againstexperimental data.

UNIT 1

Comparison between Theoretical, Experimental and Computational methods; definition of CFD and importance of CFD analyses in industry - Discretisation of space – Generation of Structured and Unstructured Grids, Various techniques of Grid Generation – Algebraic and Differential method, procedures followed for control of grid size and boundary orthogonality, qualities of a good grid, Pre- and Post processors - requirements 10 Hours

UNIT 2

Governing Equations: Review of conservation equations for mass, momentum components and energy for fluid flow and heat transfer, Dirichlet and Neuman boundary conditions. Finite

difference: Discretization, Consistency, Stability and fundamentals of discretisation, application in heat conduction and steady and unsteady diffusion problems 10 Hours

UNIT 3

Finite volume method, Upwind and Central differencing – merits and demerits – higher order upwinding for accurate results, application for steady and transient Heat Transfer and Fluid Flow

problems, handling fluid flow and heat transfer problems in non-orthogonal coordinate system,
Stream function and Vorticity formulation, introduction to SIMPLE and MAC algorithm for solution of Navier Stokes equations 10 Hours

UNIT 4

Turbulence – definition of turbulent flows and concept of Reynolds Averaging, Length and Time
scale of turbulence, Closure problem for turbulence, Eddy Viscosity Hypothesis, Kinetic Energy of
turbulence and Dissipation of turbulence energy to define turbulent fluid motion, zero-,one- and twoequation
models of turbulence, Special treatment of near wall cells 10 Hours

UNIT 5

Solving Compressible flow problems using Finite Difference and Finite Volume Methods – special
discretisation schemes to capture shocks. 08 Hours

Text Books:

1.Numerical Fluid Flow and Heat Transfer Patankar S.V. Hemisphere Publishing Corporation,
McGraw Hill
2.Computational Methods for Fluid Dynamics Peric M., Ferziger J. Springer Verlag

Reference Books:

1.An Introduction to Computational Fluid Dynamics - finite volume method Versteeg H.K.,Malalasekera, Longman Scientific & Technical

Assessment Method:

CIE:

1. Three internals tests (each 30 marks) are conducted, average of best two tests marks will be considered.
2. Project/Assignments will be evaluated by minimum two and Average of two will be considered - for
10 marks.
3. Laboratory experiments will conducted and evaluated for 10 marks.

SEE:

1. Two Questions are to be set from each unit, carrying 20 Marks each.
2. Students have to answer 5 questions selecting one full question from each unit.

SOLAR ENERGY TECHNOLOGY

Sub Code : 16MTP205E1 Credits :04
Hours/Week : 4+0+0 CIE Marks :50
Total Hours : 48 SEE marks :50
Exam Hours : 03 Course Type : Program Elective

Course Outcomes

Students studying this course will be able to:

1. Identify the different types of energy sources and define the same with special reference to the
Indian context.
2. To classify the different solar measuring devices, solar radiation devices and concentrators.
3. Interpret the various systems and power generation methods for the optimum performance.
4. Determine the effects of solar radiation, I-V, power generation and cooling systems on the performance of solar thermal radiation and photo-voltaic devices.
5. Evaluate the effect of various parameters on the performance of photo-voltaic systems, liquid
flat plate collectors and concentrators.

UNIT - 1

Introduction – Solar energy option, specialty and potential – Sun – Earth – Solar Radiation, beam
and diffuse – measurement – estimation of average solar radiation on horizontal and tilted surfaces –
problems – applications. Capturing solar radiation – physical principles of collection – types – liquid
flat plate collectors – construction details – performance analysis – concentrating collection – flat
plate collectors with plane reflectors – cylindrical parabolic collectors – Orientation and tracking –
Performance Analysis. 08 Hours

UNIT - 2

Design of solar water heating system and layout, Power generation – Solar central receiver system –
Heliostats and Receiver – Heat transport system – solar distributed receiver system – Power cycles,
working fluids and prime movers, concentration ratio. 08 Hours

UNIT - 3

Thermal energy storage: Introduction – Need for – Methods of sensible heat storage using solids and
liquids – Packed bed storage – Latent heat storage – working principle – construction – application
and limitations. Other solar devices – stills, air heaters, dryers, Solar Ponds & Solar Refrigeration,
active and passive heating systems. 08 Hours

UNIT - 4

Direct energy conversion: solid-state principles – semiconductors – solar cells –performance –
modular construction– applications. conversion efficiencies calculations. 08 Hours

UNIT - 5

Economics: Principles of Economic Analysis – Discounted cash flow – Solar system – Life Cycle
costs – cost benefit analysis and optimization – cost based analysis of water heating and photo
voltaic applications. 08 Hours

Text Books:

1. Solar energy: Principles of Thermal Collection and Storage, Sukhatme, TMH 2nd edition
2. Solar Thermal Engineering Systems, Tiwari and Suneja ,Narosa

REFERENCES:

1. Principles of solar engineering/ Kreith and Kerider/Taylor and Franscis/2nd edition
2. Solar energy thermal processes/ Duffie and Beckman/John Wiley & Sons

Assessment Method:

CIE:

1. Three internal tests each with 30 Marks are conducted, average of best two tests marks will be considered.
2. Assignment test and Surprise tests are conducted for 10 Marks each

SEE:

1. The SEE question paper consists of FIVE units each consisting of TWO main questions. In each main questions there shall be maximum of four subdivisions.
2. The student has to answer any one full question from each unit, which amounts to 100 Marks.

FUELS, COMBUSTION, AND ENVIRONMENT

Sub Code :16MTP205E2 **Credits :**04
Hours/Week :4+0+0 **CIE Marks :**50
Total Hours : 48 **SEE marks :**50
Exam Hours :03 **Course Type** : Program Elective

Course Outcomes

Students studying this course will be able to :

1. Recognize the engineering applications of the fundamental concepts learnt in this course
2. Understand the concepts of combustion phenomena in energy conversion devices
3. Apply the concept of Adiabatic Flame Temperature in design of combustion devices
4. Identify the definition of burning velocity - how it explains the phenomenon of flame stabilization in high speed combustion system for laminar and turbulent flames
5. Analyze the pollution formation mechanisms in combustion of solid, liquid & gaseous fuels

UNIT 1

Types of fuels and their properties - Coal characterization - Combustion Chemistry – Stoichiometry,
Heat of Reaction - Calorific value - Adiabatic flame temperature - Equilibrium -Mass transfer.
08 Hours

UNIT 2

Chemical kinetics - Important chemical mechanisms - Simplified conservation equations for Reacting flows - Laminar premixed flames - Simplified analysis. Factors influencing flame velocity
and thickness, flame stabilization - Diffusion flames - Introduction to turbulent flames. 08 Hours

UNIT 3

FBC - Different types of FBCs - Models for Droplet and Carbon particle combustion. Emissions -
Emission index - Corrected concentrations - Control of emissions for premixed and non-premixed
combustion 08 Hours

UNIT 4

Environmental Pollution- units of measurements, material balance and energy, fundamentals, classification of pollution, Air Pollution Control Methods & Equipment- sources and effects of air
pollution –Sampling measurement and analysis of air pollutants and Control, Solid Waste Management-Sources & Classification –Solid Waste Disposal Options - Toxic Waste Management,Water Pollution - sources of water pollutants– Classification and effects of Water Pollutants – Waterpollution Laws and Standards.
12 Hours

UNIT 5

Environment For Comfort Living & Working - Comfort & Climate –Temperature, humidity and
ventilation Control– AC load, Natural & Artificial Lighting, Noise Sources, control. 12hours

Text Books:

1. Turns, S.R., An Introduction to Combustion - Concepts and Applications, 2nd Ed., McGraw-Hill,
2000.
2. Sharma, S.P. and Mohan, C., Fuels and Combustion, Tata McGraw-Hill, 1987.

Reference Books:

1. Sarkar. S., Fuels and Combustion, Orient Longman, 2005.
2. Z. K. Morvay, D. D. Gvozdenac, Applied industrial energy and environmental management
3. Rao C.S. "Environmental Pollution Control Engineering," 2nd Edition, New Age International
Publishers, 2006.
4. Gilbert M. Masters, "Introduction to Environmental Engineering and Science", 2nd Edition,
Prentice Hall, 1998.

Assessment Method:

CIE:

1. Three internal tests each with 30 Marks are conducted, average of best two tests marks will be considered.
2. Assignment test and Surprise tests are conducted for 10 Marks each

SEE:

1. The SEE question paper consists of FIVE units each consisting of TWO main questions. In each main questions there shall be maximum of four subdivisions.
2. The student has to answer any one full question from each unit, which amounts to 100 Marks.

GAS TURBINES AND JET PROPULSION TECHNOLOGY

Sub Code : 16MTP205E3 Credits :04
Hours/Week : 4+0+0 CIE Marks :50
Total Hours : 48 SEE marks :50
Exam Hours : 03 Course Type : Program Elective

Course Outcomes

Students studying this course will be able to :

1. Explain the concept about the effect of compressibility on fluid flow and hence the concepts of Shock Wave, Mach Number and its effect on flow in a convergent-divergent nozzle with and without friction
2. Understand the thermodynamic cycle for Gas Turbine – the principle of operation of axial flow compressors and turbines and understand clearly how the phenomena of Surging and Chocking affect the performance of turbo-machines.
3. Interpret the basic principle of Jet Propulsion –for air-breathing Aircraft Engines; non-air breathing Rocket Engines and have clear understanding about the physicochemical process of combustion and flame in Gas Turbine Combustion Chambers
4. Draw the Velocity Diagrams and correlate those to the turbine performance specially for velocity compounded single and multi stage Impulse turbines for optimum performance under various operating conditions Evaluate the performance characteristics of Gas Turbines under different operating conditions including the Choking Limit
5. Analyze the design concepts for components of Axial, Radial flow Multistage Gas Turbines and Axial flow and Centrifugal compressors for optimum performance including the Surging Limit

UNIT 1

Gas Dynamics Fundamentals : Conservation Laws and governing equations for Mass, Momentum and Energy for Compressible flows; Basic definitions for Static and Stagnation Pressure, Temperature, Enthalpy, Mach Number, Subsonic, Transonic, Supersonic and Hypersonic Flow, Mach Wave, Mach Angle and Over expanding Nozzle, Adiabatic Flow through Converging-Diverging Nozzle, Adiabatic Flow through a constant area duct, Phenomenon of Shock, Rayleigh Lines, Fanno Lines in duct flows 08Hours

UNIT 2

Gas Turbines : Relative merits over conventional IC Engines, Introduction to Brayton and Atkinson cycle for Gas turbines, Pressure Ratio, Thermal Efficiency, Specific Output, optimum pressure ratio, Enhancement of Thermal Efficiency and/or specific power output using inter cooling, heat exchangers, reheat burners 08 Hours

UNIT 3

Compressors: Centrifugal Compressor-Major components – Inducer, Impeller, Vaneless Diffuser, Vaned Diffuser, Volute Casing, Velocity & Pressure variation in a stage, Pressure Rise for Radial Tipped Vanes, Degree of Reaction, Prewhirl and Surging. Axial Flow Compressor : Stage consisting of a Rotor and a Stator, Pressure Rise in a Stage, Polytropic Efficiency, Losses in a Compressor stage, Phenomenon of Blade Stall & Surging and Performance Curve Axial Flow Turbine : Stage consisting of a Rotor and a Stator, Pressure Rise in a Stage, Polytropic Efficiency, Losses in a Compressor stage, Phenomenon of

Chocking, Performance Curves 08 Hours

UNIT 4

Jet Propulsion : Concept of Propulsion and Thurst, Variety of Propulsion systems for flying vehicles – Turboprop, Turbojet, Ram Jet, Pulse Jet, SCRAM Jets with supersonic combustion. Definition & derivation for Pressure Thurst, Momentum Thurst, Propulsive Power, Propulsive Efficiency, Thermal and Overall Efficiency Thrust Augmentation: Water Injection, Liquid Injection, Afterburning, Bleed Air system Rocket Propulsion :Distinction between Turbojets and Rockets, Rocket Thrust, Specific Impulse, Total Impulse, Thermal Efficiency, Rocket Equation and applications 08 Hours

UNIT 5

Combustion Systems: Concept of Flame, Adiabatic Flame Temperature, Combustion Mechanism in a combustor, Activation Energy, Arrhenius Law, Stoichiometry, Flame Propagation, Flame Stability, Pressure Losses, Combustion Intensity, Combustion Efficiency, Combustion Chamber requirements, Outlet Temperature distribution, Gas Turbine Fuels, Pollution problems, Blade Cooling Methods, Requirements of the Combustion Chamber 08 Hours

Text Books:

1. Gas Turbines, V.Ganesan, Tata McGraw-Hill Education, 3rd Edition, 2010.
2. Aircraft Gas Turbine Powerplants by Charles E. Otis & Peter A. Vosbury, Jeppesen Publisher, ISBN-13, 2010

Reference Book:

1. Gas Turbine Theory by H.I.H. Saravanamuttoo, G.F.C. Rogers, H. Cohen , Paul Straznicky, Pearson education Ltd, 6th edition, 2009.

Assessment Method:

CIE:

1. Three internal tests each with 30 Marks are conducted, average of best two tests marks will be considered.
2. Assignment test and Surprise tests are conducted for 10 Marks each

SEE:

1. The SEE question paper consists of FIVE units each consisting of TWO main questions. In each main questions there shall be maximum of four subdivisions.
2. The student has to answer any one full question from each unit, which amounts to 100 Marks.

ALTERNATIVE FUELS FOR IC ENGINES

Sub Code :16MTP205E4 **Credits :**04
Hours/Week :4+0+0 **CIE Marks :**50
Total Hours : 48 **SEE marks :**50
Exam Hours :03 **Course Type** : Program Core

Course Outcomes
Students studying this course will be able to :
1. Analyze and understand the chemical structure, production, refining and various properties of petrol and diesel.
2. Appreciate the need of Alternate Fuels - their manufacturing processes, properties, thermal performance and emission characteristics.
3. Analyze the working principle, combustion, properties, performance and emission characteristics of dual fuel engines.
4. Realize the need, forms, properties and scope for Biodiesel as an alternate fuel in India.
5. Assess and compare the pollution levels of the conventional petroleum engine against the same characteristics for engines running on alternate fuels and methods to control both power and pollution level for the engines run by alternative fuel.

UNIT 1

Fuels: Introduction, Structure of petroleum, Refining process, Products of refining process, Fuels for spark ignition, Knock rating of SI engine Fuels, Octane number requirement, Diesel Engine Fuels.**Properties of petroleum products**: Specific gravity, Density, Molecular weight, Vapour pressure, Viscosity, Flash point, Fire point, Cloud point, Pour point, Freezing point, Smoke point & Char value, Aniline point, Octane Number, Performance Number, Cetane Number, Emulsification, Oxidation Stability, Acid Value/Number, Distillation Range, Sulphur content.
08 Hours

UNIT 2

Alternative fuels for I.C. engines: Need for alternative fuels such as Ethanol, Methanol, LPG, CNG, Hydrogen, Biogas and Producer gas and their methods of manufacturing.**Single Fuel Engines**: Properties of alternative fuels, Use of alternative fuels in SI engines, Engine modifications required, Performance and emission characteristics of alternative fuels in SI mode of operation v/s gasoline operation. 08 Hours

UNIT 3

Dual fuel Engine: Need and advantages, Working principle, Combustion in dual fuel engines, Factors affecting combustion in dual fuel engine, Use of alcohols, LPG, CNG, Hydrogen, Biogas and Producer gas in CI engines in dual fuel mode. Engine modifications required. Performance and

emission characteristics of alternative fuels (mentioned above) in Dual Fuel mode of operation v/s
Diesel operation. 08 Hours

UNIT 4

Bio-diesels: What are bio-diesels ? Need of bio-diesels, Properties of bio-diesels v/s petro-diesel,
Performance and emission characteristics of bio-diesels v/s Petro diesel operation.**Availability:**
Suitability & Future prospects of these gaseous fuels in Indian context.
08 Hours

UNIT 5

Environmental pollution: with conventional and alternate fuels, Pollution control methods and
packages. Euro norms I & II, Engine Emissions, Emission Control Methods, EPA. 08 Hours

Text Books:

1**. A Course in Internal Combustion Engines -** R.P Sharma & M.L. Mathur, DanpatRai& Sons.

2**. Elements of Fuels, Furnaces & Refractories -** O.P. Gupta, Khanna Publishers.

Reference Books:

1**. Internal Combustion Engines -** V. Ganesan, Tata McGraw-Hill Publications

2. **Present and Future Automotive Fuels -** Osamu Hirao& Richard Pefley, Wiley Interscience

Assessment Method:

CIE:

1. Three internal tests each with 30 Marks are conducted, average of best two tests marks will be considered.
2. Assignment test and Surprise tests are conducted for 10 Marks each

SEE:

1. The SEE question paper consists of FIVE units each consisting of TWO main questions. In each main questions there shall be maximum of four subdivisions.
2. The student has to answer any one full question from each unit, which amounts to 100 Marks.

M.TECH – MACHINE DESIGN, SYLLABUS

APPLIED MATHEMATICS

Sub Code : 16MMD101 **Credits : 04**
Hours/Week : 4+0+0 **CIE Marks : 50**
Total hours : 48 **SEE Marks : 50**
Exam Hours : 03 **Course type: Prog. Core**

UNIT-I

Linear Algebra System of linear algebraic equations –Direct Elimination methods -Cramer's Rule, Gauss Elimination, LU Decomposition, Cholesky Method, and Iterative Methods like Point Jacobi, Gauss
Seidel, Eigen values and Eigenvectors for Matrices – Jacobi method,, Givens method, Power method and
Inverse Power method **10Hrs**

UNIT-II

ODE and PDE ODE: Initial and Boundary value problems, Single step method, Taylors series method and
RungeKutta method (R-K method 4_{th} order, for system of equations and higher order systems) PDE ; Classification of second order pdes, Parabolic- 1D heat diffusion equation – explicit, fully implicit, Crank
Nicolson, Hyperbolic equations - Wave equation, Elliptic equations- Laplace and Poisson solvers **12Hrs**

UNIT-III

Numerical Methods Roots of Transcendental equations using Bisection method, Regula-Falsi method, Newton- Raphson method. Handling Multiple roots, Roots of a polynomial - Graeffe's Roots Squaring
Method, Interpolationanad Approximation – Cubic Spline, Finite Difference, Numerical Differentiation
and Integration: Newton – Cotes and Gauss Quadrature Integration formulae, Simpson and Trapezoidal
Rules of integration, **10Hrs**

UNIT-IV

Vectors and Tensors Definition of Tensor, Vector and Scalar. Inner and Outer Product, Gradient, Divergence and Curl of Vectors, directional derivatives, Line, Surface and Volume Integrals, Gauss's and
Green's Theorems.**08Hrs**

UNIT-V

Probability and Statistics Probability and Statistics: Definitions of Probability, Conditional Probability; Mean, Median, Mode and Standard Deviation; Binomial, Poisson and Standard Normal distributions, Sampling distribution -Tests of Significance based on the T and Chi-square distribution, Testing of Hypothesis - Confidence Interval and Significance Level
12Hrs

Text Book:

1. Computational Methods for Partial Differential Equations, M. K. Jain, S.R.K. iyengar, R.K. Jain, NewAge International, 1994.
2. Numerical Methods for Engineers, Steven C. Chapra, Raymond P. Canale,TataMcgraw Hill, 4th Edition,2002.
3. Numerical Methods for Scientific and Engineering Computation, M. K. Jain, S.R.K. iyengar, R.K. Jain,New Age International, 2003.

Reference Book:

1. Introductory methods of Numerical Analysis, S.S. Sastry,PHI, 2005
2. Higher Engineering Mathematics, Dr. B. S. Grewal,Khanna Publishers, 2003

3. Fundamentals of Engineering Numerical Analysis,PervezMoin, Cambridge, 2010.

Assessment Method:
CIE:
4. Three internals tests (each 30 marks) are conducted, average of best two tests marks will be considered.
5. Assignments will be evaluated by minimum two and Average of two will be considered - for 10 marks.
6. Two written surprise quiz tests conducted and evaluated for 10 marks. Average of these two will be considered.
SEE:
3. Two Questions are to be set from each unit, carrying 20 Marks each.
4. Students have to answer 5 questions selecting one full question from each unit.

FINITE ELEMENTS ANALYSIS IN DESIGN

Sub Code : 16MMD102 **Credits : 05**
Hours/Week : 4+0+2 **CIE Marks : 50**
Total hours : 48+0+24 **SEE Marks : 50**
Exam Hours : 03 **Course type: Prog. Core**

UNIT-I

One Dimensional problem:
Overview of Finite Element Method: Concept of FEM, Element Shapes, Discretization process,
Meshing, Interpolation Polynomials, Converge Requirements, Shape Functions, Coordinate systems: Local, Global and Natural.
Generic Form of Finite Element Equations for 1-D Elements, Formulation of Shape Functions,
Element Matrices: Linear Bar, Quadratic Bar, Boundary conditions and their incorporation: Elimination method, Penalty Method, Analysis of 1-D elements using FEA Software: Bars.
Case studies based on 1-D Bar. **12Hrs**

UNIT-II

One Dimensional problem:
Formulation of Shape Functions, Element Matrices: Beam and Frame Element, 1-D Heat Transfer, Boundary conditions and their incorporation, Analysis of 1-D elements using FEA Software: Trusses, Beams.
Case studies based on Beam and Truss Element. **10Hrs**
Two dimensional Problems:
Dimensionality of 2-D Problem, Approximation of Geometry and Field variable: Three noded
triangular Element, Four noded rectangular Elements, Six noded triangular Elements. Coordinate
Transformations: Concept of Jacobian , Shape functions using Lagrange's interpolation, Natural
Coordinates- Triangular and Quadrilateral Elements.
Case Studies on Linear static analysis of Bracket, Members of Plane Stress and Plane Strain with stress concentration, Axi-symmetric problems **10Hrs**

UNIT-III

Formulation of Shape Functions, Element Matrices:
Three, Six Noded triangular Element, Four Noded rectangular Element, Four Noded Quadrilateral,
Case Studies on 2-D Problems.10Hrs

UNIT-IV

Basics of plates and shell theories:
Classical thin plate Theory, Shear deformation Theory and Thick Plate theory. Finite Element Formulations for triangular and quadrilateral Plate elements. Finite element formulation of flat,
curved, cylindrical and conical Shell elements. **10Hrs**

UNIT-V

Dynamic Analysis:
Static Vs Dynamic Analysis, Equations of Motion for members under vibration based on weak
form, Lagrange's approach, Consistent and lumped mass models for Bar, Beam and 2-D Elements. Element Matrices of bar undergoing axial vibration, Free Vibration analysis
Non Linear Analysis:
Types of Non Linearity, Stress-Strain Measures and solution techniques for Nonlinear Analysis,
Procedure for Non Linear static Analysis.**10Hrs**

Text Books
1. Rao,S.S., "The Finite Element Method in Engineering", Butterworth-Heinemann(An imprint of Elsevier), reprinted 2006,2007, Published by Elsevier India Pvt. Ltd., New Delhi, Indian Reprint
2. P.Seshu, "Textbook of Finite Element Analysis", PHI, 2012.
3. H.S.Govinda Rao, "Finite Element Method Vs Classical Methods", New Age International,2008
4. Ted Belytschko, Wing Kam Liu, Brian Moran, Khalil Elkhodary "Nonlinear Finite Elements for Continua and Structures", 2nd Edition, November 2013

References:
1. Reddy, J.N., "Introduction to Non-Linear Finite Element Analysis", Oxford Uniiversity Press, 2008
2. "Finite Element Procedures"- February 15, 2007 by K.J. Bathe
3. S.S.Bhavikatti, Finite Element Analysis, New Age International,2010
4. S.M.Murigendrappa, "Fundamentals of Finite Element Method:, Interline Publishing, 2009
5. Numerical Solution of Partial Differential Equations: An Introduction by K. W. Morton , D. F. Mayers , Cambridge University Press; 2 edition (11 April 2005)

Assessment Method:
CIE:
4. Three internals tests (each 30 marks) are conducted, average of best two tests marks will be considered.
5. Project/Assignments will be evaluated by minimum two and Average of two will be considered - for 10 marks.
6. Laboratory experiments will conducted and evaluated for 10 marks.
SEE:
3. Two Questions are to be set from each unit, carrying 20 Marks each.
4. Students have to answer 5 questions selecting one full question from each unit.

THEORY OF ELASTICITY

Sub Code : 16MMD103 **Credits : 05**
Hours/Week : 4+0+2 **CIE Marks : 50**
Total hours : 48+0+24 **SEE Marks : 50**
Exam Hours : 03 **Course type: Prog. Core**

UNIT - I

Introduction:
Body, surface force and stress vector, State of stress at a point, Normal shear stress components,
rectangular stress components, stress components on an arbitrary plane, Equality of cross shears,
Principal stress, invariants, State of stress referred to principal axes, Mohr‘s circles for the 3D state of stress, Mohr‘s stress plane, Planes of max. shear, Octahedral stress, State of pure shear,
Decomposition into hydro static and pure shear state, plane state of stress, differential equations
of equilibrium, equilibrium equations for plane stress state, boundary conditions.
10 Hours

UNIT - II

Analysis of Stress in Cylindrical Co-ordinates:
Equations of equilibrium in cylindrical coordinates, Axis symmetric case and plane stress case.
Analysis of Strain: Introduction, deformation, change of length, strain at a point, interpretation of
shear strain components, change in direction of linear element, cubical dilation, principal axis of
strain, principal strains, plane state of strain, compatibility conditions, strain deviators and its invariants.
10 Hours

UNIT - III

Stress strain relationship:
Generalized statement of Hooke‘s law, isotropic materials, modulus of rigidity, bulk modulus,
young‘s modulus and Poisson‘s ratio. Relationship between elastic constants, displacement equation of equilibrium. Airy‟s function: Investigation of Airy‘s stress function for simple Beam
Problems
Bending of Prismatic Bars: Stress function - Bending of cantilever beam - Beam of rectangular
cross-section - Beams of circular cross-section.
10 Hours

UNIT - IV

Torsion & Axisymmetric Problems:
Torsional of general prismatic bars-solid sections, Torsion of circular, elliptical, triangular and

rectangular bars, Torsional of Rolled sections, Thick walled cylinder subjected to internal and external pressures-lames-problems, Stresses in composite tubes, Thermal Stresses.
10 Hours

UNIT - V

Plasticity:
Basic concept and definitions, idealized plastic behaviour. Yield condition- Tresca and Von-Mises criteria.yield surface. Post yield behaviour-isotropic and kinematic hardening. Plastic stress-strain equations, plastic potential theory. Equivalent stress, equivalent plastic strain increment. Plastic work, strain hardening hypothesis.

Viscoelasticity:
Linear viscoelastic behaviour. Simple viscoelastic models-generalized models, linear differential
operator equation. Creep and Relaxation- creep function, relaxation function, hereditary integrals. Complex moduli and compliances.
12 Hours

Text Books
1. Advanced Mechanics of Solids, L.S. Srinath, 3rd Edition,TMH, 2009.
2. Applied Elasticity, T.G. Sitharam and L.GovindaRaju, Interline Publishing, 2010.
3. Theory of Plasticity,Dr. Sadhu Singh, Khanna Publications, New Delhi, 2012.

References
1. Theory of Elasticity, S.P. Timoshenko and J.N. Gordier, Mc. Graw Hill, 3rd edition, 1972.
2. Applied Elasticity, C.T. Wang Sc. D. Mc.Graw Hill, 1953
3. Mechanics of Deformable Solids, Irving H. Shames, Krieger Pub Co, 2008.

Assessment Method:
CIE:
1. Three internals tests (each 30 marks) are conducted, average of best two tests marks will be considered.
2. Project/Assignments will be evaluated by minimum two and Average of two will be considered - for 10 marks.
3. Laboratory experiments will conducted and evaluated for 10 marks.

SEE:
1. Two Questions are to be set from each unit, carrying 20 Marks each.
2. Students have to answer 5 questions selecting one full question from each unit.

EXPERIMENTAL STRESS ANALYSIS

Sub Code : 16MMD104 **Credits : 05**
Hours/Week : 4+0+2 **CIE Marks : 50**
Total hours : 48+0+24 **SEE Marks : 50**
Exam Hours : 03 **Course type: Prog. Core**

UNIT-I

Introduction: Definition of terms, calibration, standards, dimensions and units, generalized measurement system, Basic concepts in dynamic measurements, system response, distortion, impedance matching, experiment planning.

Analysis of Experimental Data: Cause and types of experimental errors, error analysis. Statistical analysis of experimental data- Probability distribution, gaussian, normal distribution.

Chi-square test, Method of least square, correlation coefficient, multivariable regression, standard deviation of mean, graphical analysis and curve fitting, general consideration in data analysis.

10 Hours

UNIT-II

Data Acquisition and Processing: General data acquisition system, data transmission, Computer program as a substitute for wired logic. Force, Torque and Strain Measurement: Mass

balance measurement, Elastic Element for force measurement, torque measurement. Strain Gages -Strain sensitivity of gage metals, Gage construction, Gage sensitivity and gage factor, Performance characteristics, Environmental effects Strain, gage circuits, Potentiometer, Wheat

Stone's bridges, Constant current circuits. Strain Analysis Methods-Two element and three element, rectangular and delta rosettes, Correction for transverse strains effects, stress gage - plane shear gage, Stress intensity factor gage.

12 Hours

UNIT-III

Two Dimensional Photo elasticity: Absolute and relative phase difference, quarter wave plate

and half wave plate. Production of plane polarized light. Stress-optic law, Plane polariscope, Isochromatics and Isoclinics, analysis through trigonometricresolutions. Circular polariscopedark

field arrangement. Circular polariscope- dark and light field arrangement. Plane and circular polariscope, analysis using jones calculus.

Two Dimensional Photo Elastic Analysis:

Isoclinics and isochromatics fringe order at a point, methods of compensation, calibration methods and separation techniques. Properties of an ideal photo elastic material, casting techniques, stress relieving, two dimensional applications.

10 Hours

UNIT-IV

Electrical Resistance and Strain Gauges: Electrical strain gauges – Induction, capacitance and

electrical resistance strain gauges. Gauge factor, types of metal resistance gauges, gauge material, backing material, adhesives. Method of bonding strain gauges. Lead wires and connections. Temperature compensation, transverse sensitivity, gauges length. Strain gauge transducers, multiple gauge circuits, slip rings, calibration of strain measuring system. **10 Hours**

UNIT-V

Three Dimensional Photo elasticity: Stress freezing method, General slice, Effective stresses,
Stresses separation, Shear deference method, Oblique incidence method Secondary principals stresses, Scattered light photo elasticity, Principals, Polari scope and stress data analyses.
Coating Methods: Photoelastic Coating Method-Birefringence coating techniques Sensitivity
Reinforcing and thickness effects – data reduction - Stress separation techniques Photo elastic strain gauges. Brittle Coatings Method: Brittle coating technique Principles data analysis - coating materials, Coating techniques. Moire Technique - Geometrical approach, Displacement
approach- sensitivity of Moire data reduction, Moire photography, Moire grid production.
10 Hours

Text Books:

1. Holman,"Experimental Methods for Engineers" McGraw-Hill Education; 8 edition (September 1, 2011)
2. Experimental Stress Analysis - Srinath, Lingaiah, Raghavan, Gargesa, Ramachandra and Pant, Tata McGraw Hill, 1984.

Reference Books:

1. Design and Analysis of Experiments – Import, 25 May 2012 by Douglas C. Montgomery.
2. Experimental Stress Analysis - Dally and Riley, McGraw Hill, 1991.
3. Experimental Stress Analysis - Sadhu Singh, Khanna publisher, 1990.
4. PhotoelasticityVol I and Vol II - M.M.Frocht,.John Wiley and sons, 1969.

Assessment Method:

CIE:

1. Three internals tests (each 30 marks) are conducted, average of best two tests marks will be considered.
2. Project/Assignments will be evaluated by minimum two and Average of two will be considered - for 10 marks.
3. Laboratory experiments will conducted and evaluated for 10 marks.

SEE:

1. Two Questions are to be set from each unit, carrying 20 Marks each.
2. Students have to answer 5 questions selecting one full question from each unit.

DESIGN FOR MANUFACTURE AND ASSEMBLY

Sub Code : 16MMD105E1 **Credits : 04**
Hours/Week : 4+0+0 **CIE Marks : 50**
Total hours : 48 **SEE Marks : 50**
Exam Hours : 03 **Course type: Program Elective**

UNIT-I

Introduction to DFMA: Design philosophy, Steps in design process, Introduction to DFMA, History of
DFMA, Steps for applying DFMA during product design, Advantages of applying DFMA during product
design, Creativity in design, Material properties,. Effect of material properties on design, effect of manufacturing processes on design. Materials selection process. Examples of Good & Bad Designs for
Manufacturing and Assembly.
08 Hours

UNIT-II

Design for Casting Process: Sand casting: Introduction, typical characteristics of a sand cast part, Design recommendations. Investment casting: Introduction, Design consideration of Investment casting,
typical characteristics and applications. Die casting: Introduction, Advantages & Disadvantages, Applications, Suitable material consideration, general design consideration, Specific design recommendations.
Design for Forging: Introduction, forging nomenclature, Suitable materials for forging, Design recommendations.
Design for Metal Extrusion: Introduction, Suitable material for extrusion, Design recommendations
12 Hours

UNIT-III

Design for Machining: Introduction to Machining, , Recommended materials for Machinability, design
specific rules for machining, Dimensional tolerance and surface roughness, Design for manufacturing process with case studies- Turning, Milling, Drilling &Planing. **Design for Injection moulding**: Introduction to injection moulding, typical characteristics of injection moulded parts, Effect of shrinkage,
Suitable materials, and Design recommendations. **Design for Powder Metallurgy:** Introduction to powder metal processing, typical characteristics and applications, Limitations, Design recommendations
10 Hours

UNIT-IV

Design for Metal Forming: Process, Characteristics and application of metal stamping, Suitable materials for stamping, Design Recommendations for metal stamping, Fine blanked parts: Fine blanking
process, Material suitable for fine blanked parts, Design recommendations for piece parts
Design for Additive Manufacturing: Introduction to FDM, SLA, SLS processes, Materials & its Selection, Process parameters & its influence in FDM, General design guidelines, 3D CAD model to STL
conversion, Topology Optimization, Cellular Structures. Case Studies of Good & Bad Designs.
10 Hours

UNIT-V

Design for Assembly

Introduction to Assembly: Introduction, The assembly process, Characteristics and applications, Example of common assembly, Economic significance of assembly, General taxonomies of assembly operation and systems, assembling a product, Tolerance stack up analysis, Digital mock up analysis general design considerations for manual & automated assembly system.

Design for Fasteners: Introduction, Design recommendation for fasteners.

Design for Arc Welding, Brazing & Adhesive Bonding: Introduction, Design Recommendations, Typical characteristics, Suitable materials.

10 Hours

Text Book:

4. **Product design for manufacture and assembly -** Geoffrey Boothroyd, peter dewhurst, Winston Knight, Merceldekker. Inc. New York. 2011 Edition

5. **Designing for Manufacturing -** Harry Peck, Pitman Publications, 1983

Reference Book:

1. **Material selection and Design,** Vol. 20 - ASM Hand book

2. **Product design and Manufacturing,** A.K. Chitale and R.C. Gupta, Prentice Hall of India, New Delhi. (1999)

3. **Engineering Design,** George E. Dieter and Linda C. Schmidt (2009),Fourth edition, McGraw-Hill companies, New York, USA

4. **Engineering Design -Material & Processing Approach,** George E. Deiter/McGraw Hill Intl. 2nd Ed.2000

Assessment Method:

CIE:

1. Three internals tests (each 30 marks) are conducted, average of best two tests marks will be considered.
2. Project/Assignments will be evaluated by minimum two and Average of two will be considered - for 10 marks.
3. Two written surprise quiz tests/ seminar/laboratory experiments will conducted and evaluated for 10 marks. Average of these two will be considered.

SEE:

1. Two Questions are to be set from each unit, carrying 20 Marks each.
2. Students have to answer 5 questions selecting one full question from each unit.

TOOL DESIGN

Sub Code : 16MMD105E2 **Credits : 04**
Hours/Week : 4+0+0 **CIE Marks : 50**
Total hours : 48 **SEE Marks : 50**
Exam Hours : 03 **Course type: Program Elective**

UNIT-I

Introduction to tool design: Tooling requirement of a tool designer, General tool designing procedure.

Design of Single Point Cutting Tool: Design of single point lathe tool, Design of shank dimension using
strength and rigidity considerations for rectangular, square and round cross section and selection of tool
geometry. Solid type tool, brazed tip tool, long indexable insert, thruway indexable insert types and chip
breakers.

05 Hours

Design of Multi Point cutting Tool: Drill bit design of elements like back taper, Web thickness, land width, Margin, flute length, Cross section and selection of tool geometry. **Design of milling cutter**: Design elements like Number of teeth and Height circular pitch, Body thickness, Chamfer width, fillet radius and Selection of tool geometry.

05 Hours

UNIT-II

Design of Jigs: Functions and differences between jigs and fixtures, Advantages in mass production, Design principles, Econ0mics of jigs and fixtures, Principles of location 3-2-1. Types of location, Different types of locating elements. Clamping: Principle of clamping, types of clamping including power
clamping devices. Drill jigs: Types, Drill bushes, Simple exercises of designing jigs for given components.

05 Hours

Design of Fixtures: Fixture design, Turning fixtures, Milling fixtures, Grinding and Broaching fixtures,
Indexing fixtures, Design of fixtures for simple components.

05 Hours

UNIT-III

Design of sheet metal: Working of power press and classification of presses. Components of a simple die, Press tool operations, Die accessories, Shearing action in a punch & die, Clearance, Shear on punch
&die, Design problems on blanking and punching dies for simple components.

05 Hours

Strip layout: Scrap strip layout, Simple, Progressive, Compound, Combination and Inverted dies. Estimation of Centre pressure.Problems for simple components.

05 Hours

UNIT-IV

Bending: Bending dies: Introduction, Bend allowances, Spring back, Types of bending dies. Simple problems on Bending,

05 Hours

Drawing dies: Single action, Double action and triple action dies, Factors affecting drawing, Drawing die
design. Determination of Forming Limit Curve for Formability.Simple problems on Drawing.

05 Hours

UNIT-V

Unconventional Machining Processes: Abrasive jet machining: Principles, applications, process parameters. Ultrasonic machining: Principles, applications, analysis of process parameters. Electrochemical
machining and grinding: Principles, classifications, choice of electrolytes, applications.
05 Hours
Electric discharge machining: Principles, selection of tools materials and dielectric fluid. Electron beam
machining: Generation of electron beam, relative merits and demerits. Laser beam machining: Principles
and applications. **05 Hours**

TEXT BOOKS:
1. Tool Design. C.Donaldson, G.H.LeCainV.V, Goold.Tata McGraw Hill Pub. 1976
2. Modern Machining Process P.C.Pandey&H.S.Shan. Tata McGraw Hill Pub 2011
REFERENCE BOOKS:
1. Metal cutting theory & cutting tool design, by V. Arshinov and G. Alkseev Mir Pub. Mascow Edn. 1976.
2. Typical example and problems in metal Cutting theory and cutting tool design, by N. Nefdov, K. Osipov, Mir Pub. Edn. 1987
3. Introduction to jigs and fixture design, M.H.A. Kempster, elbs, edn. 1974. 3.
4. Tool engineering and design, NagapalKhanna Pub. Edn. 1998.
5. Fundamentals of tools design, ASTME prentice hall India. 2000.
6. Metal cutting and tool design, Dr. B. J. Ranga, Vikas Pub. Edn. 1993.

Assessment Method:
CIE:
1. Three internals tests (each 30 marks) are conducted, average of best two tests marks will be considered.
2. Project/Assignments will be evaluated by minimum two and Average of two will be considered - for 10 marks.
3. Two written surprise quiz tests/ seminar/laboratory experiments will conducted and evaluated for 10 marks. Average of these two will be considered.
SEE:
1. Two Questions are to be set from each unit, carrying 20 Marks each.
2. Students have to answer 5 questions selecting one full question from each unit

NANO MATERIALS AND TECHNOLOGY

Sub Code : 16MMD105E3 **Credits : 04**
Hours/Week : 4+0+0 **CIE Marks : 50**
Total hours : 48 **SEE Marks : 50**
Exam Hours : 03 **Course type: Program Elective**

UNIT – I

Overview: Why nanoscale materials? definitions, and examples. Top-down and bottom-up approaches.
Structurally Confined Materials: Thin Films, Islands, Nanowires, and Nanoparticles. Metal Nanoparticles:
Fundamentals, Applications. Ceramic NanoMaterials: Fundamentals, Applications. Magnetic Nanoparticles: Fundamentals, Applications. Bionanomaterials, Composite NanoMaterials and Applications.**9 Hours**

UNIT-II

Nanoscale Characterization and Properties of NanoMaterials:
Structural characterization: XRD, SMXS, SEM, TEM STM, FTIR,
Chemical characterization: Optical spectroscopy, Electron Spectroscopy, ionic spectroscopy
Physical properties of NanoMaterials: melting points and lattice constants, mechanical properties, optical
properties.
10Hours

UNIT-III

Special Nano Materials: Fullerenes and Carbon Nanotubes and Nanotubes: Fundamentals, Micro and
Mesoporous Materials: ordered and random Mesoporous structures. Core shell structures: Metal oxide,
Metal polymer, Oxide polymer structures.Organic Inorganic structures.
10 Hours

UNIT-IV

Nano structures Fabricated by physical techniques: Nanolithography: E-beam, X –ray lithography ,
Soft lithography: nano imprint, Dip-Pen nano lithography
Physical methods for nanostructures (thin film processing and self-assembly): (a) Fundamentals of vacuum science and technology (b) Thin film growth modes for nanolayers
Ion-implantation based methods for nanostructures: (a) Fundamentals of ion implantation (b) Nonequilibrium
processing (c) Control of clustering kinetics and Ostwald ripening**.**
10 Hours

UNIT - V

123
123

Applications of Nano Materials: Molecular electronics and nano electronics, nanobots, biological applications of Nanoparticles, catalysis by gold Nanoparticles, nanomechanics, photoelectrochemical cells, photonic crystals, band gap engineered quantum devices.
9 Hours

Text Book:

1. **NanoscaleMaterials**by Luis M. Liz-Marzán, Prashant V. Kamat, Springer; 2003 edition

2. **Nanoparticles: From Theory to Application, 2nd, Completely Revised and Updated Edition** by Gunter Schmid, John Wiley &Sons,August 2010.

Reference Book:

1. **Nanostructures &nanomaterials**by Guozhong Cao, Imperial College Press, 2004

Assessment Method:

CIE:

1. Three internals tests (each 30 marks) are conducted, average of best two tests marks will be considered.
2. Project/Assignments will be evaluated by minimum two and Average of two will be considered - for 10 marks.
3. Two written surprise quiz tests/ seminar/laboratory experiments will conducted and evaluated for 10 marks. Average of these two will be considered.

SEE:

1. Two Questions are to be set from each unit, carrying 20 Marks each.
2. Students have to answer 5 questions selecting one full question from each unit

RAPID PROTOTYPING

Sub Code : 16MMD105E4 **Credits : 04**
Hours/Week : 4+0+0 **CIE Marks : 50**
Total hours : 48 **SEE Marks : 50**
Exam Hours : 03 **Course type: Program Elective**

UNIT–I

Fundamentals of Rapid Prototyping: Introduction to Prototyping- Historical Development, Traditional
Prototyping vs. Rapid Prototyping, Need of RP in contextof batch production, Basic Principles of RP, Steps in RP, Process chain in RP in integrated CAD-CAM environment, **Classifications of different RP**
techniques: based on raw material, layering technique (2D or 3D) and energy sources; Applications: Design, Planning, Manufacturing, Tooling, Automotive, Jewellery, Coin and Bio-Medical, Design Process, Rapid Prototyping Process Chain.
9 Hours

UNIT-II

CAD Modeling and Data Processing for RP:
Subsystems of RP machine - Optical System, Mechanical Scanning System, Computer Interfacing hardware, DAQs, Signal Flow.
Introduction to 3D Modelling Software - Auto-CAD, PROE, CATIA, IDEAs etc., Slicing and Scan Path Generation Algorithms, Data Conversion and Transmission, File Formats (IGES, STL, SLC, CLI,
RPI, LEAF, HP/GL, CT, STEP), Pre-processing and Post-processing (part removal, part cleaning, post
curing, part finishing, machine accuracy & part accuracy)
10 Hours

UNIT-III

RP Systems (Basic concept & process detail of RP process):
Photo polymerization
Stereo lithography (SL), SL resin curing process, SL scan patterns, Micro stereo lithography, Applications of Photo polymerization Processes.
Powder Bed Fusion:
Selective laser Sintering (SLS), Powder fusion mechanism and powder handling, SLS Metal and ceramic
part creation, Electron Beam melting (EBM), Applications of Powder Bed Fusion Processes.
Extrusion-Based RP Systems:
Fused Deposition Modelling (FDM), Principles, Plotting and path control, Applications of Extrusion-Based Processes.
10 Hours

UNIT-IV

RP Systems (Continued):
3D Printing:
3D printing (3DP), Research achievements in printing deposition, Technical challenges in printing, Printing process modelling, Applications of Printing Processes.
Sheet Lamination:
Laminated Object Manufacturing (LOM), Ultrasonic Consolidation (UC), Gluing, Thermal bonding, LOM and UC applications.
Beam Deposition:

Laser Engineered Net Shaping (LENS), Direct Metal Deposition (DMD), Processing-structure-properties,
relationships, Benefits and drawbacks.
10 Hours

UNIT-V

Rapid Tooling:
Conventional Tooling Vs. Rapid Tooling, Classification of Rapid Tooling, Direct and Indirect Tooling
Methods, Soft and Hard Tooling methods.
Errors in RP Processes:
Pre-processing, processing, post-processing errors, Part building errors in SLA & SLS.
Advances in RP Systems:
Advances in RP: Resolution & Accuracy issues, Integrated Hardening Process, Two Photon Process for
Micro/Nano Fabrication, Reverse Engineering Process and Applications.
9 Hours

Text Book:
1. **Rapid Prototyping Principles and Applications** by Chua C.K., Leong K.F., and Lim C.S., World Scientific Publishing Co Pte Ltd; 3rd Revised edition edition (16 December 2008).
2. Rapid Prototyping: Principles and Applications Hardcover – Import, 8 Nov 2005 byRafiq I. Noorani
3. Additive Manufacturing Technologies Hardcover – 9 Dec 2014 by Ian Gibson (Author), David Rosen (Author), Brent Stucker.
Reference Book:
1. Rapid Prototyping: Theory and Practice (Manufacturing Systems Engineering Series)21 March 2006 by Ali K. Kamrani and EmadAbouel Nasr
2. **Rapid Prototyping Technology Selection and Application**by Kenneth G. Cooper, 2001, Marcel Dekker Inc, New York.
3. **Rapid Prototyping**by Amitabh Ghosh, , East West Press Pvt. Ltd

Assessment Method:
CIE:
1. Three internals tests (each 30 marks) are conducted, average of best two tests marks will be considered.
2. Project/Assignments will be evaluated by minimum two and Average of two will be considered - for 10 marks.
125
125
3. Two written surprise quiz tests/ seminar/laboratory experiments will conducted and evaluated for 10 marks. Average of these two will be considered.
SEE:
1. Two Questions are to be set from each unit, carrying 20 Marks each.
2. Students have to answer 5 questions selecting one full question from each unit.

HYDRAULICS AND PNEUMATICS

Sub Code : 16MMD105E5 **Credits : 04**
Hours/Week : 4+0+0 **CIE Marks : 50**
Total hours : 48 **SEE Marks : 50**
Exam Hours : 03 **Course type: Program Elective**

UNIT-I

Introduction to Hydraulic Power:
Pascal's law and problems on Pascal's Law, continuity equations, introduction to conversion of units. Structure of Hydraulic Control System.
The Source of Hydraulic Power:
Pumps Pumping theory, pump classification, gear pumps, vane pumps, piston pumps, pump performance,
pump selection. Variable displacement pumps. Reservoirsystem, Filters & Strainer & Sealing Device.
9 Hours

UNIT-II

Hydraulic Actuators and Motors:
Linear Hydraulic Actuators [cylinders], Mechanics of Hydraulic Cylinder loading, Hydraulic Rotary Actuators, Gear motors, vane motors, piston motors, Hydraulic motor theoretical torque,
power and flow rate, hydraulic motor performance.
Control Components in Hydraulic Systems:
Directional Control Valves – Symbolic representation, Constructional features, pressure control
valves – direct and pilot operated types, flow control valves.
10 Hours

UNIT-III

Hydraulic Circuit Design and Analysis:
Control of single and Double – acting Hydraulic cylinder, regenerative circuit, pump unloading
circuit, Double pump Hydraulic system, Counter Balance Valve application, Hydraulic cylinder
sequencing circuits. Locked cylinder using pilot check valve, cylinder synchronizing circuits, speed control of hydraulic cylinder, speed control of hydraulic motors, accumulators and accumulator circuits.
Maintenance of Hydraulic systems:
Hydraulic oils – Desirable properties, general type of fluids, sealing devices, problem caused by
gases in hydraulic fluids, wear of moving parts due to solid particle contamination, temperature
control, trouble shooting.
10 Hours

UNIT-IV

Introduction to Pneumatic control:
Choice of working medium, characteristics of compressed air. Structure of Pneumatic control system.
Pneumatic Actuators: Linear cylinders – Types, conventional type of cylinder working, end

position cushioning, seals, mounting arrangements applications. Rod – less cylinders – types, working advantages. Rotary cylinder types construction and application. Design parameters – selection .

Directional Control valves: Symbolic representation as per ISO 1219 and ISO 5599. Design and constructional aspects, poppet valves, slide valves spool valve, suspended seat type slide valve.

Simple Pneumatic Control: Direct and indirect actuation pneumatic cylinders, use of memory
valve. Flow control valves and speed control of cylinders supply air throttling and exhaust air throttling use of quick exhaust valve.

Signal processing elements: Use of Logic gates – OR and AND gates pneumatic applications.

Practical examples involving the use of logic gates. Pressure dependent controls types construction –practical applications. Time dependent controls – Principle, construction, practical
applications.

10 Hours

UNIT-V

Multi-cylinder applications:

Coordinated and sequential motion control. Motion and control diagrams – Signal elimination methods. Cascading method – principle. Practical application examples (up to two cylinders) using cascading method (using reversing valves).

Electro-Pneumatic control:

Principles-signal input and output pilot assisted solenoid control of directional control valves, use of relay and contactors. Control circuitry for simple single cylinder applications.

Compressed air: Production of compressed air – compressors, preparation of compressed air-
Driers, Filters, Regulators, Lubricators, Distribution of compressed air- Piping layout.

9 Hours

Text Book:

1. **Fluid Power with applications:** Anthony Esposito, Fifth edition pearson education, Inc. 2000.

2. **Pneumatics and Hydraulics**: Andrew Parr. Jaico Publishing Co. 2000.**Reliability in**

Reference Book:

1. **Oil Hydraulic Systems – Principles and Maintenance:** S.R. 2002 Majumdar, Tata Mc Graw Hill publishing company Ltd. 2001.

2. **Pneumatic systems** by S.R.Majumdar, Tata Mc Graw Hill publishing Co., 1995.

Assessment Method:

CIE:

1. Three internals tests (each 30 marks) are conducted, average of best two tests marks will be considered.
2. Project/Assignments will be evaluated by minimum two and Average of two will be considered - for 10 marks.
3. Two written surprise quiz tests/ seminar/laboratory experiments will conducted and evaluated for 10 marks. Average of these two will be considered.

SEE:

1. Two Questions are to be set from each unit, carrying 20 Marks each.
2. Students have to answer 5 questions selecting one full question from each unit

SEMINAR

Sub Code : 16MMDP106S **Credits : 02**
Hours/Week : 0+0+4 **CIE Marks : 50**
Total hours : 48 **SEE Marks : 50**
Exam Hours : 01 **Course type: Prog. Core**

Seminar work shall be a topic on the recent trends in the line of Machine design course. The seminar should be done individual. On completion of the literature survey and presentation, student shall prepare a report according to the guidelines and submit it to the concerned authority. Seminar course should be carried out with the guidance of an internal guide

MINI PROJECT

Sub Code : 16MMDP107P **Credits : 03**
Hours/Week : 0+0+4 **CIE Marks : 50**
Total hours : 24 **SEE Marks : 50**
Exam Hours : 01 **Course type: Prog. Core**

The Mini Project work shall be on a topic in the area of specialization specified by the guide and
selected by the candidate, in line with machine design course. The mini project should be doneindividual. The student shall seek the guidance of the internal guide on a continuous basis, andthe guide shall give a certificate to the effect that the candidate has worked satisfactorily underhis/her guidance on completion of the mini project work.
On completion of the work, student shall prepare a report according to the guidelines and submitit to the concerned authority.
The student is supposed to finalize the topic of the project work at the beginning of the 1st semester. 2 seminars have to be given, to evaluate the progress of work.
1. Mid of the semester
2. Final Presentation.
The seminars will be assessed by a committee who will make suitable recommendations at eachstage

FRACTURE MECHANICS

Sub Code : 16MMD201 **Credits : 05**
Hours/Week : 4+0+2 **CIE Marks : 50**
Total hours : 48+0+24 **SEE Marks : 50**
Exam Hours : 03 **Course type: Prog. Core**

UNIT-I

Summary of basic problems and concepts:
A crack in a structure, the stress at a crack tip, the Griffith criterion, the crack opening displacement criterion, crack propagation.

Mechanism of facture and crack growth:
Introduction, Cleavage fracture, ductile fracture, fatigue cracking, environment assisted cracking,
service failure analysis.

10 Hours

UNIT-II

The elastic crack-tip stress field:
The airy stress function, complex stress function, solution to crack problems, the effect of finite
size, special cases, elliptical cracks.
128
128

The crack tip plastic zone:
The Irwin plastic zone correction, the Dugdale approach, the shape of the plastic zone, plane stress versus plane strain, plastic constraint factor, the thickness effect.

10 Hours

UNIT-III

The energy principle:
The energy release rate, the criterion for crack growth, the crack resistance (R curve), compliance, the J integral, tearing modulus, stability.

Dynamics and crack arrest:
Crack speed and kinetic energy, the dynamic stress intensity and elastic energy release rate, crack branching, the principles of crack arrest, crack arrest in practice, dynamic fracture toughness.

10 Hours

UNIT-IV

Plane stain fracture toughness:
The standard test, size requirements, non-linearity, applicability.

Plane stress and transitional behavior:
Introduction, an engineering concept of plane stress, the R curve concept, the thickness effect,
plane stress testing.

10 Hours

UNIT-V

Elastic plastic fracture:

Fracture beyond general yield, the crack tip opening displacement, the possible use of CTOD criterion, experimental determination of CTOD , parameters affecting the critical CTOD, limitation fracture at general yield, Use of J integral, limitations of J integral, measurement of Jic
and JR.

Fatigue crack propagation:

Introduction, crack growth and stress intensity factor, factors affecting crack propagation, variable amplitude service loading, retardation models, similitude, small cracks. **10 Hours**

Text Books

1. David Broek 'Elementary Engineering Fracture Mechanics'. MartinusNijhoff Publishers. 1982.
2. Fracture Mechanics for Modern Engineering Design by K. R. Y. Simha, Universities Press India Pvt Ltd 2001

References

1. Fracture Mechanics: Fundamentals and Applications, Third Edition Ted L. Anderson Publisher: CRC Press, 2004
2. Knott, 'Fundamentals of Fracture Mechanics; Butterworths, 1973.
3.

Assessment Method:

CIE:

1. Three internals tests (each 30 marks) are conducted, average of best two tests marks will be considered.
2. Project/Assignments will be evaluated by minimum two and Average of two will be considered - for 10 marks.
3. Laboratory experiments will conducted and evaluated for 10 marks.

SEE:

1. Two Questions are to be set from each unit, carrying 20 Marks each.

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3. Students have to answer 5 questions selecting one full question from each unit.

MECHANICAL VIBRATIONS AND SYSTEM CONTROL

Sub Code : 16MMD202 **Credits : 05**
Hours/Week : 4+0+2 **CIE Marks : 50**
Total hours : 48+0+24 **SEE Marks : 50**
Exam Hours : 03 **Course type: Prog. Core**

UNIT-I

Undamped Free Vibrations of Single-Degree of freedom Systems:
Free Vibration of an Undamped Translational System,Torsional Vibration, Natural frequency of
free longitudinal vibrations, Natural frequency of free transverse vibrations, Effect of the Inertia
of shaft on longitudinal and transverse vibrations, Natural frequency of transverse vibrations of
shafts or beams under different types of loads and end conditions.
Damped Free Vibrations of Single Degree of freedom systems
Free Vibrations with Viscous Damping, Logarithmic Decrement, Torsional System with Viscous
Damping, Free Vibration with Coulomb Damping,Torsional system with viscous damping.
Simulation study using mathematical simulation software on Single DOF system
12Hours

UNIT-II

Multi Degree Freedom System:
Free vibration equation of motion, influence coefficient, generalized coordinates, coordinate couplings, Lagrange's equations matrix method; Eigen values Eigen vector problems, modal analysis, numerical methods
Simulation study using mathematical simulation software on Multi DOF system
10Hours

UNIT-III

Continuous systems:
Transverse vibration of string, longitudinal and torsional vibrations of rods, Euler equations for
beams.
Simulation study using finite element software on modal analysis, Harmonic analysis.
10Hours

UNIT-IV

Transient Vibration of Single Degree of freedom systems:
Impulse excitation, arbitrary excitation, Laplace transforms formulation, Pulse excitation and rise
time, Shock response spectrum, Shock isolation.
Random Vibration:
Random Variable and random processes, Time averaging and expected value, Probability Distribution, Correlation functions of a Random Process.
10Hours

UNIT-V

Non Linear Vibrations:

130

130

Non Linear Vibrations:Introduction,Sources of nonlinearity,Qualitative analysis of nonlinear systems.Phaseplane,Conservative systems, Stability of equilibrium, Method of isoclines, Perturbation method, Method of iteration, Self-excited oscillations.

Hands on session using MATLAB Problems 10Hours

Text Books

1. Mechanical Vibrations: S SRao,Pearson Education Inc,4th Edition,2003.
2. Mechanical Vibrations:V P Singh, DhanpatRai& Company Pvt Ltd.,3rd edition,2006.
3. Fundamentals of Mechanical Vibrations: S.Graham Kelly Schaum's McGraw-Hill Higher Education; 2 edition (1 June 2000)

References:

1. Theory of Vibration with Applications:W.T.Thomson and Marie Dillon Dahleh, Pearson Education 5th edition,2007.
2. Elements of Vibrations Analysis:LeonanrdMeirovitch, Tata Mc Graw Hill, Special Indian edition,2007.
3. Theory&Practice of Mechanical Vibrations: J.S.Rao& K Gupta, New Age International Publications,New Delhi,2001.
4. C Sujatha,"Vibrations and Acoustics-Measurements and signal analysis" ,Tata McGraw Hill, 2010.
5. Mechanical Vibration Analysis :P Srinivasan Tata Mcgrw Hill Publishing Company Limited.2010
6. Mechanical Vibrations:RaoV.Dukkipati J. Srinivas PHI Learning Private Limited New Delhi-110001 Sixth printing (second edition) February 2012.
7. Vibrations of Shells and Plates by Werner Soedel CRC Press; 3 edition (11 August 2004)

Assessment Method:

CIE:

1. Three internals tests (each 30 marks) are conducted, average of best two tests marks will be considered.
2. Project/Assignments will be evaluated by minimum two and Average of two will be considered - for 10 marks.
3. Laboratory experiments will conducted and evaluated for 10 marks.

SEE:

1. Two Questions are to be set from each unit, carrying 20 Marks each.
2. Students have to answer 5 questions selecting one full question from each unit.

ADVANCED MACHINE DESIGN

Sub Code : 16MMD203 **Credits : 05**
Hours/Week : 4+0+2 **CIE Marks : 50**
Total hours : 48+0+24 **SEE Marks : 50**
Exam Hours : 03 **Course type: Prog. Core**

UNIT-I

Introduction:
131
131
Role of failure prevention analysis in mechanical design, Modes of mechanical failure, Review
of failure theories forductile and brittle materials including Mohr's theory and modified Mohr's
theory, Numerical examples.
10Hours

UNIT-II

Fatigue of Materials:
Introductory concepts, High cycle and low cycle fatigue, Fatigue design models, Fatigue design
methods, Fatigue design criteria, Fatigue testing, Test methods and standard test specimens, Fatigue fracture surfaces and macroscopic features, Fatiguemechanisms and microscopic features.
10Hours

UNIT-III

Stess-Life (S-N) Approach:
S-N curves, Statistical nature of fatigue test data, General S-N behavior, Mean stress effects, Different factors influencing S-N behavior, S-N curve representation and approximations, Constant life diagrams, Fatigue life estimation using SN approach.
Strain-Life(ε-N)approach:
Monotonic stress-strain behavior ,Strain controlled test methods ,Cyclic stress-strain behavior ,Strain based approach to life estimation, Determination of strain life fatigue properties, Mean stress effects, Effect of surface finish, Life estimation byε-N approach.
10Hours

UNIT-IV

LEFM Approach:
LEFM concepts, Crack tip plastic zone, Fracture toughness, Fatigue crack growth, Mean stress
effects, Crack growthlife estimation. Notches and their effects: Concentrations and gradients in
stress and strain, S-N approach for notched membranes, mean 30stress effects and Haigh diagrams, Notch strain analysis and the strain – life approach, Neuber's rule, Glinka's rule, applications of fracture mechanics to crack growth at notches.
Fatigue from Variable Amplitude Loading:
Spectrum loads and cumulative damage, Damage quantification and the concepts of

damagefraction and accumulation, Cumulative damage theories, Load interaction and sequence
effects, Cycle counting methods, Life estimationusing stress life approach.
10Hours

UNIT-V

Surface Failure:
Introduction, Surface geometry, Mating surface, Friction, Adhesive wear, Abrasive wear, Corrosion wear, Surface fatigue spherical contact, Cylindrical contact, General contact, Dynamic
contact stresses, Surface fatigue strength.

Text Books:
1. Ralph I. Stephens, Ali Fatemi, Robert, Henry o. Fuchs, "Metal Fatigue in engineering", John
Wiley New York, Second edition. 2001.
132
132
2. Failure of Materials in Mechanical Design, Jack. A. Collins, John Wiley, New York 1992.
3. Robert L. Norton , "Machine Design", Pearson Education India, 2000
Reference Books:
1. Suresh , "Fatigue of Materials", Cambridge University Press, -1998
2. Julie.A.Benantine , "Fundamentals of Metal Fatigue Analysis", Prentice Hall,1990
3. Fatigue and Fracture, ASM Hand Book, Vol 19,2002.

Assessment Method:
CIE:
1. Three internals tests (each 30 marks) are conducted, average of best two tests marks will be considered.
2. Project/Assignments will be evaluated by minimum two and Average of two will be considered - for 10 marks.
3. Laboratory experiments will conducted and evaluated for 10 marks.
SEE:
1. Two Questions are to be set from each unit, carrying 20 Marks each.
2. Students have to answer 5 questions selecting one full question from each unit.

COMPUTER AIDED ENGINEERING

Sub Code : 16MMD204 **Credits : 05**
Hours/Week : 4+0+2 **CIE Marks : 50**
Total hours : 48+0+24 **SEE Marks : 50**
Exam Hours : 03 **Course type: Prog. Core**

UNIT-I

Introduction to CAD/CAM: Computers in Industrial Manufacturing, Product cycle
Geometric modeling: Requirements, geometric models, geometric construction models, curve
representation methods, surface representation methods, modeling facilities desired Drafting. Modeling systems: Basic geometric commands, layers, display control commands, editing, dimensioning, solid modeling, constraint based modeling.
08 HOURS

UNIT-II

Transformations: Translation, Rotation, Scaling Symmetry and Reflection, Homogeneous Transformations.
10 HOURS

UNIT-III

Fundamentals of Manufacturing and Automation:
Automation, Reasons for automation, Manufacturing Industries, Types of production, Functions in
Manufacturing, Organization and information processing in manufacturing, Plant layout, Production
concepts and Mathematical models, Automation strategies Detroit type Automation: Automated flow
lines, methods of work part transport, transfer mechanisms, Buffer storage, Automation for machining operations.
10 HOURS

UNIT-IV

Analysis of automated flow lines:
133
133
General terminology and analysis, Analysis of transfer line without storage, with storage, partial automation.
Assembly Systems and Line Balancing:
The assembly process, Assembly systems, manual assembly systems, Line balancing, design of automated assembly, types, parts feeding devices, analysis of multi-station assembly machines and
single-station assembly machine.
10 HOURS

UNIT-V

Material Handling and Storage:
Functions, types of material handling, analysis of material handling, design of system, AGVs, storage

system performance, AS/RS, Carousel storage system, work-in-process storage, interfacing handling
and storage with manufacturing.

Group Technology and Flexible Manufacturing Systems:

Part families, Parts classification and coding, production flow lines, machine cell design, Benefits of
Group technology, FMS workstation, Material handling and storage system, computer control systems, Planning the FMS.

10 HOURS

Text Books:

1. Computer Aided Drawing/Computer Aided Manufacturing by AC Niranjan Pooja publications 2011
2. Computer Integrated Manufacturing by AC Niranjan Pooja publications 2012

Reference Books:

1. Automation, Production System & Computer Integrated Manufacturing, M. P. Groover Person India, 2007 2nd edition.
2. CAD/CAM by Zeid, Tata Mcgraw-Hill Publishing Company Limited, 1991
3. Principles of Computer Integrated Manufacturing, S. Kant Vajpayee, Pearson; Facsimile edition
(1 November 1994)

Assessment Method:

CIE:

1. Three internals tests (each 30 marks) are conducted, average of best two tests marks will be considered.
2. Project/Assignments will be evaluated by minimum two and Average of two will be considered - for 10 marks.
3. Laboratory experiments will conducted and evaluated for 10 marks.

SEE:

1. Two Questions are to be set from each unit, carrying 20 Marks each.
2. Students have to answer 5 questions selecting one full question from each unit

THEORY OF PLASTICITY

Sub Code : 16MMD205E1 **Credits : 04**
Hours/Week : 4+0+0 **CIE Marks : 50**
Total hours : 48 **SEE Marks : 50**
Exam Hours : 03 **Course type: Program Elective**

UNIT-I

Introduction:
Definition and scope of the subject, Brief review of elasticity, Octahedral normal and shear stresses, Spherical and deviatric-stress, Invariance in terms of the deviatoric stresses, Idealised
stress-strain diagrams for different material models, Engineering and natural strains, Mathematical relationships between true stress and true strains, Cubical dilation, finite strains coefficient
Octahedral strain, Strain rate and the strain rate tensor.
10 Hours

UNIT-II

Material Models:
Stress-strain relations, Yield criteria for ductile metal, Von Mises, Tresca, Yield surface for an
Isotropic Plastic materials, Stress space, Experimental verification of Yield criteria, Yield criteria
for an anisotropic material, flow rule normality, Yield locus, Symmetry convexity, Deformation
of isotropic and kinematic hardening, bilinear stress-strain relationship, power law hardening, deformation theory of plasticity, J2 flow theory, J2incremental theory.
10 Hours

UNIT-III

Plastic stress-strain relations:
Prandtl- Rouss Saint Venant, Levy-Von Mises,Experimental verification of the Prandtl-Rouss
equation Upper and lower bound theorems and corollaries, Application to problems: Uniaxial tension and compression, Stages of plastic yielding.
10 Hours

UNIT-IV

Development of Equations and metal forming:
Bending of beams, Torsion of rods and tubes, nonlinear bending and torsion equations. Application of metal forming: Drawing and Extrusion process, stresses in drawing and extruding
with and without friction.
10 Hours

UNIT-V

Slipline theory:
Slipline theory, Introduction, Basic equations for incompressible two dimensional flow,

continuity equations, Stresses in conditions of plain-strain convention for slip-lines, Geometry of
sliplines, Properties of sliplines, Computational Plasticity- Finite element method, Formulations,
Plasticity models
08 Hours

Text Books:
1. Engineering Plasticity - Theory and Application to Metal Forming Process -R.A.C..Slater, McMillan Press Ltd., 1977
2. Theory of Plasticity and Metal forming Process - Sadhu Singh, Khanna Publishers, Delhi, 2003.
Reference Books:
1. Introduction to the Theory of Plasticity for Engineers- Haffman and Sachs, LLC, 2012.
2. Theory of plasticity - J Chakrabarty, Butterworth, 2006.
3. Plasticity for Mechanical Engineers - Johnson and Mellor, Van Nostrand, 1966.

Assessment Method:
CIE:
1. Three internals tests (each 30 marks) are conducted, average of best two tests marks will be considered.
2. Project/Assignments will be evaluated by minimum two and Average of two will be considered - for 10 marks.
3. Laboratory experiments will conducted and evaluated for 10 marks.
SEE:
1. Two Questions are to be set from each unit, carrying 20 Marks each.
2. Students have to answer 5 questions selecting one full question from each unit

SMART MATERIALS & SYSTEMS

Sub Code : 16MMD205E2 **Credits : 04**
Hours/Week : 4+0+0 **CIE Marks : 50**
Total hours : 48 **SEE Marks : 50**
Exam Hours : 03 **Course type: Program Elective**

UNIT-I

Introduction:
Characteristics of metals, polymers and ceramics.Introduction to smart materials. Classification
of smart materials.
Sensing and actuation:
Principles of electromagnetic, acoustics, chemical and mechanical sensing and actuation. Types
of sensors and their applications. Compatibility with conventional and advanced materials.
08 Hours

UNIT-II

Shape Memory Alloys:
History of shape memory alloys. Classification of shape memory alloys. NITINOLS – melting, casting
and forming of NITINOLS, shape memory and pseudoelasticity. Mechanical and bio-medical applications of NITINOL. Vibration control through shape memory alloys.
12 Hours

UNIT-III

Piezoelectric Materials:
Piezoelectric properties, piezoelectric materials.Making of piezoelectric actuators. Inchworm linear motor and application of piezo-actuators for precision movement control. Piezoresisters as sensors. Thermoelectris and Ferroelectrics.Magnetostrictive materials. Magnetostrictive actuators
12 Hours

UNIT-IV

Electro rheological (ER) and magneto rheological (MR) fluids:
Mechanisms and properties, fluid composition and behavior. Applications to clutches, vibration dampers
and others. Chromic materials – thermochromic, photochromic, piezochromic materials and their applications. Engineering applications of Chromic materials.
08 Hours

UNIT-V

Biomimetics:
Learning from nature..Smart structures.Devising self repairing structures.smart composites in transport.
Bio-mimetics
08 Hours
Pre-requisites:
The student must have basic knowledge of Material Science and Metallurgy

Text Books:

1. Smart Materials and Structures, M V Gandhi and B S Thompson Chapmen & Hall, London, 1992.

Reference Books:

1. Smart Materials and Structures, Banks HT, RC Smith, Y Wang, Massow S A, Paris 1996
2. G P Gibss' Adaptive Structures, Clark R L, W R Saunolers, Jhon Wiles and Sons, New York, 1998
3. An Introduction for Scientists and Engineers, EsicUdd, Optic Sensors :Jhon Wiley & Sons, New
York, 1991 (ISBN : 0471830070).

Assessment Method:

CIE:

4. Three internals tests (each 30 marks) are conducted, average of best two tests marks will be considered.
5. Project/Assignments will be evaluated by minimum two and Average of two will be considered - for 10 marks.
6. Laboratory experiments will conducted and evaluated for 10 marks.

SEE:

3. Two Questions are to be set from each unit, carrying 20 Marks each.
4. Students have to answer 5 questions selecting one full question from each unit.

ADVANCED CONTROL SYSTEMS

Sub Code : 16MMD205E3 **Credits : 04**
Hours/Week : 4+0+0 **CIE Marks : 50**
Total hours : 48 **SEE Marks : 50**
Exam Hours : 03 **Course type: Program Elective**

UNIT-I

Introduction, Mathematical Preliminaries:
Functions, Transformations and Mapping, (Discussion session will immediately start covering
Linear Algebra), Laplace transformation and z-transformation (Continuous time function vs. Discrete time sequence)
12 Hours

UNIT-II

State variables and state space models
State variables and state space models of dynamical systems, Relations between state space models and transfer function models (Controllable Canonical Form, Observable Canonical Form,
Diagonal Form)
12 Hours

UNIT-III

Solutions for Eigen-values and Eigen-vectors:
137
137
Solutions of unforced linear state equations, matrix exponential, eigen-values and eigen-vectors,
Jordan form. Solutions of linear state equations, transition matrix, discrete time models of continuous time systems.
08 Hours

UNIT-IV

Modeling of physical systems:
power, energy, sources, passive elements through and across variables, linear graph, modeling
examples for typical mechanical systems
such as vehicle suspension, electrical motor, etc.
08 Hours

UNIT-V

Stability and Controlability:
Stability, Lyapunov stability, Lyapunov function Controllability and observability, definition and
criteria, stabilizability and detectability, balanced realization and model reduction
08 Hours

Text Books:

1. "Digital Control and State Variable Methods" by MadanGopal, McGraw Hill Education (2008)

Reference Books:

1. "Modern Control Engineering" by K. Ogata 5th Edition Pearson 2010
2. “Advanced Control Systems Design” by Bernard Friedl 1995 ISBN 10 (0130140104)

Assessment Method:

CIE:

1. Three internals tests (each 30 marks) are conducted, average of best two tests marks will be considered.
2. Project/Assignments will be evaluated by minimum two and Average of two will be considered - for 10 marks.
3. Laboratory experiments will conducted and evaluated for 10 marks.

SEE:

1. Two Questions are to be set from each unit, carrying 20 Marks each.
2. Students have to answer 5 questions selecting one full question from each unit.

OPTIMIZATION TECHNIQUES IN DESIGN

Sub Code : 16MMD205E4 **Credits : 04**
Hours/Week : 4+0+0 **CIE Marks : 50**
Total hours : 48 **SEE Marks : 50**
Exam Hours : 03 **Course type: Program Elective**

UNIT-I

Introduction to Optimal Design:
feasibility and boundedness, topography of search space, classification of methods
12 Hours

UNIT-II

Optimization Problems:
Single variable optimization problems, Gradient and Direct search based methods. Constrained
and unconstrained problems
12 Hours

UNIT-III

Optimization methods:
Traditional and Non-traditional optimization methods
08 Hours

UNIT-IV

Optimization with parameter uncertainities:
Robust Optimisation, formulation, algorithms, applications. Methods of Multi-Disciplinary Optimization (MDO) with case studies in automotive engineering
08 Hours

UNIT-V

Optimization for modular design:
Optimization for modular design, System Identification (inverse) problems with applications on
Structural Health
08 Hours

Text Book:
1. S. S. Rao, Engineering Optimization Wiley Eastern Limited Publishers 1996
Reference Book
2. Kalyanmoy Deb, Optimization for Engineering Design. PHI learning Pvt Ltd Second Edition
November 2012
Assessment Method:
CIE:
1. Three internals tests (each 30 marks) are conducted, average of best two tests marks will be considered.
2. Project/Assignments will be evaluated by minimum two and Average of two will be considered - for 10 marks.

3. Laboratory experiments will conducted and evaluated for 10 marks.

SEE:

1. Two Questions are to be set from each unit, carrying 20 Marks each.
2. Students have to answer 5 questions selecting one full question from each unit.

TRIBOLOGY-LUBRICATION AND BEARING DESIGN

Sub Code : 16MMD205E5 **Credits : 04**
Hours/Week : 4+0+0 **CIE Marks : 50**
Total hours : 48 **SEE Marks : 50**
Exam Hours : 03 **Course type: Program Elective**

UNIT-I

Introduction to Tribiology:
Properties of oils and equation of flow: Viscosity, Newton‘s Law of viscosity, Hagen-Poiseuille Law,
Flow between parallel stationary planes, viscosity measuring apparatus. Lubrication principles, classification of lubricants.
07 Hours

UNIT II

Hydrodynamic Lubrication:
Friction forces and power loss in lightly loaded bearing, Petroff's law, Tower's experiments, idealized
full journal bearings.
Mechanism of Pressure Development in an Oil Film:
Reynold‘s investigations, Reynold's equation in two dimensions. Partial journal bearings, end leakages in journal bearing, numerical problems.
08 Hours

UNIT III

Slider / Pad Bearing with a Fixed and Pivoted Shoe:
Pressure distribution, Load carrying capacity, coefficient of friction, frictional resistance in a pivoted
shoe bearing, influence of end leakage, numerical examples.
08 Hours

UNIT IV

Hydrostatic Lubrication:
Introduction to hydrostatic lubrication, hydrostatic step bearings, load carrying capacity and oil flow
through the hydrostatic step bearing.
Bearing Materials:
Commonly used bearings materials, properties of typical bearing materials.
08 Hours

UNIT V

Wear:
Classification of wear, wear of polymers, wear of ceramic materials, wear measurements, effect of
speed, temperature and pressure.
Behavior of Tribological Components:
Selection, friction, Wear of ceramic materials, wear measurements, effects of speed, temperature and
pressure. Tribological measures, Material selection, improved design, surface engineering.
07 Hours

Text Book

1. Lubrication of Bearings – Theoretical Principles and Design, Redzimovskay E I., Oxford press company 2000
2. Principles and Applications of Tribology, Moore, Pergamaon press 1998

Reference Book

1. Fundamentals of Tribology , Basu S K., Sengupta A N., Ahuja B. B., , PHI 2006 .
2. Introduction to Tribology Bearings, Mujumdar B. C., S. Chand company pvt. Ltd 2008

Assessment Method:

CIE:

4. Three internals tests (each 30 marks) are conducted, average of best two tests marks will be considered.
5. Project/Assignments will be evaluated by minimum two and Average of two will be considered - for 10 marks.
6. Laboratory experiments will conducted and evaluated for 10 marks.

SEE:

3. Two Questions are to be set from each unit, carrying 20 Marks each.
4. Students have to answer 5 questions selecting one full question from each unit.

SEMINAR

Sub Code : 16MMD206S **Credits : 02**
Hours/Week : 0+0+4 **CIE Marks : 50**
Total hours : 48 **SEE Marks : 50**
Exam Hours : 01 **Course type: Prog. Core**

Seminar work shall be a topic on the recent trends in the line of Machine design course. The seminar should be done individual. On completion of the literature survey and presentation, student shall prepare a report according to the guidelines and submit it to the concerned authority. Seminar course should be carried out with the guidance of an internal guide

MINI PROJECT

Sub Code : 16MMD207P **Credits : 03**
Hours/Week : 0+0+4 **CIE Marks : 50**
Total hours : 24 **SEE Marks : 50**
Exam Hours : 01 **Course type: Prog. Core**

The Mini Project work shall be on a topic in the area of specialization specified by the guide and
selected by the candidate, in line with machine design course. The mini project should be done
individual. The student shall seek the guidance of the internal guide on a continuous basis, and
the guide shall give a certificate to the effect that the candidate has worked satisfactorily under
his/her guidance on completion of the mini project work.
On completion of the work, student shall prepare a report according to the guidelines and submit
it to the concerned authority.

The student is supposed to finalize the topic of the project work at the beginning of the 1st semester. 2 seminars have to be given, to evaluate the progress of work.
1. Mid of the semester
2. Final Presentation.
The seminars will be assessed by a committee who will make suitable recommendations at eachstage.