

BE MECHANICAL ENGINEERING

SEMESTER - 1

19M101 CALCULUS AND ITS APPLICATIONS

3 1 0 4

DIFFERENTIAL CALCULUS : Function of two variables, limits and continuity, partial derivatives, chain rule, extreme values and saddle points, Lagrange multipliers, Taylor's formula for two variables. (9 + 3)

INTEGRAL CALCULUS : Double integrals — double and iterated integrals over rectangles, double integrals over general regions, Fubini's theorem, area and volume by double integration, reversing the order of integration, polar form. (9 + 3)

FIRST ORDER ORDINARY DIFFERENTIAL EQUATIONS : Basic concepts, separable differential equations, exact differential equations, integrating factors, linear differential equations, modeling - mixing problems, Newton's law of cooling. (9 + 3)

SECOND ORDER LINEAR DIFFERENTIAL EQUATIONS : Homogeneous linear equations of second order, homogeneous linear ODEs with constant coefficients, Euler–Cauchy equations, solution by variation of parameters, free oscillations of mass-spring systems. (9 + 3)

VECTOR CALCULUS : Gradient and directional derivative of a scalar field, divergence and curl of a vector field. Integration in vector field — line integrals, path independence of line integrals, Green's theorem in the plane, divergence theorem of Gauss and Stokes's theorems. (9 + 3)

Total L: 45 +T: 15 = 60

TEXT BOOKS:

1. Joel Hass, Christopher Heil, Maurice D.Weir "Thomas' Calculus", Pearson Education., New Delhi, 2018
2. Erwin Kreyszig "Advanced Engineering Mathematics", Wiley India Pvt Ltd., New Delhi, 2015

REFERENCES:

1. Howard Anton, Irl Bivens, Stephen Davis "Calculus", John Wiley & Sons, INC., USA, 2016
2. Wylie C R and Barrett L C "Advanced Engineering Mathematics", Tata McGraw-Hill., New Delhi, 2019
3. Michael D.Greenberg "Foundations of Applied Mathematics", Dover Publications, INC., New York, 2013
4. Gilbert Strang "Calculus", Wellesley Cambridge Press., USA, 2017

19M102 PHYSICS

3 0 0 3

MECHANICS : Introduction to vectors — velocity and acceleration vectors in two dimensions; Newton's laws of motion - mass, inertia and force, application of Newton's second and third laws in two dimensions - free body diagram, work done by a varying force, work-kinetic energy theorem; System of particles - centre of mass in one and two dimensions; Rotational motion - radial and tangential acceleration, torque, rotation energy, conservation of angular momentum, gyroscopes and precession. (9)

OSCILLATORY MOTION AND WAVE MOTION : Oscillatory motion: Simple harmonic motion, spring mass system, torsional oscillator; Spring mass system - free, damped, forced oscillations and resonance; Wave motion: Plane progressive wave, attenuation of waves, differential equation and solution of a plane progressive wave, phase velocity, superposition of waves and group velocity. (9)

OPTICS : Review of Image formation by lenses, combination of thin and thick lenses; Chromatic and spherical aberrations, methods to reduce aberrations; Interference- superposition principle, intensity distribution, condition for interference, coherent and non-coherent sources, classification of fringes, system for observing interference phenomena, engineering applications - interferometric displacement measurement; Diffraction - Fraunhofer diffraction for single slit and double slit, diffraction grating, resolving power of a grating; Image formation system -optical microscope. (9)

HEAT : Heat transfer modes: Convection, conduction and radiation; Specific heat capacity; Coefficient of linear thermal expansion - measurement of thermal expansion - optical lever and dilatometry methods; Thermal stresses in composite structures due to non-homogeneous thermal expansion - applications in bimetallic strip, expansion gaps and rollers in engineering structures; Thermal conductivity - differential equation of one dimensional heat flow - Searle's apparatus and Lee's disc apparatus for determination of thermal conductivity - applications to refrigerators and ovens. (9)

ELECTROMAGNETISM : Review of definitions of fundamental terms; Permeability; Forces due to currents; Uniform and non-uniform magnetic fields; Static and time-varying magnetic fields; Electromagnetic induction - expression for induced emf; Electric fields - permittivity and dielectric displacement; Gauss theorem; Maxwell's equations and interpretation of Maxwell's equations; Electromagnetic waves - propagation of electromagnetic waves through isotropic media. (9)

Total L: 45

TEXT BOOKS:

1. Richard Wolfson "Essential University Physics", Pearson Education., Singapore, 2016
2. Hugh D. Young, Roger A. Freedman, Lewis Ford .A "University Physics with Modern Physics", Pearson Education., India, 2008

REFERENCES:

1. Halliday D, Resnick R, Walker J "Fundamentals of Physics", Wiley Publications., 2013
2. Raymond A. Serway, John W, Jewett "Physics for Scientists and Engineers", Cengage Learning., 2017
3. Paul A Tipler, Gene Mosca "Physics for Scientists and Engineers", W.H.Freeman and Company., New york, 2007
4. Gaur R K, Gupta S L "Engineering Physics", Dhanpat Rai Publications., 2013

19M103 CHEMISTRY**3 0 0 3**

THERMODYNAMICS : Review of first law, variation of heat of reaction with temperature, adiabatic flame temperature. Joule Thomson effect and its significance- inversion temperature-liquefaction of gases. Second law- statements- entropy and spontaneity-free energy and spontaneity. Gibbs-Helmholtz equation. Concept of chemical potential-variation of chemical potential with T and P, Gibbs-Duhem equation- Clausius Clapeyron equation- concept of fugacity and activity. (9)

PHASE EQUILIBRIA : Definitions—one component system (water), two component systems-Cu-Ni and Pb-Ag systems-lever rule. Solubility of gas in liquids. Distribution law-principle of extraction-applications. Binary liquid systems-fractional distillation-azeotropic mixtures. (9)

KINETICS : Review of Integrated rate laws. Complex reactions- opposing, parallel and consecutive reactions- steady state approximation- branched chain reactions-mechanism and kinetics of combustion of hydrogen and hydrocarbons. (9)

SURFACE CHEMISTRY : Adsorption - Freundlich and Langmuir adsorption isotherms, application of BET isotherm (Derivation not required). Applications of adsorption- abatement of air and water pollution- automobile catalytic converters. Surface active agents-surfactants, detergents, emulsifiers, properties- critical micellar concentration, contact angle, wetting and water repellency. Superhydrophobic surfaces. (9)

ELECTROCHEMISTRY : Electrode potential- emf series- standard and reference electrodes — SHE, calomel, Ag/AgCl. Nernst equation-galvanic and concentration cells-Ion selective electrodes- glass electrode-applications. Potentiometric and conductometric titrations. Applied Electrochemistry: electroplating, electropolishing, electrochemical machining, electrophoretic painting, anodization of aluminium. (9)

Total L: 45**TEXT BOOKS:**

1. Peter Atkins, Julio de Paula "Elements of Physical Chemistry", Oxford university press., UK, 2013 , 6th ed
2. B.R. Puri, L.R. Sharma, M.S. Pathania "Principles of Physical Chemistry", Vishal Publishing Company., India, 2017 , 47th ed

REFERENCES:

1. Donald A. McQuarrie, John D. Simon "Physical Chemistry: A Molecular Approach", University Science Books., USA, 1997 , 1st ed
2. Derek Pletcher, Frank C. Walsh "Industrial Electrochemistry", Chapman and Hall., London, 1990 , 2nd ed
3. J. Rajaram, J. C. Kuriakose "Thermodynamics for Students of Chemistry", Shobanlal Nagin Chand Company., India, 1986 , 1st ed

19G105 ENGLISH LANGUAGE PROFICIENCY**2 1 0 3**

LEARNING LANGUAGE THROUGH STANDARD LITERARY AND GENERAL TEXTS : Integrated tasks focusing on language skills ; Training based on Text based vocabulary, tone, register and Syntax features (12 + 0)

GRAMMAR IN CONTEXT : Word Order ; Subject Verb Concord ; Style features - Tenses, Conditionals, Prepositions, Active and Passive Voice, Modals, Cloze and Spotting Error exercises (10 + 0)

GUIDELINES FOR WRITTEN COMMUNICATION : Principles of clear writing, Paragraph writing, Essay writing, Emphasis Techniques, Summarizing and Paraphrasing, Analytical writing (8 + 0)

FOCUS ON SPOKEN ENGLISH : Task — based activities: Graded levels of difficulty and with focus on language functions - Level 1: Self — expression — Greetings in Conversation, Hobbies, Special interests, Daily routine - Level 2: General Awareness — Expression of Concepts, Opinions, Social Issues, Description of a process / picture/chart, news presentation / review - Level 3: Advanced Skills — Making Short Speeches and Participating in Role Plays (0 + 10)

LISTENING ACTIVITY : Task based activities using Language Laboratory (0 + 5)

Total L: 30 +T: 15 = 45

TEXT BOOKS:

1. Faculty Incharge "Course Material on "English Language Proficiency", PSG College of Technology., Coimbatore, 2019

REFERENCES:

1. Jill Singleton "Writers at Work: The Paragraph", Cambridge University Press., New York, 2012
2. Simon Haines, Mark Nettle and Martin Hewings "Advanced Grammar In Use", Cambridge University Press., New Delhi, 2008
3. Anne Laws "Writing Skills", Orient Black Swan., Hyderabad, 2011
4. Sinha DK "Specimens of English Prose", Orient Black Swan., Hyderabad, 2012

19M110 ENGINEERING GRAPHICS I**0 0 4 2****INTRODUCTION :**

1. Lettering practice
2. Geometric constructions
3. Dimensioning practice as per BIS conventions (15)

ORTHOGRAPHIC PROJECTION :

1. Projection of points and lines
2. Projection of planes
3. Projection of solids
4. Projection of simple engineering components and missing view exercises (15)

PICTORIAL PROJECTIONS :

1. Isometric view of simple engineering components
2. Free hand sketching of orthographic views from pictorial views
3. Free hand sketching of isometric views from orthographic views (15)

COMPUTER GRAPHICS :

1. Modeling of simple engineering components
2. Extraction of 2D views from 3D models (15)

Total P: 60**REFERENCES:**

1. Venugopal K , Prabhu Raja V "Engineering Graphics", New Age International Publishers., 2018
2. John K.C "Engineering Graphics for Degree", PHI Learning Private Limited., 2009
3. Bureau of Indian Standards "Engineering Drawing Practices for Schools and Colleges SP 46-2003", BIS., 2003
4. Shaw M.B , Rana B.C "Engineering Drawing", Pearson Education India., 2009

19M111 BASIC SCIENCES LABORATORY**0 0 4 2****PHYSICS (ANY EIGHT EXPERIMENTS):**

1. Determination of Young's Modulus of a wooden bar – cantilever method
2. Determination of rigidity modulus of a given material using Torsion pendulum
3. Determination of thermal conductivity of bad conductor using Lee's Disc method
4. Determination of fibre thickness – air wedge method
5. Determination of wavelength of mercury spectrum using transmission grating
6. Measurement of vibration frequency of electrically maintained tuning fork using Melde's apparatus
7. Determination of Hysteresis loss of a ferromagnetic material
8. Determination of thermal conductivity of a metallic material using Wiedemann – Franz law
9. Determination of capacitance using LCR bridge
10. Determination of lattice constant using X-ray powder photograph (30)

CHEMISTRY (ANY EIGHT EXPERIMENTS) :

1. Determination of rate constant of hydrolysis of an ester
2. Construction of eutectic phase diagram
3. Conductometric estimation of acid strength of a pickling bath
4. Electroplating of nickel and copper and determination of cathode efficiency
5. Anodizing of aluminium and determination of thickness of anodized film
6. Determination of kinematic viscosity of lubricating oil using Redwood viscometer
7. Determination of flash point and fire point of lubricating oil
8. Analysis of solid fuel by proximate analysis of coal
9. Mechanism of galvanic corrosion–determination of corrosion rate by corrosion current measurement
10. Estimation of hardness of water by EDTA method (30)

Total P: 60

REFERENCES:

1. Department of Chemistry "Chemistry Laboratory Manual", .., 2019
2. Department of Physics "Physics Practicals", .., 2019
3. Wilson J. D. and Hernandez C. A. "Physics Laboratory Experiments", Houghton Mifflin Company., New York, 2009

19M112 C PROGRAMMING LABORATORY**0 0 4 2**

1. Working with RAPTOR Tool – Flowchart Interpreter
2. Simple programs to understand Operators and expressions.
3. Decision making Statements :simple if, if..else, nested if .. else,elseifladder, switch case
4. Loops : while , do..while, for
5. Implementation of one dimensional array
6. Implementation of two dimensional array
7. Working with Strings
8. Functions
9. Recursive functions
10. Structures: Arrays and Structures,Nested Structures
11. Structures and functions
12. Implementation of pointer and pointer arithmetic
13. Types of pointer:const pointer, pointer to a constant, void pointer, null pointer

Total P: 60**REFERENCES:**

1. Deitel H. M. and Deitel P. J "C: How To Program", Prentice Hall of India., New Delhi, 2015
2. Ajay Mittal "Programming in C - A Practical approach", Pearson., New Delhi, 2010
3. Gottfried B "Programming with C", McGraw Hill Education., New Delhi, 2018
4. Herbert Schildt "C: The Complete Reference", McGraw Hill., New Delhi, 2017

19IP15 INDUCTION PROGRAMME**0 0 0 0**

As per AICTE guidelines

SEMESTER - 2**19M201 COMPLEX VARIABLES AND TRANSFORMS****3 1 0 4**

COMPLEX DIFFERENTIATION : Derivative, analytic function, Cauchy-Riemann equations, Laplace's equation, linear fractional transformations. (9 + 3)

COMPLEX INTEGRATION : Cauchy's integral theorem, Cauchy's integral formula, Laurent series, singularities and zeros, residue integration method (Residue integration of complex integrals only). (9 + 3)

LAPLACE TRANSFORMS : Laplace transform, linearity, first shifting theorem, transforms of derivatives and integrals, ODEs, unit step function, second shifting theorem, Dirac's delta function, periodic functions. (9 + 3)

FOURIER SERIES AND FOURIER TRANSFORMS : Fourier series — arbitrary period, even and odd functions, half range expansions. Fourier transforms, Fourier cosine and sine transforms. (9 + 3)

PARTIAL DIFFERENTIAL EQUATIONS : Basic concepts of PDEs, wave equation, heat equation, steady state two-dimensional heat problems, solution by separating variables and Fourier series. (9 + 3)

Total L: 45 +T: 15 = 60**TEXT BOOKS:**

1. Erwin Kreyszig "Advanced Engineering Mathematics", Wiley India Pvt Ltd., New Delhi, 2015
2. Wylie C R and Barret L C "Advanced Engineering Mathematics", Tata McGraw-Hill., New Delhi, 2019

REFERENCES:

1. Dennis G Zill and Patrick D Shanahan "A First Course in Complex Analysis with Applications", Jones and Bartlett Pvt Ltd., New Delhi, 2015
2. Mathews J H and Howell R W "Analysis for Mathematics and Engineering", Narosa Publishing House., New Delhi, 2012
3. Peter V.O Neil "Advanced Engineering Mathematics", Cengage., New Delhi, 2016
4. Dennis G Zill "Advanced Engineering Mathematics", Jones & Bartlett Pvt Ltd., New Delhi, 2017

19M202 MATERIALS SCIENCE

2 0 0 2

CRYSTAL STRUCTURE : Atomic bonding in solids, crystalline state of solids, unit cells and space lattices, crystal structures, crystal planes and directions, Miller Indices, coordination number, atomic packing factor of simple cubic, BCC, FCC and HCP structures; Crystal imperfections — point, line, surface and volume imperfections. (7)

FUNCTIONAL CERAMICS : Sintering, hot isostatic pressing, sol-gel process, chemical vapour deposition, injection moulding; Dielectric properties — dielectric constant, dielectric strength and dielectric loss factor; Piezoelectric and pyroelectric properties; Mechanical properties — fracture toughness, strength of ceramics; Ceramic cutting tools; Thermal properties – thermal stress, thermal shock and thermal conductivity. (8)

POLYMERS : Classification of polymers; Structure-property relationships in thermoplastics - degree of polymerization, effect of side groups, crystallization and deformation; Effect of temperature on thermoplastics; Crystallinity in polymers; Mechanical properties - elastic and plastic behavior, creep and stress relaxation, impact and deformation; Thermosetting polymers. (7)

COMPOSITES : Connectivity, reinforcement, fibres — glass fibre, aramid fibre, carbon fibre, properties and fabrication; Particulate and whisker reinforcements; Metal matrix - aluminium, titanium and magnesium alloys, MMC processing — solid and liquid state processes, Al / ceramic reinforcements - properties; Ceramic matrix - hot pressing, Al₂O₃ / SiC whisker - properties; Polymer matrix - carbon– epoxy and boron–epoxy composites; Volume fraction and weight fraction, applications - aircraft engineering, space, wind turbines, sports equipment and automobiles. (8)

Total L: 30

TEXT BOOKS:

1. Michel W Barsoum "Fundamentals of Ceramics", McGraw Hill Book Co., 2000
2. Mathews F.L, Rawlings "Composite Materials and Science", Woodhead Publishing Ltd., 2002

REFERENCES:

1. James F Shackelford "Introduction to Materials Science for Engineers", Pearson Prentice Hall., 2009
2. Kingery W.D, Bowen H.K, Uhlmann D.R "Introduction to Ceramics", John Wiley and Sons., 2004
3. Krishan K Chawla "Composite Materials, Science and Engineering", Springer-Verlag., 2013
4. Raghavan V "Materials Science and Engineering: A First Course", Prentice Hall of India Pvt. Ltd., 2015

19M203 CHEMISTRY OF ENGINEERING MATERIALS

2 0 0 2

FUELS AND COMBUSTION : Petroleum - refining, cracking and polymerisation- petrol and diesel knocking-octane and cetane rating of fuels-reforming of gasoline. Coal- carbonization- coke manufacture-Otto-Hoffmann method. Synthetic petrol- Bergius process. Combustion of fuel- calorific value and theoretical air calculations. (6)

BATTERIES AND FUEL CELLS : Batteries- characteristics-construction and working of Leclanche, lead-acid, nickel-cadmium and lithium ion batteries- supercapacitors. Batteries for automobiles, satellites, torpedos, computer standby supplies. Fuel cell- theory, working principle and applications of proton exchange membrane, direct methanol fuel cells and solid oxide fuel cells. (6)

CORROSION AND PROTECTIVE COATINGS : Forms of corrosion and their mechanism- galvanic, atmospheric, pitting, crevice and stress corrosion. Corrosion protection by design, cathodic protection, protective coatings, corrosion inhibitors - mention of types and applications. (6)

MACROMOLECULES : Classification, molecular weight - Mn and Mw. Mechanism of polymerization- structure related to thermal, electrical and mechanical properties of polymers. Compounding of plastics, Moulding of plastics- compression, injection, extrusion and blow moulding techniques. Rubber — structure, vulcanization- fibre and carbon reinforced plastics, types of adhesives and sealants. (6)

MISCELLANEOUS MATERIALS : Lubricants-classification- properties, mechanism of lubrication- additives and improvers. Solid lubricants (graphite and MoS₂). Abrasives: Natural abrasives (diamond and corundum)-synthetic abrasives (silicon carbide and boron carbide). Refractories- characteristics — classification –alumina, magnesite and zirconia bricks-applications. Boiler feed water- requisites -estimation of hardness-demineralization process. Nanomaterials and their applications-Graphene, CNT, ferrofluids. (6)

Total L: 30

TEXT BOOKS:

1. Shashi Chawla "A Text Book of Engineering Chemistry", Dhanpat Rai and Company., New Delhi, 2005 , 1st ed
2. SS Dara, SS Umare "A Textbook of Engineering Chemistry", S Chand and Company., India, 2010 , 20th ed

REFERENCES:

1. Sharma B. K "Engineering Chemistry", Krishna Prakashan Media (P) Ltd., Meerut, 2005 , 1st ed
2. Mary Jane Shultz "Engineering Chemistry", Cengage learning., USA, 2009 , 1st ed
3. P. C. Jain, M. Jain "Engineering Chemistry", Dhanpat Rai Publishing Company., New Delhi, 2005 , 1st ed

19M204 ENGINEERING MECHANICS

3 1 0 4

STATICS OF PARTICLES AND RIGID BODIES : Particles: Forces on a particle, transmissibility, resultant of two forces and several concurrent forces - resolution of a force, equilibrium of a particle, free body diagram, force in space - equilibrium of a particle in space; Rigid Bodies: External and internal forces, moment of a force, Varignon's theorem moment of a couple, resolution of a force into a force and a couple - reduction of a system of forces, reactions at supports and connections. (10 + 4)

ANALYSIS OF STRUCTURES AND FRICTION : Structures: Simple trusses: Method of joints, method of sections, joints under special loading conditions, space trusses and analysis of frames; Friction: Laws of dry friction, angles of friction, coefficient of static and kinetic friction, belt friction, wedges, journal bearings - axle friction, thrust bearings - disk friction, wheel friction - rolling resistance. (10 + 4)

CENTROID, CENTRE OF GRAVITY AND MOMENT OF INERTIA : Centroids of areas, composite areas, determination of moment of inertia of plane figures, polar moment of inertia, radius of gyration, mass moment of inertia of simple solids. (8 + 2)

KINEMATICS AND KINETICS : Kinematics : Plane, rectilinear and rotary motion, time dependent motion, rectangular coordinates, projectile motion; Kinetics: Equation of motion - Newton's II law, D'Alembert's principle, Energy: potential energy, kinetic energy, conservation of energy; work done by a force, work energy method. (9 + 3)

IMPULSE AND MOMENTUM : Concept of conservation of momentum, Impulse-momentum principle, Non - impulsive forces; Impact: Direct central impact, oblique central impact, impact against fixed plane. (8 + 2)

Total L: 45 +T: 15 = 60

TEXT BOOKS:

1. Ferdinand P. Beer, E. Russell Johnston, David F. Mazurek, Philip J. Cornwell, Sanjeev Sanghi, Brian P. Self "Vector Mechanics for Engineers Statics and Dynamics", McGraw Hill Education(India) Private limited., New Delhi, 2013, 10
2. Nelson. A "Engineering Mechanics -Statics and Dynamics", Tata Mcgraw-Hill., New Delhi, 2006

REFERENCES:

1. Young D H, Timashenko S "Engineering Mechanics", Tata Mcgraw-Hill., New Delhi, 2006
2. Rajasekaran S, Sankarasubramanian G "Engineering Mechanics-Statics and Dynamics", Vikas Publishing House Pvt. Ltd., New Delhi, 2006
3. Bansal R K "Engineering Mechanics", Laxmi Publications Pvt. Ltd., New Delhi, 2006
4. R.C. HEBLER "ENGINEERING MECHANICS -STATICS AND DYNAMICS", PEARSON., 2017, Thirteenth Edition

19M205 MANUFACTURING PROCESSES I

3 0 0 3

METAL CASTING : Casting terminology, hand moulding, pattern material, allowance; Pattern types: Single piece, split, gated; Core prints, moulding sand properties, gating system, sprue, gate, riser; Melting practice: Cupola, crucible, induction furnaces; Casting defects; Special casting processes: investment casting, die-casting. (9)

JOINING PROCESSES : Gas welding: flame types, equipment; Electric Arc Welding (EAW), Metal Inert-Gas (MIG) welding, Tungsten Inert-Gas (TIG) welding, types of electrodes, flux material, resistance welding: Principle, spot, seam, lap welding; Welding defects; Modern welding processes: Laser beam, friction-stir welding; Soldering, brazing and adhesive bonding. (9)

SHEET METAL PROCESSES : Principle of shearing, punch-die clearance, shear on punch and die; Sheet metal operations: Blanking, punching, bending, drawing, spinning; Blanking force calculation; Die-set: simple, progressive, compound; Press: open back inclinable press, hydraulic press; High energy rate forming processes: Explosive forming, electromagnetic forming, electrohydraulic forming. (9)

BULK DEFORMATION PROCESSES : Hot and cold working, principle of plastic deformation, principle of rolling; Rolling mills, universal rolling; Defects in rolled parts; Drawing: Wire and rod drawing; Forging: Open and closed die forging; Equipment: Pneumatic, drop hammers; Rotary swaging; Extrusion methods. (9)

POWDER METALLURGY AND PLASTIC PROCESSING : Production of metal powder: Atomization, crushing; Blending; Compacting: Die pressing, iso-static pressing; Sintering: Principle, continuous sintering process; Plastic processing: Injection, blow moulding and rotational moulding. (9)

Total L: 45

TEXT BOOKS:

1. Rao P N "Manufacturing Technology", Tata McGraw Hill Education Private Limited., New Delhi, 2013, 4
2. Serope Kalpakjian and Stephen Schmid "Manufacturing, Engineering and Technology", Pearson Education., 2018, 7

REFERENCES:

1. Mikell P Groover "Fundamentals of Modern Manufacturing: Materials, Processes, and Systems", Wiley., 2015, 6

2. Arora R P "Manufacturing Technology", Macmillan India Limited., New Delhi, 2011
3. Jain R K "Production Technology", Khanna Publishers., 2004
4. HMT "Production Technology", Tata McGraw-Hill., 2002

19M210 ENGINEERING GRAPHICS II

0 0 4 2

SECTIONS OF SOLIDS :

1. Sections of regular solids as per BIS conventions
2. Types of sections- sectional views of engineering components
3. Constructing sectional views (15)

DEVELOPMENT OF SURFACES :

1. Development of lateral surfaces of regular solids
2. Projection of truncated solids and simple engineering sheet metal components (15)

PERSPECTIVE PROJECTION :

1. Perspective projection of solids
2. Perspective projection of engineering components (15)

COMPUTER GRAPHICS :

1. Modeling of engineering components
2. Preparation of drawings with sectional views. (15)

Total P: 60

TEXT BOOKS:

1. Venugopal K and Prabhu Raja V "Engineering Graphics", New Age International Publishers., 2018
2. John K.C "Engineering Graphics for Degree", PHI Learning Private Limited., 2009

REFERENCES:

1. Bureau of Indian Standards "Engineering Drawing Practices for Schools and Colleges SP 46:2003", BIS., 2003
2. Shaw M B and Rana B C "Engineering Drawing", Pearson Education India., 2009

19M211 ENGINEERING PRACTICES AND MANUFACTURING PROCESSES LABORATORY

0 0 4 2

CYCLE -1 (ENGINEERING PRACTICES) :

1. Foundry: Study of tool; Preparation of molding sand using different types of patterns.
2. Welding: Study of arc welding tools and equipment; Exercises: Arc welding and TIG welding methods.
3. Fitting: Study of tools and operations; Exercises: Making of "L" Joint and "V" Joint.
4. Carpentry: Study of tools and operations; Exercises: Making of "L" Joint and "T" Joint.
5. Plumbing: Study of tools and operations; Exercises: External thread cutting and joining of PVC pipes.
6. Sheet metal work and Soldering: Study of tools and operations; Exercises: Making a rectangular tray. (30)

CYCLE - 2 (LATHE) :

1. Study of Lathe: Specifications, constructional details, mechanisms, operations, cutting tools, work holding devices.
2. Machining a component having facing, chamfering and step turning operations.
3. Machining a component having taper turning and knurling operations.
4. Machining a component having step turning and grooving operations.
5. Machining a component having step turning and external thread cutting operations.
6. Machining a component having facing, drilling and boring. (30)

Total P: 60

REFERENCES:

1. Department of Mechanical Engineering "Engineering Practices and Manufacturing Processes Laboratory Manual", PSG College of Technology.,2019
2. Chapman WAJ "Workshop Technology", Edward Arnold., 2001 ,2

19M213 INTERNSHIP

0 0 0 2

INTRODUCTION TO MATLAB & SIMULINK: Introduction to MATLAB built-in functions, array manipulation, solution of linear algebraic equations, basic plotting techniques, Introduction to programming and user-defined functions, loop structures, symbolic mathematics, visualization of multivariable functions, development of simple GUI (Graphical User Interface), developing simple SIMULINK model, Applications of MATLAB to Mechanical differential equations with SIMULINK (E.g. free vibration response of simple pendulum, projectile motion etc.)

TRAINING IN CAD PACKAGE: Solid modeling and assembly practice, Extraction of 2D view from 3D modeling, Coloring and shading of 3D models, Mold Design.

INDUSTRY ORIENTED ACTIVITIES: Factory layout, Organization structure, various departments, Study of Broaching machine — Construction, mechanism of working, Study of Boring machine — Construction, mechanism of working, Study of Grinding machine — Construction, mechanism of working, Study of Pressure die casting process, Study of Pump Assembly, Study of Motor Assembly, Study of Lathe Assembly, Study of Electro Discharge Machining and die making, Visit to Foundry Division, Visit to TIFAC — CORE, Visit to Nano Technology Laboratory.

NOTE: A comprehensive report should be submitted by the students based on the activities carried out during InPlant training, which will be assessed by a committee of faculty members.

SEMESTER - 3

19M301 NUMERICAL METHODS

2 1 0 3

SYSTEM OF LINEAR EQUATIONS, EIGENVALUES AND EIGENVECTORS : Errors - approximations and round-off errors, truncation errors, system of linear equations, Gauss-elimination method, Crout's method, Gauss–Seidel method, eigenvalues and eigenvectors - power method. (6 + 3)

NONLINEAR EQUATIONS : False- position method, Newton-Raphson method, modified Newton-Raphson method, Bairstow's method. (6 + 3)

INTERPOLATION, DIFFERENTIATION AND INTEGRATION : Lagrange interpolating polynomials, equally spaced data-Newton's forward and backward interpolating polynomials, numerical differentiation – evenly spaced data, numerical integration- Newton-Cotes formulae, Trapezoidal rule, Simpson's 1/3 rule. (6 + 3)

NUMERICAL SOLUTION TO ORDINARY DIFFERENTIAL EQUATIONS : Taylor-series method, Euler method, 4th order Runge-Kutta method, multi step method - Milne method. (6 + 3)

NUMERICAL SOLUTION TO PARTIAL DIFFERENTIAL EQUATIONS : Finite difference: elliptic equations - Laplace equation, Poisson equation – Liebmann method, parabolic equations – heat conduction equation – Crank Nicolson's method, hyperbolic equations – vibrating string. (6 + 3)

Total L: 30 +T: 15 = 45

TEXT BOOKS:

1. Steven C Chapra and Raymond P Canale , "Numerical Methods for Engineers", Tata McGraw Hill, New Delhi, 2017.
2. Curtis F Gerald and Patrick O Wheatly , "Applied Numerical Analysis", Pearson, New Delhi, 2017.

REFERENCES:

1. Richard L Burden and Douglas J Faires , "Numerical Analysis", Thomas Learning, NewYork, 2017.
2. G. Miller , "Numerical Analysis for Engineers and Scientists", Cambridge University Press, UK, 2014.
3. Amos Gilat and Vish Subramaniam , "Numerical Methods for Engineers and Scientists", Wiley India, New Delhi, 2014.
4. Ward Cheney and David Kincaid , "Numerical Mathematics and Computing", Cengage learning, USA, 2018.

19M302 MANUFACTURING PROCESSES II

3 0 0 3

THEORY OF METAL CUTTING : Introduction: Material removal processes, types of machine tools; Metal cutting fundamentals: Theory of chip formation, types of chips, Piispänen model of card analogy, orthogonal cutting and oblique cutting; Nomenclature of single point cutting tools; Mechanics of metal cutting: Machining forces and Merchant's Circle Diagram (MCD) – simple calculations, cutting tool materials, tool wear, tool life, surface finish, cutting fluids; Overview of high speed machining. (10)

CENTRE LATHE AND CNC LATHES : Centre lathe, constructional features, cutting tool geometry, various operations, taper turning methods, machining time calculation; Capstan and Turret lathes; CNC turning centre: Constructional features, turret, linear motion guide ways, hydraulic chuck, ball screw, axes feed drive arrangement; Feedback devices: Linear encoder, rotary encoder. (9)

MACHINING USING OTHER MACHINE TOOLS : Reciprocating machine tools: Shaper, planer, slotter; Milling: Types of milling machines, up milling, down milling, milling cutters, operations; Constructional features of CNC machining centres; Drilling: Column and radial drilling machines, machining time calculations; Reaming, tapping and boring; Broaching machines: Push, pull broaching processes; Overview of work holding devices. (9)

ABRASIVE PROCESSES AND GEAR CUTTING : Abrasive processes: Grinding wheel designation and selection; Types of

grinding processes: Cylindrical grinding, surface grinding, centreless grinding; Honing, lapping; Gear cutting: Forming, generation, shaping and hobbing; Cost comparison. (9)

NON-CONVENTIONAL MACHINING : Need, Electric Discharge Machining (EDM), ultrasonic machining, Laser Beam Machining (LBM), Abrasive Water Jet Machining (AWJM), Electron Beam Machining (EBM), Plasma Arc Machining (PAM), equipment, applications and limitations, cost comparison. (8)

Total L: 45

TEXT BOOKS:

1. Rao P N , "Manufacturing Technology - Vol.2", 4th Edition, McGraw-Hill Education, USA, 2018.
2. Milton C Shaw , "Metal Cutting Principles", 2nd Edition, Oxford University Press, USA, 2012.

REFERENCES:

1. Serope Kalpakjian and Stephen Schmid , "Manufacturing, Engineering and Technology", 7th Edition, Pearson Education, USA, 2018.
2. Mikell P Groover , "Principles of Modern Manufacturing", 5th Edition, Wiley& Sons Pvt. Ltd, India, 2013.
3. Radhakrishnan P , "Computer Numerical Control Machining and Computer Aided Manufacturing", 1st Edition, New Age International Publishers, India, 2018.
4. Anup Goel , "Manufacturing Technology - II", 2nd Edition, Technical Publications, Pune, 2011.

19M303 MECHANICS OF MATERIALS

3 0 0 3

CONCEPTS OF STRESS AND STRAIN : Axial and shear stresses and strains: Elastic limit, Hooke's law, lateral strain, Poisson's ratio, volumetric strain, relationship between elastic constants, factor of safety; Stepped bars, uniformly varying sections, stresses in composite bar due to axial force and temperature; Strain energy due to axial force: Proof resilience, stresses due to gradual, sudden and impact loads. (9)

BENDING MOMENT AND SHEAR FORCE : Relationship between load, shear force and bending moment; Shear force and bending moment diagrams: Cantilever, simply supported and overhanging beams subjected to concentrated load, uniformly distributed load, uniformly varying load, concentrated moments; Determination of maximum bending moment and point of contraflexure. (9)

BENDING STRESSES AND DEFLECTION OF DETERMINATE BEAMS : Theory of simple bending: Assumptions and derivation, section modulus, normal stresses due to bending; Deflection of beams: Governing differential equations using Macaulay's method and moment area method, application to simple problems. (9)

TORSION : Theory of torsion: Assumptions and derivation, polar modulus; Stresses in solid and hollow circular shafts, power transmitted by a shaft, design for torsional rigidity; Stresses and deflection in close coiled helical spring, springs in series and parallel. (8)

THIN CYLINDERS, PRINCIPAL STRESSES AND STRAINS : Stresses in thin cylindrical and spherical shells subjected to internal pressure; State of stress at a point: Normal and tangential stresses on a given plane, principal stresses and their planes, plane of maximum shear stress - analytical method, Mohr's circle method, application to simple problems; Determination of principal stresses in a shaft subjected to bending, axial and torsional loads. (10)

Total L: 45

TEXT BOOKS:

1. James M.Gere , "Mechanics of Materials", 8th Edition, Cengage Learning, USA, 2013.
2. Ferdinand Beer, Russell Johnston, John Dewolf, David Mazurek , "Mechanics of Materials", 7th Edition, McGraw- Hill Education, USA, 2014.

REFERENCES:

1. Jindal U C , "Textbook on Strength of Materials", 2nd Edition, Asian Books Pvt. Ltd., New Delhi, 2010.
2. William F. Riley, Leroy D. Sturges, Don H. Morris , "Mechanics of Materials", 6th Edition, John Wiley & Sons, USA, 2006.
3. Russell C Hibbler , "Mechanics of Materials", 10th Edition, Pearson, USA, 2016.
4. Popov E , "Engineering Mechanics of Solids", 2nd Edition, Prentice Hall, India, 2002.

19M304 KINEMATICS OF MACHINERY

3 1 0 4

BASICS AND SYNTHESIS OF MECHANISMS : Basics of mechanism: Terminology and definitions, kinematic pairs, degrees of freedom, Grashoff's law; Kinematic inversions: Four bar chain, slider crank chain, indices of merit; Synthesis of mechanisms: Type, number and dimensional synthesis: Graphical synthesis: Two, three position synthesis of slider crank, four bar mechanisms, analytical synthesis using Freudenstien's equation, precision positions, structural error, Chebyshev's spacing. (9 + 3)

KINEMATIC ANALYSIS : Displacement, velocity and acceleration analysis of simple mechanisms- graphical method,

instantaneous centre method; Kinematic analysis of four bar linkages using loop closure equations, computer aided kinematic analysis of mechanisms. (9 + 3)

GEARS AND GEAR TRAIN : Gear: Terminology and definitions, law of gearing, tooth forms, contact ratio, interference and undercutting; Gear trains: velocity ratio, simple, compound and epicyclic gear trains, holding torque. (9 + 3)

KINEMATICS OF CAM : Fundamentals of cam, classifications, displacement diagram, derivatives of uniform velocity, simple harmonic motion, cycloidal, uniform acceleration and retardation motion; Layout of cam profiles for different types of followers; Knife edged, roller and flat faced followers, pressure angle. (9 + 3)

GYROSCOPIC COUPLE AND SPATIAL MECHANISMS : Gyroscopic couple and its effect on aircraft, ship, two and four wheeled automobiles; Spatial mechanisms: Introduction, serial and parallel manipulators, mobility, topological arrangements, DH parameters. (9 + 3)

Total L: 45 +T: 15 = 60

TEXT BOOKS:

1. John J Uicker Jr., Gordon R Pennock, Joseph E Shigley , "Theory of Machines and Mechanisms", 5th Edition, Oxford University Press, New Delhi, 2016.
2. Rattan S S , "Theory of Machines", 4th Edition, Tata McGraw Hill Publishers, New Delhi, 2017.

REFERENCES:

1. Robert L Norton , "Kinematics and Dynamics of Machinery (SI Units)", 1st Edition, McGraw Hill Higher Education, New Delhi, 2008.
2. David H Myszka , "Machines and Mechanism", 4th Edition, Pearson Education, USA, 2015.
3. Kenneth J. Waldron, Gary L. Kinzel, Sunil K. Agrawal , "Kinematics, Dynamics, and Design of Machinery", 3rd Edition, Wiley- Blackwell, USA, 2016.
4. Ashok G Ambekar, "Mechanisms and Machines Theory", 1st Edition, PHI learning Pvt. Ltd, New Delhi, 2009.

19M305 ENGINEERING THERMODYNAMICS

3 1 0 4

FIRST LAW OF THERMODYNAMICS : Introduction, system, properties, zeroth law of thermodynamics and application, thermodynamic state and equilibrium, process and cycle, work, heat and other forms of energy; First law of thermodynamics, application to open and closed systems, general energy equation and applications. (9 + 3)

PROPERTIES OF PURE SUBSTANCES : Ideal gas properties, equations of state, properties of mixtures, compressibility, pure substances, P-V-T surfaces, phase change processes, vapor pressure, properties of steam, use of property tables, T-S diagrams, Mollier chart, Rankine cycle. (9 + 3)

SECOND LAW OF THERMODYNAMICS : Kelvin-Planck and Clausius statements, heat engines and heat pump, reversibility, Carnot cycle, Carnot theorem, thermodynamic temperature scale; Third law of thermodynamics, types of irreversibility; first and second law efficiencies. (9 + 3)

ENTROPY : Clausius theorem, property of entropy, Clausius inequality, entropy and its applications, microscopic interpretation of entropy, maximum work obtainable from finite heat reservoirs, entropy generation in open and closed systems, isentropic work in a steady flow open system. (9 + 3)

AVAILABILITY AND IRREVERSIBILITY : Availability, available energy referred to a cycle, maximum work in a reversible process, reversible work-open and closed systems; Availability and irreversibility; Thermodynamic relations, Maxwell's equations, Joule Kelvin effect, Clausius-Clapeyron equation, conditions of thermodynamic equilibrium and stability. (9 + 3)

Total L: 45 +T: 15 = 60

TEXT BOOKS:

1. Sonntag R E, Borgnakke C, Van Wylen G.J , "Fundamentals of Engineering Thermodynamics", 9th Edition, John Wiley & Sons, USA, 2017.
2. Nag P K , "Engineering Thermodynamics", 6th Edition, Tata McGraw Hill, India, 2017.

REFERENCES:

1. Yunus A Cengel, Boles M A , "Thermodynamics: An Engineering Approach", 8th Edition, Tata McGraw Hill, USA, 2017.
2. Michael Moran J, Howard Shapiro N, Daisie Boettner D, Margaret Bailey D , "Fundamentals of Engineering Thermodynamics", 8th Edition, John Wiley & Sons, USA, 2014.
3. Onkar Singh , "Engineering Thermodynamics", 1st Edition, New Age International, India, 2007.
4. Holman J P , "Thermodynamics", 3rd Edition, Tata McGraw Hill, USA, 2003.

190306 ECONOMICS FOR ENGINEERS

3 0 0 3

INTRODUCTION : Definition, Nature and Scope, Central Problems of an Economy, Positive and Normative Economics, Micro Economics and Macro Economics, Significance of Economics, Economic Assumptions (9)

THEORY OF CONSUMER BEHAVIOR : Utility, Indifference Curve Analysis, Properties, Consumer's Budget Line, Demand Analysis: Demand Function and Law of Demand, Elasticity of Demand. Demand forecasting using Econometric Techniques. Supply: Factors Affecting Supply, Market Equilibrium Price, Consumer Surplus. (9)

PRODUCTION, COST AND REVENUE : Production Function, Total Product, Average Product and Marginal Product, Returns to Scale. Costs, Nature of Costs, Short-run and Long-run Cost Curves, Revenue concepts. (9)

MARKET STRUCTURE : Types of Markets, Perfect Competition, Characteristics, Imperfect Competition: Monopoly, Monopolistic Competition, Oligopoly and Duopoly, Price Discrimination and Product Differentiation under Different Markets, Price and Output Determination in Short run and Long run and profit maximization. (9)

PERFORMANCE OF AN ECONOMY (MACRO ECONOMICS) : Demand and Supply of Money, Quantity Theory of Money, Banking: Functions of Commercial Banks and Central Bank, Inflation: Causes, Control Measures, National Income: Concepts, Methods of Calculating National Income, Problems in Calculating National Income. (9)

Total L: 45

TEXT BOOKS:

1. Varian H.R. , "Intermediate Microeconomics", East– West Press, New Delhi, 2014.
2. Dewett.K.K, Navalur. M.H. , "Modern Economic Theory", S. Chand, New Delhi, 2015.

REFERENCES:

1. William A, McEachern, Simrit Kaur , "Micro ECON", Cengage Learning, Noida, 2013.
2. William A, McEachern, Indira A. , "Macro ECON", Cengage Learning, Noida, 2014.
3. Deepashree , "Principles of Economics", Ane Books Pvt Ltd, New Delhi, 2010.
4. Dwivedi , "Essentials of Business Economics", Vikas Publishing House Pvt Ltd, New Delhi, 2010.

19M310 MANUFACTURING PROCESSES LABORATORY

0 0 2 1

LIST OF EXERCISES :

1. Study of various machine tools: Specification, working principle, constructional details, operations, cutting tools, work and tool holding devices
2. Drilling holes on a component using radial drilling machine and cutting force measurement using drill tool dynamometer
3. Machining a cast iron cube using shaping machine
4. Machining a keyway using slotting machine
5. Milling a die-pocket using vertical milling machine
6. Machining spur and helical gears using gear hobbing machine
7. Grinding a rectangular mild steel block using surfacegrinder
8. Grinding a cylindrical rod using cylindrical grinder
9. Making a single point cutting tool using tool and cuttergrinder
10. Machining a profile using electrical discharge machine (EDM)
11. Study of additive manufacturing processes

(26)

CASE STUDY:

1. Manufacture of a model or prototype of a prismatic component used in industrial applications.

(4)

Total P: 30

REFERENCES:

1. Department of Mechanical Engineering , "Manufacturing Processes Laboratory Manual", PSG College of Technology, 2019.
2. Chapman WAJ , "Workshop Technology - Part II", 4th Edition, CBS Publications, New Delhi, 2007.

19M311 MATERIALS SCIENCE AND MECHANICS OF MATERIALS LABORATORY

0 0 2 1

MATERIALS SCIENCE LABORATORY :

1. Study of metallurgical microscope and specimen preparation
 2. Microstructural study of white cast iron, grey cast iron, SG iron and malleable cast iron
 3. Microstructural study of low, medium and high carbon steels
 4. Microstructural study of normalized, hardened, hardened and tempered and case carburized steels
 5. Microstructural study of Al and Cu alloys
- (15)

MECHANICS OF MATERIALS LABORATORY :

1. Tension test on metals: Stress-strain characteristics
 2. Hardness test on metals: Brinell, Vicker and Rockwell hardness tests
 3. Impact test on metals: Charpy impact test
 4. Torsion test on shafts: Torque and angle of twist characteristics
 5. Tests on helical springs: Compression, tension springs-load deformation characteristics, stiffness, torsional shear stress, modulus of rigidity, strain energy
- (15)

Total P: 30

REFERENCES:

1. Department of Metallurgical Engineering, "Materials Science Laboratory Manual", PSG College of Technology, 2019.
2. Department of Mechanical Engineering, "Mechanics of Materials Laboratory Manual", PSG College of Technology, 2019.

19K312 ENVIRONMENTAL SCIENCE

2 0 0 0

INTRODUCTION TO ENVIRONMENT: Environment - Definition, scope and importance. Types and composition of atmosphere – particles, ions and radicals. Ozone layer- significance, formation and depletion. Ecosystems- Structure and functions, components, energy flow, food chains, food web, Biodiversity-levels, values and threats – India as a mega-diversity nation, hotspots of biodiversity, endangered and endemic species of India, conservation of biodiversity. (6)

ENERGY RESOURCES : Introduction – National and International status- exploitation - sustainable strategies- Fossil fuels- classification, composition, physico-chemical characteristics and energy content of coal, petroleum and natural gas; solar energy - introduction, harnessing strategies. Wind energy - availability, wind power plants, wind energy conversion systems, site characteristics, and types of wind turbines. Supporting renewable energy resources - tidal, geothermal, hydroelectric. (6)

ENVIRONMENTAL POLLUTION : Definition, Sources, causes, impacts and control measures of air pollution, water pollution, soil pollution, marine pollution, noise pollution, thermal pollution, nuclear hazards, RF hazards, Role of an individual in prevention of pollution. Disaster Management: Floods, earthquake, cyclone and landslides – Case studies, consequences and rescue measures (6)

WASTE MANAGEMENT : Wastewater - Characteristics of domestic and industrial wastewater - COD and BOD, Various stages of treatment – primary, secondary, tertiary treatment- Biological and advanced oxidation processes. Solid waste management – Characteristics of municipal solid waste (MSW), biomedical, automobile and e-wastes and their management, landfills, incineration, pyrolysis, gasification and composting. (6)

SOCIAL ISSUES AND THE ENVIRONMENT : Environmentally Sustainable work practices- Rain water harvesting, Role of non-governmental organizations. Human ethics and rights- impact on environment and human health, role of information technology on environment and human kind. Green IT policies, Process of EIA - ISO 14000. Legislation- Environment protection act – Air (Prevention and Control of Pollution) act – Water (Prevention and control of Pollution) act – Wildlife protection act – Forest conservation act. (6)

Total L: 30

TEXT BOOKS:

1. Gilbert M. Masters , "Introduction to Environmental Engineering and Science", Pearson Education, New Delhi, 2004.
2. De AK , "Environmental Chemistry", New Age International P Ltd, New Delhi, 2006.

REFERENCES:

1. Benny Joseph , "Environmental Science and Engineering", Tata McGraw-Hill, New Delhi, 2006.
2. Koteswara Rao MVR, "Energy Resources: Conventional & Non-Conventional", BSP Publications, New Delhi, 2006.
3. Deswal S and Deswal A, "A Basic Course in Environmental Studies", Dhanpat Rai and Co, New Delhi, 2004.

SEMESTER - 4

19M401 PROBABILITY AND STATISTICS

2 1 0 3

PROBABILITY AND DISCRETE RANDOM VARIABLES : Probability, axiomatic approach to probability, Baye's theorem , discrete random variables, probability distributions and probability mass functions, cumulative distribution functions, mean and variance, binomial, Poisson and geometric distributions. (6 + 3)

CONTINUOUS RANDOM VARIABLES : Continuous random variables, probability distributions and probability density functions, cumulative distribution functions, mean and variance, uniform, exponential, and normal distributions. (6 + 3)

JOINT PROBABILITY DISTRIBUTIONS : Two dimensional discrete and continuous random variables, marginal and conditional probability distributions, independence, covariance, correlation and linear regression. (6 + 3)

STATISTICAL INFERENCE : Point estimation - interval estimation – testing of hypotheses for means – large, small samples and matched pairs tests – testing of hypotheses for proportions, chi square test for goodness of fit and independence of attributes. (6 + 3)

VARIANCE TESTS AND ANALYSIS OF VARIANCE : Testing of Hypotheses for variances - analysis of variance - completely randomized design, randomized block design. (6 + 3)

Total L: 30 +T: 15 = 45

TEXT BOOKS:

1. Douglas C. Montgomery and George C. Runger , "Applied Statistics and Probability for Engineers", Wiley India, New Delhi, 2018.
2. Richard A. Johnson , "Miller & Freund's, Probability and Statistics for Engineers", Prentice Hall, New Delhi, 2017.

REFERENCES:

1. Jay L. Devore , "Probability and Statistics for Engineering and the Sciences", Brooks/Cole, USA, 2015.
2. Ronald E. Walpole, Raymond H. Myers, Sharon L. Myers and Keying Ye , "Probability & Statistics for Engineers & Scientists", Pearson, New Delhi, 2016.
3. Robert V. Hogg, Elliot Tanis and Dale Zimmerman , "Probability and Statistical Inference", Pearson Education, USA, 2014.
4. Sheldon M Ross , "Introduction to Probability and Statistics for Engineers and Scientists", Academic press, USA, 2014.

19M402 BASICS OF ELECTRICAL AND ELECTRONICS ENGINEERING

3 0 0 3

ELECTRIC CIRCUITS : Ohm's law, Kirchoff's Laws, solving simple DC Circuits-single phase AC circuit fundamentals-Power, Power factor-solving simple AC circuits- Introduction to three-phase AC circuits (8)

ELECTRICAL MACHINES : DC MOTORS: Principle of Operation-types-torque equation - speed-torque characteristics-losses and efficiency- speed control of DC motors-Electric Braking AC MACHINES: Single phase Transformers - Construction and working principle, 3 phase Induction Motor-construction-Principle of operation- types-torque equation-speed -torque characteristics-1 phase Induction Motor-Principle of operation-types – Industrial Applications. (12)

ELECTRONIC DEVICES : Operation of PN junction diodes, VI characteristics, zener diode, BJT, types-CB, CE, CC configurations, input and output characteristics, JFET - working principle and characteristics - Comparison of BJT and FET. MOSFET-types, principle of operation and characteristics, Opto Electronic Devices - Introduction, types, photo conductive cells, photo diode, phototransistor, Light emitting diode-Principles and Applications (8)

ELECTRONIC CIRCUITS : (Qualitative analysis only) Half wave and full wave rectifier, capacitive filters, zener voltage regulator, RC- coupled amplifier, frequency response, RC phase shift oscillator. Linear Integrated Circuits: Operational amplifiers, Ideal op-amp characteristics, Inverting and Non-inverting amplifier, op-amp applications - Adder- Subtractor, integrator, differentiator, comparator, zero crossing detector (10)

DIGITAL ELECTRONICS : Number systems-representation of signed numbers: 1's complement and 2's complement, logic gates, Half adder, full adder, Flip flops, RS,JK,JK Master slave, D and T type, counters and shift registers (7)

Total L: 45

TEXT BOOKS:

1. Mehta V.K., Rohit Mehta , "Principles of Electrical Engineering and Electronics", S.Chand & Co. Limited., 2006.
2. Salivahanan.S, Muraleedharan.K.A, Muthusubramanian R. , "Basic Electrical, Electronics and Computer Engineering", Tata McGraw Hill Publishers, 2006.

REFERENCES:

1. Pillai S.K. , "A First Course on Electrical Drives", New Age International Publications Limited, 2011.
2. Murugesh Kumar K. , "Basic Electrical Science and Technology", Vikas Publishing Limited, 2011.
3. Roy Choudhury, Shail Jain , "Linear Integrated Circuits", New Age International Limited, 2003.
4. Malvino.A.P, Goutam Saha, Leach D.P., "Digital Principles and Applications", Tata Mc Graw – Hill, 2008.

19M403 FLUID MECHANICS**3 1 0 4**

FLUID STATICS AND KINEMATICS : Properties of fluids, concept of gauge and absolute pressure, measurement of pressure using manometers; Types of flow - laminar, turbulent, steady, unsteady, uniform and non-uniform flows; Flow visualization : Stream, streak and path lines; Lagrangian and Eulerian descriptions of fluid motion. (9 + 3)

DIFFERENTIAL ANALYSIS OF FLUID FLOW : Irrotational and rotational flows, vorticity, stream function, potential function, continuity equation - derivation and applications to one dimensional flow, differential momentum equation, impact of jets - force on fixed and moving vanes; Navier Stokes equation, Euler's equation and Bernoulli's energy equation, applications of energy equations. (10 + 3)

FLOW THROUGH PIPES : Hagen Poiseuille equation: Velocity profile, power calculation; Laminar flow between parallel plates : Couette flow; Pipes in series and parallel, Darcy-Weisbach equation, use of Moody diagram; Minor losses: Sudden expansion, contraction and losses in pipe fittings. (10 + 3)

FLOW MEASUREMENTS : Orifice meter, mouthpiece, venturimeter, flow nozzle, pitot tube, multi-hole probe, anemometer, rotameter, hotwire anemometer, displacement meter, vortex flow meter, selection of flow meters (8 + 3)

DIMENSIONAL ANALYSIS AND BOUNDARY LAYER THEORY : Buckingham Pi theorem, Reynolds, Froude and Mach numbers and their applications in model testing; Boundary layer theory, development of boundary layer, Prandtl's boundary layer equations, integral momentum equation, drag on a flat plate, boundary layer separation and its control, streamlined and bluff bodies, flow around circular bodies and airfoil, calculation of lift and drag. (8 + 3)

Total L: 45 +T: 15 = 60**TEXT BOOKS:**

1. Munson B R, Young D F, Okiishi T H and Huebsch W W , "Fundamentals of Fluid Mechanics", 7th Edition, John Wiley & Sons, USA, 2013.
2. Yunus A Cengel and John M Cimbala , "Fluid Mechanics", 3rd Edition, McGraw Hill Education, USA, 2017.

REFERENCES:

1. Kumar D S , "Fluid Mechanics and Fluid Power Engineering", 2nd Edition, Kataria S K and Sons, India, 2016.
2. Frank M White , "Fluid mechanics", 8th Edition, McGraw-Hill Education, USA, 2016.
3. Victor Streeter E, Benjamin Wylie K, Bedford W , "Fluid Mechanics", 9th Edition, McGraw Hill Higher Education, USA, 2010.
4. Subramanya K , "Fluid Mechanics and Hydraulic Machines", 2nd Edition, McGraw Hill Education, India, 2018.

19M404 DYNAMICS OF MACHINERY**3 1 0 4**

STATIC FORCE ANALYSIS OF MECHANISM : Free body diagram: Conditions of equilibrium, two, three and four force members, effect of friction in rolling and sliding pairs. (9 + 3)

DYNAMIC FORCE ANALYSIS OF MECHANISM : Inertia force and D' Alembert's principle; Dynamic force analysis of mechanisms; Turning moment diagram: Fluctuation of energy and speed, mass of flywheel required for IC engines and mechanical presses. (9 + 3)

BALANCING : Balancing of rotating masses: Masses in single plane and several planes; Balancing of reciprocating masses: Primary and secondary forces and couples, balancing of multi-cylinder inline engines, V and radial engines, direct and reverse crank technique; Balancing machines: Field balancing. (9 + 3)

FREE VIBRATION : Basic features of vibratory systems: Elements, single degree of freedom system; Undamped free vibration: Equation of motion, natural frequency; Damped free vibration: Damping ratio, logarithmic decrement; Transverse vibration: Dunkerley's method; Critical speed of shaft. (9 + 3)

FREE TORSIONAL VIBRATION AND FORCED VIBRATION : Torsional vibration: Two and three rotor systems, geared systems; Response to periodic force: Forcing by unbalance, support motion, force and amplitude transmissibility, vibration isolation; Vibration measurement and analysis: General considerations, vibration measurement, vibration pickups, signature analysis, preparation of Campbell diagram for rotating equipment, ISO severity code. (9 + 3)

Total L: 45 +T: 15 = 60

TEXT BOOKS:

1. Shigley J E , Uicker J J , "Theory of Machines and Mechanisms", 5th Edition, Oxford University Press, 2016.
2. Rattan S S , "Theory of Machines", Fourth Edition, McGraw Hill Education, 2017.

REFERENCES:

1. Singiresu S. Rao , "Mechanical Vibrations", 6th Edition, Pearson India, 2016.
2. Ghosh , Mallick , "Theory of Mechanisms and Machines", 3rd Edition, Affiliated East-West Pvt. Ltd., 2008.
3. Graham Kelly.S , "Fundamentals of Mechanical Vibrations", 2nd Edition, McGraw-Hill Corporation, 2000.
4. V P Singh , "Theory of Machines", 6th Edition, Dhanpat Rai & Co. (P) Limited, 2017.

19M405 THERMAL ENGINEERING I**3 0 0 3**

AIR STANDARD CYCLES AND IC ENGINES : Air standard assumptions, cycles and efficiencies; Carnot, Otto, Diesel and Dual cycles, comparison of Otto, Diesel, and Dual cycles; Classification and comparison of engines, working principle of Wankel engine, four stroke and two stroke engines, petrol and diesel engines with P-V and T-S diagrams, valve and port timing diagrams. (9)

ENGINE AUXILIARY SYSTEMS: Working principles and types of carburetors, ignition systems, fuel pumps and injectors, MPFI, CRDI, lubricating and cooling systems; Super and turbocharging. (9)

PERFORMANCE OF IC ENGINES : Engine testing: Constant speed and variable speed tests, indicated power, brake power, frictional power - Willan's line and Morse test, volumetric efficiency, heat balance test; Emission measurements and reduction techniques. (9)

BOILERS: Requirements of boiler; Types: Water tube, fire tube, fluidized bed boilers; Boiler draught; Boiler performance: Direct and indirect heat balance. (9)

COMPRESSORS : Classification, working principle of air and gas reciprocating compressors, equations for shaft work and efficiencies, effect of clearance on volumetric efficiency, multi-stage compression, inter-cooler and optimum intermediate pressure in a two stage compressor; Rotary compressor: Roots-type blower, sliding vane and screw compressors, working principle and performance. (9)

Total L: 45**TEXT BOOKS:**

1. John B. Heywood , "Internal Combustion Engine Fundamentals", 2nd Edition, McGraw-Hill Education, USA, 2018.
2. Ganesan V , "Internal Combustion Engine", 4th Edition, McGraw Hill Publishers, India, 2012.

REFERENCES:

1. Allan T Kirkpatrick, Colin R Ferguson , "Internal Combustion Engines: Applied Thermosciences", 3rd Edition, Wiley, India, 2015.
2. Kothandaraman C P, Domkundwar S , "Thermodynamics and Thermal Engineering", 3rd Edition, Dhanpat Rai and Sons, India, 2013.
3. Rudramoorthy R , "Thermal Engineering", 3rd Edition, Tata McGraw Hill Publishers Co. Ltd, India, 2017.
4. Willard W Pulkrabek , "Engineering Fundamentals of the Internal Combustion Engine", 2nd Edition, Pearson Education, USA, 2003.

19M406 INDUSTRIAL METALLURGY**3 0 0 3**

CONSTITUTION OF ALLOYS AND PHASE DIAGRAMS : Introduction to unit cells and crystal systems, imperfections in crystal systems; Solid solutions: Types and conditions; Gibbs phase rule, binary phase diagrams: Isomorphous and eutectic systems; Iron – Iron carbide equilibrium diagram. (9)

HEAT TREATMENT AND STRENGTHENING METHODS : Annealing: Full annealing, stress relief annealing, recrystallization annealing, spheroidizing; Normalizing, hardening and tempering of steel; Concept of TTT and CCT diagrams, hardenability - Jominy end quench test, austempering and martempering; Surface hardening techniques: Carburizing, nitriding, cyaniding, carbonitriding, flame and induction hardening; Strengthening of metals and alloys: Cold working/strain hardening, solid solution strengthening, dispersion hardening, precipitation hardening and grain size strengthening. (9)

MECHANICAL PROPERTIES AND TESTING : Mechanism of plastic deformation, deformation by slip, critical resolved shear stress, deformation by twinning; Types of fracture; Tensile testing: Stress-strain curve; Hardness tests (Brinell, Vickers and Rockwell); Impact test :Izod and Charpy, fracture toughness tests; Fatigue: Types, mechanism, S-N curves; Creep: Mechanisms, stages, creep curve; Fatigue and creep tests; ASTM standards for different mechanical tests; Introduction to NDT techniques: LPT, MPT, UT and RT. (9)

FERROUS ALLOYS : Cast iron: Compositions, types, properties, applications, effect of alloying elements in steels; Plain carbon steels: Types, properties, applications; Stainless steel: Types, properties and applications; Tool steels: Types, heat treatment, properties, applications; HSLA, maraging steels, silicon steels, hadfield manganese steels. (9)

NON-FERROUS ALLOYS : Copper and copper alloys: Brass, bronze; Aluminium alloys: Heat treatable and non heat treatable aluminium alloys, properties, precipitation hardening of aluminium alloys; Magnesium alloys: Types, properties, applications, grain refinement; Nickel base and titanium base alloys-types, properties and applications. (9)

Total L: 45

TEXT BOOKS:

1. William D Callister , "Material Science and Engineering", John Wiley and Sons, 2018.
2. Donald R Askeland, Pradeep P Fulay, Wendelin J Wright , "The Science and Engineering of Materials", Thomson brooks, 2010.

REFERENCES:

1. Kenneth G Budinski and Michael K Budinski , "Engineering Materials", 4th Edition, Prentice-Hall of India Private Limited, 2013.
2. Raghavan V , "Materials Science and Engineering", Prentice Hall of India Pvt., Ltd, 2018.
3. Sydney H Avner , "Introduction to Physical Metallurgy", McGraw-Hill Book Company, 2015.
4. Dieter G E , "Mechanical Metallurgy", McGraw-Hill Book Company, 2018.

19M410 MACHINE DRAWING

0 0 4 2

INTRODUCTION AND CONVENTIONS : Introduction to machine drawing, sectional views of machining components; Code of practice for engineering drawing; Conventional representation of features: Drilled and tapped holes, countersunk and counter bored holes, internal and external threads, undercuts, grooves, chamfers, fillet radii and keyways; Conventional representation of standard parts: Bolts, nuts, washers, screws, cotters, pins, circlips, bearings, gears, springs and flanges. (18)

ASSEMBLY CONCEPTS: Assembly requirements, bill of materials; Methods of assembly-bolts, nuts, studs, screws and pins; Methods of axial and radial retention of parts of an assembly; Assembly of parts with emphasis on assembly sequence and appropriate fits. (10)

FITS AND TOLERANCES : Limits, fits and tolerances; Need, types, representation of tolerances on drawing, calculation of minimum and maximum clearances and allowances; Geometric tolerance: uses, types of form and position tolerances, symbols, method of indicating geometric tolerances on part drawings; Surface finish symbols - methods of indicating the surface roughness; Blue print reading exercises; Preparation of production drawing. (18)

ASSEMBLY DRAWING PRACTICE : Drawing practice of typical subassemblies: Sleeve and cotter joint, flange coupling, plummer block, stuffing box, gear box, foot step bearing, screw jack. (8)

ASSEMBLY USING SOLID MODELING : Modeling and assembly using a modelling software-extracting views and sections; Drawing of assemblies: Machine vice, stop valve, drill jig, tail stock; Creation of bill of materials, calculation of mass and section properties, interference check between solids. (6)

Total P: 60

REFERENCES:

1. BIS , "SP:46-2003 – Engineering Drawing Practice for Schools and Colleges", New Delhi, 2003.
2. John K C , "Text book of Machine Drawing", PHI Learning Pvt. Ltd, New Delhi, 2009.
3. ASME Y 14.5M-2009 , "Dimensioning and Tolerancing-Engineering Drawing and Related Documentation Practices", ASME, New York, 2009.
4. K. L. Narayana, P. Kanniah, K. Venkata Reddy , "Machine Drawing", Third Edition, New Age International Publishers, New Delhi, 2006.

19M411 ELECTRICAL AND ELECTRONICS ENGINEERING LABORATORY

0 0 2 1

LIST OF EXPERIMENTS :

1. Verification of Ohm's and Kirchhoff's Laws
2. Measurement of Power and Power Factor in Single Phase RLC Circuit
3. Mechanical Characteristics of DC Shunt and Compound Motor
4. Load Test on 3 Phase Induction Motor
5. Electric Braking of 3 Phase Induction Motor (Dynamic Braking /Plugging)
6. Study of Half Wave and Full Wave Rectifiers with and without Filters

7. RC Coupled Amplifier
8. Application of Operational Amplifier : Adder, Subtractor, Integrator, and Differentiator
9. Study of Logic Gates and Implementation of Binary Adder / Subtractor
10. Implementation of Modulo – 16 Counter

Total P: 30

REFERENCES:

1. Department of EEE , "Manual Prepared by EEE Department", PSG College of Technology, Coimbatore.

19O412 INDIAN CONSTITUTION

2 0 0 0

INTRODUCTION : Evolution of Indian Constitution; Significance of Constitution; Composition; Preamble and its Philosophy. (4)

RIGHTS, DUTIES AND DIRECTIVE PRINCIPLES : Fundamental Rights- Writs and Duties, Directive Principles of State Policy. (6)

COMPOSITION OF PARLIAMENT AND FEDERALISM : Union Government, President and Vice President, Houses of the Parliament and their functions; Composition of State Legislature; Powers, Functions and Position of Governor, Function of Chief Ministers, Council of Ministers; The Indian Federal System, Administrative Relationship between Union and States. (8)

BILLS AND CONSTITUTION AMENDMENT PROCEDURE : Types of Bills, Stages of passing of Bill into an Act, Veto Power, Constitution Amendment Procedure, Various Amendments made and their significance for India. (6)

JUDICIARY : Supreme Court and High Court; Functions and powers, Judicial Review. (6)

Total L: 30

TEXT BOOKS:

1. Subash C. Kashyap , "Our Constitution" , 5th Edition, NBT, India, New Delhi, 2015.
2. Basu D D , "Introduction to the Constitution of India" , 20th Edition, Prentice Hall of India, New Delhi, 2011.

REFERENCES:

1. Brijji Kishore Sharma , "Introduction to the Constitution of India" , 8th Edition, Prentice Hall of India, New Delhi, 2017.
2. Hoshiar Singh , "Indian Administration" , 1st Edition, Pearson Education, New Delhi, 2011.
3. Jain M C , "The Constitution of India" , 5th Edition, State Mutual Book & Periodical Service, Limited, New Delhi, 1988.
4. Shukla V N , "Constitution of India" , 13th Edition, Eastern Book Company Limited, New Delhi, 2017.

19Q413 SOFT SKILLS DEVELOPMENT

0 0 2 1

SOFT SKILLS DEVELOPMENT:

1. Body Language and Professionalism
2. Interpersonal skills
3. Goal setting
4. Impression Management
5. Team Building
6. Time Management
7. Stress Management
8. Convincing Skills
9. Motivation
10. Change Management
11. Communication Confidence
12. Group discussion basics
13. Personal Interview basics
14. Resume writing

Total P: 30

REFERENCES:

1. Jeff Butterfield , "Soft Skills for Everyone" , 6th Edition, Cengage Learning, Delhi, 2015.
2. Rao MS , "Soft Skills - Enhancing Employability" , LK International Publishing House, New Delhi, 2011.

SEMESTER - 5

19M501 DESIGN OF MACHINE ELEMENTS

3 1 0 4

STATIC AND VARIABLE LOADING : Machine design: Definition, design process, machine element design, standards and codes in design, types of stress including buckling stress, contact stress and impact stress; Design for static loading: Modes of failure, factor of safety, eccentric loading, theories of failure, problems; Design for variable loading: Stress concentration, fatigue failure, endurance limit, design equations - Soderberg, Goodman and Gerber equations, combined stresses; Overview of fracture mechanics. (10 + 3)

SHAFTS, KEYS AND COUPLINGS : Design of shafts: Forces on shafts due to gears, belts and chains, design for strength and rigidity – lateral stiffness, torsional rigidity, critical speed; Design of keys; Overview of couplings and coupling design. (8 + 3)

SPRINGS : Helical springs: Stresses and deflection in round wire helical springs accounting for variable loading, concentric springs; Design of leaf springs- stress and deflection equation, nipping; Overview of the design of helical and leaf springs in automobile suspension system. (9 + 3)

RIVETED, BOLTED AND WELDED JOINTS : Riveted joints: Modes of failure, strength and efficiency, design of riveted joints – axial loading and eccentric loading, Lozenge joints; Bolted joints: Design of eccentrically loaded bolted joints; Overview of elastic analysis; Welded joints: Types, design of welded joints for different types of loading, unsymmetrical sections. (9 + 3)

BEARINGS : Rolling contact bearings: Types, method of assembly, load ratings, bearing failure, preloading, selection of deep groove ball bearings and roller bearings; Bearing mounting for machine tool spindles and axles of automobiles; Overview of hybrid bearings; Sliding contact bearings: Theory of lubrication, hydrodynamic bearings, Sommerfeld number, design of hydrodynamic bearings. (9 + 3)

Total L: 45 +T: 15 = 60

TEXT BOOKS:

1. Richard G Budynas, J Keith Nisbett , "Shigley's Mechanical Engineering Design", 10th Edition, McGraw Hill Publishers Co. Ltd, 2017.
2. Bandari V.B , "Design of Machine Elements", 4th Edition, Tata McGraw Hill Publishers Co. Ltd, 2017.

REFERENCES:

1. Robert L Norton , "Machine Design - An integrated approach", 1st Edition, Pearson publishers, 2013.
2. Jacobson B O, Bernard J Hamrock, Steven R Schmid , "Fundamentals of Machine Elements", 2nd Edition, McGraw Hill, 2004.
3. G. K. Vijayaraghavan , "Design of Machine Elements", 6th Edition, Laxmi Publications, 2015.
4. Faculty of Mechanical Engineering, PSG College of Technology , "PSG Design Data Book", Kalaikathir Achagam, 2012.

19M502 THERMAL ENGINEERING II

3 1 0 4

REFRIGERATION : Reverse Carnot and Brayton cycles, air refrigeration, vapour compression refrigeration, use of T- s and P-h diagrams, sub-cooling, superheating, performance calculations and applications, working principle of vapour absorption refrigeration, adsorption cooling, evaporative cooling and steam jet refrigeration, refrigerants and properties. (9 + 3)

AIR CONDITIONING : Atmospheric air, properties, psychrometry chart, psychrometric processes, air- conditioning processes, requirements for comfort and industrial air-conditioning, summer and winter air conditioning systems, by-pass factor, apparatus dew point, sensible heat factor, balancing of components, cooling load calculation, working principle of window type, split, package and centralized AC systems. (9 + 3)

COMPRESSIBLE FLOW : Thermodynamic concepts, conservation equations, stagnation state properties, pressure waves in gases, effect of compressibility, differential equations for one dimensional flow, isentropic flow with area variations and calculation of parameter variations; Fanno and Rayleigh flows, analysis of parameter variations. (9 + 3)

NORMAL AND OBLIQUE SHOCKS : Development of normal shock wave, Prandtl - Meyer relation, property calculations; Concept of oblique shock wave, Shocks in convergent and divergent nozzles. (9 + 3)

JET PROPULSION : Turbo propeller and turbo jet: Thrust, fuel power, thrust power, propulsive power, efficiencies; Rocket propulsion, solid and liquid propellants, ram and scramjets. (9 + 3)

Total L: 45 +T: 15 = 60

TEXT BOOKS:

1. Sarao AS , "Thermal Engineering", Satyaprakashan Publishers, 2016.
2. Munson B R, Young D F, Okiishi T H, Huebsch W W , "Fundamentals of Fluid Mechanics", John Wiley & Sons, 2013.

REFERENCES:

1. Arora C P , "Refrigeration and Airconditioning", Tata McGraw Hill, 2017.
2. Rudramoorthy R , "Thermal Engineering", Tata McGraw Hill Publishers Co. Ltd, 2010.
3. William E Carscallen, Oosthuizen P H , "Compressible Fluid Flow", CRC Press, 2014.
4. Rajput R K , "Thermal Engineering", Laxmi Publications (P) Limited, 2018.

19M503 OPERATIONS RESEARCH**3 1 0 4**

CONCEPTS OF OPERATIONS RESEARCH AND LINEAR PROGRAMMING TECHNIQUES : Operations research and decision making, types of mathematical models and their construction; Formulation of linear programming problem, applications and limitations: Graphical method, Simplex method, Big-M method, Two-phase method; Dual problems. (8 + 3)

TRANSPORTATION PROBLEMS : Least cost method, North West corner rule, Vogel's approximation method, Modified distribution method optimization models, degeneracy in transportation model, unbalanced and maximization models. (8 + 3)

ASSIGNMENT MODELS, SCHEDULING AND INVENTORY CONTROL : Assignment models: Hungarian algorithm, unbalanced assignment problems, maximization case in assignment problems, traveling salesman problem; Sequencing and scheduling problems: $m \times 2$, $m \times 3$, $m \times n$ and $2 \times n$ problems; Inventory control: Variables in inventory problems, inventory models with penalty, shortage and quantity discount, safety stock, inventory models with probability, lead time, demand, multi item deterministic model. (9 + 3)

PROJECT MANAGEMENT BY CPM AND PERT : Constructing project network, network computations in CPM and PERT, cost crashing, resource leveling. (8 + 3)

GAME THEORY, QUEUING MODELS AND REPLACEMENT MODELS : Game theory: Theory of games, competitive games, rules for game theory, mixed strategies, two person zero sum game, n person zero sum game, graphical method, and linear programming in game theory; Queuing models: The M/M/1 queue, The M/M/m queue, batch arrival queuing system, queues with breakdowns; Replacement models: Replacement of Items due to deterioration with and without time value of Money, Group replacement policy. (10 + 3)

Total L: 45 +T: 15 = 60**TEXT BOOKS:**

1. Premkumar Gupta and Hira.DS , "Operations Research", 7th Edition, S Chand and Company Limited, New Delhi, 2014.
2. Sundaresan V, Ganapathy Subramanian K S and Ganesan K , "Operations Research (Resource Management Techniques)", 6th Edition, AR Publications, 2007.

REFERENCES:

1. Dharani Venkatakrishnan. S , "Operations Research", 5th Edition, Keerthi Publication House, Coimbatore, 1996.
2. G Srinivasan , "Operations Research: Principles and Application", 3rd Edition, PHI Learning Pvt. Ltd, New Delhi, 2017.
3. Kanthi Swarup, Gupta P K, Manmohan , "Operations Research", Sultan Chand and Sons, New Delhi, 2014.
4. Frederick S, Hillier and Gerald J. Lieberman , "Introduction to Operations Research", 10th Edition, McGraw-Hill, 2016.

19M504 TURBOMACHINERY**3 1 0 4**

TURBINES : Energy transfer between fluid and rotor, Euler's energy transfer equation, components of energy transfer, degree of reaction, effect of blade angle on degree of reaction and energy transfer; Types of turbines: Pelton, Francis, Kaplan and Propeller -principles of operation, velocity triangles, turbine design, regulation and performance; Cavitation, types of draft tubes, specific speed and its significance. (9 + 3)

PUMPS : Types of pumps, differences between positive displacement pump and roto-dynamic pump, performance calculation, determination of main dimensions, minimum starting speed, cavitation in pumps, NPSH (net positive suction head), efficiency and slip, selection of pumps. (9 + 3)

TURBO-COMPRESSORS : Classification, radial flow type, work done by the impeller, isentropic efficiency, pressure and flow coefficients, characteristic curves, surging and choking; Axial flow type, airfoil analysis, stalling, calculation of delivery pressure, isentropic and polytropic efficiencies, number of stages, selection of fans and compressors. (9 + 3)

STEAM NOZZLES AND TURBINES : Types of steam nozzle, maximum mass flow rate and velocity of steam at exit, critical pressure ratio, meta stable flow in nozzle; Types of steam turbines, compounding of steam turbines, degree of reaction, estimation of efficiency. (9 + 3)

GAS TURBINES : Brayton cycle, open cycle, closed cycle, methods of improving the efficiency of a simple cycle, inter-cooling, reheating and regeneration, multistage compression; Effect of operating variables on thermal efficiency, work ratio; Open cycle gas turbine and calculations. (9 + 3)

Total L: 45 +T: 15 = 60

TEXT BOOKS:

1. Dixon S L , "Fluid Mechanics and Thermodynamics of Turbomachinery", Butterworth-Heinemann, 2010.
2. Yahya S M , "Turbines, Compressors and Fans", Tata McGraw-Hill Education, 2017.

REFERENCES:

1. Valan Arasu A , "Turbo Machines", Vikas Publishing House, 2013.
2. Seppo A Korpela , "Principles of Turbomachinery", John Wiley & Sons, 2011.
3. Venkanna B K , "Fundamentals of Turbomachinery", PHI Learning, 2009.
4. R. K. Turton , "Principles of Turbomachinery", Springer, 1994.

19M505 MANUFACTURING AUTOMATION

3 0 0 3

PNEUMATICS: Symbols, compressors, types of actuators, pressure, flow and direction control valves, time delay valves and counters, design of sequential circuits using intuitive and cascade methods. (9)

COMPUTER NUMERICAL CONTROL MACHINES: Numerical control: Basic theory, advantages of numerical control, open and closed loop systems, classification of CNC machine tools; Salient design features of CNC machines; Drive system for CNC machine tools; Manual and computer aided part programming: G and M functions, canned cycles for turning and machining centers. (9)

INDUSTRIAL ROBOTICS: Anatomy of a robot and robot end effectors, classification of robots based on physical configuration, transducers; Sensors: Tactile sensors, proximity and range sensors, velocity sensors and vision systems; Robot programming methods; Concepts of forward and inverse kinematics. (9)

REAL TIME INTERFACING: Data acquisition systems, virtual instrumentation, interfacing of sensors/actuators with PC, condition monitoring, adaptive control, HMI and SCADA systems. (9)

INDUSTRIAL IOT : IoT architecture, M2M Architecture; Cloud: Types, edge analytics, fog computing; Augmented reality and virtual reality, big data analytics, predictive analytics. (9)

Total L: 45

TEXT BOOKS:

1. Mikell P Groover , "Automation, Production Systems and Computer-Integrated Manufacturing", Pearson Education, 2016.
2. Devdas Shetty and Richard A Kolk , "Mechatronics System Design", PWS Publishing Company, 2010.

REFERENCES:

1. Mikell P Groover, Mitchell Weiss, Roger N Nagel, Nicholas G Odrey , "Industrial Robotics", Tata McGraw-Hill, 2008.
2. Anthony Esposito , "Fluid Power with Applications", 7th Edition, Pearson Education, India, 2013.
3. Alasdair Gilchrist , "Industry 4.0: The Industrial Internet of Things", 1st Edition, Apress, 2017.
4. Sanjay Gupta and Joseph John , "Virtual instrumentation using Lab VIEW", Tata McGraw-Hill Publications Co. Ltd, 2017.

19M510 FLUID MACHINERY LABORATORY

0 0 2 1

LIST OF EXPERIMENTS :

1. Flow measurement using mouthpiece and orifice.
2. Calibration and comparison of instruments for measuring flow through pipes- orifice, venturimeter, water meter and rotameter.
3. Calibration and comparison of open channel flow measuring instruments- V-Notch and Rectangular Notch
4. Measurement of force on vane due to impact of jet
5. Determination of lift and drag coefficients using wind tunnel
6. Performance test on axial flow fan
7. Performance test on centrifugal blower
8. Performance test on reciprocating pump
9. Performance test on centrifugal pump
10. Performance test on impulse water turbine
11. Performance test on reaction water turbine

Total P: 30

REFERENCES:

1. Department of Mechanical Engineering , "Fluid Machinery Laboratory Manual", PSG College of Technology, 2019.
2. Kumar D S , "Fluid Mechanics and Fluid Power Engineering", Kataria S K and Sons, 2016.

19M511 THERMAL ENGINEERING LABORATORY

0 0 2 1

LIST OF EXPERIMENTS :

1. Valve timing diagram of a 4-stroke diesel engine
2. Port timing diagram of a 2-stroke petrol engine
3. Performance test on constant speed 4-stroke diesel engine.
4. Variable speed test on multi-cylinder diesel engine
5. Heat balance test on 4-stroke diesel engine
6. Performance test on of petrol engine
7. Performance test on two stage reciprocating air compressor
8. IC engine performance evaluation using PC interface module
9. Test on of HVAC (heating, ventilation and air conditioning) system
10. Performance analysis of refrigeration system
11. Study on diesel fired steam power plant

Total P: 30

REFERENCES:

1. Department of Mechanical Engineering , "Thermal Engineering Laboratory Manual", PSG College of Technology, 2019.
2. Ganesan V , "Internal Combustion Engines", Tata McGraw Hill, 2013.

19M512 MANUFACTURING AUTOMATION LABORATORY

0 0 2 1

LIST OF EXPERIMENTS :

1. Co-ordinated motion of multiple pneumatic actuators in a desired sequence using intuitive method
2. Co-ordinated motion of multiple pneumatic actuators in a desired sequence using cascade method
3. Co-ordinated motion of multiple actuators, electro-pneumatic systems in a desired sequence using hard wire and PLC control systems
4. Programming of CNC turning center
5. Programming of CNC machining center
6. Programming of an obstacle avoidance robot using servo motors, ultrasonic and touch sensors
7. Programming of a path following mobile robot
8. Interfacing of LVDT with a PC for monitoring the displacement of machine slide
9. Interfacing of thermocouple to monitor and maintain chamber temperature
10. Interfacing of hot wire anemometer with data acquisition system to measure air flow rate
11. IoT based temperature and position measurements

CASE STUDY :

1. Development of an automation system integrating sensors, actuators and control unit

Total P: 30**REFERENCES:**

1. Department of Mechanical Engineering , "Manufacturing Automation Laboratory Manual", PSG College of Technology, 2019.
2. J Jerome , "Virtual Instrumentation Using Labview", Prentice Hall, New Delhi, 2010.
3. Mahesh Dhotre, D Rao , "CNC Machine Tool Technology with Programming and Operating", Sai Prakashan, Pune, 2018.
4. Agus Kurniawan , "SimpleLink Wi-Fi CC3200 LaunchPad Primer", 2nd Edition, PE Press, USA, 2018.

19Q513 BUSINESS AND MANAGERIAL COMMUNICATIONS**0 0 2 1****BUSINESS AND MANAGERIAL COMMUNICATIONS:**

1. Advanced Group discussion
2. Advanced Resume writing
3. Mock Group discussion
4. Advanced Personal Interview
5. Mock Personal Interview
6. Cracking special Interviews
7. Essential Grammar for Placements
8. Vocabulary for Placements
9. Email writing
10. Paragraph writing
11. Essay writing

Total P: 30**REFERENCES:**

1. Priyadarshi Patnaik , "Group Discussion and Interview Skills", Cambridge, New Delhi, 2011.
2. Hari Mohan Prasad, Rajnish Mohan , "How to Prepare for Group Discussion and Interview", 2nd Edition, Tata McGrawhill, New Delhi, 2009.

SEMESTER - 6**19M601 DESIGN OF TRANSMISSION ELEMENTS****3 0 0 3**

SPUR AND HELICAL GEARS : Review of gear fundamentals, types of gears, interference and undercutting, gear force analysis; Spur gears: Failures in gears, beam strength, comparison of tooth shapes, design of spur gears including non-metallic gears; Helical gear: Virtual number of teeth, design of helical gears; Overview of bevel gear design. (9)

WORM GEARS, SPEED REDUCERS AND GEAR BOXES : Worm gears: Materials, modes of failure and design stresses, efficiency, thermal considerations, design of worm gears; Speed reducers: Design of single stage speed reducer, gear tooth forces, shaft design and bearing selection; Overview of gear box design for automotive manual transmission and automatic transmission. (10)

BELT AND CHAIN DRIVES : Belt drives: Design using basic equations, design of flat and V- belt drives based on manufacturer's data, timing belt; Chain drives: Chordal action, drive failures, design of chain drive, silent chain. (9)

POWER SCREWS: Forms of threads, square and trapezoidal threads, collar friction, force analysis and design of power screws and screw jack; Design of differential and compound screws, recirculating ball screws. (8)

CLUTCHES AND BRAKES : Clutches: Role of clutches, positive and gradually engaged clutches, design of single plate and multiple plate clutches; Brakes: Role of brakes, types of brakes, self-energizing and de-energizing brakes, thermal considerations, design of single shoe and double shoe brakes, design of disc brakes, design of internally expanding shoe brakes; Overview of band brakes and anti-lock braking system. (9)

Total L: 45**TEXT BOOKS:**

1. Bandari V.B, "Design of Machine Elements", 4th Edition, Tata McGraw Hill Publishers Co. Ltd, New Delhi, 2017.
2. Robert L Norton , "Machine Design - An Integrated Approach", 2nd Edition, Pearson Education, 2013.

REFERENCES:

1. Richard G Budynas, J Keith Nisbett , "Shigley's Mechanical Engineering Design", 10th Edition, McGraw Hill Publishers Co. Ltd., 2017.

2. Robert L Mott , "Machine Elements in Mechanical Design", 4th Edition, Pearson/Prentice Hall, 2004.
3. V. Jayakumar , "Design of Transmission Elements", 7th Edition, Laxmi Publications, 2015.
4. Faculty of Mechanical Engineering, PSG College of Technology , "PSG Design Data Book", Kalaikathir Achagam, 2019.

19M602 HEAT AND MASS TRANSFER

3 1 0 4

STEADY STATE HEAT CONDUCTION : Concepts of heat and mass transfer, three-dimensional heat conduction equations in various co-ordinate systems, steady state one dimensional heat conduction equation, thermal analogy for complex system analysis, variable thermal conductivity, heat transfer with heat generation in different shapes. (9 + 3)

UNSTEADY STATE HEAT CONDUCTION : Lumped parameter systems, infinite solids, and semi- infinite solids, numerical and graphical methods. (9 + 3)

CONVECTION HEAT TRANSFER : Differential analysis of hydrodynamic and thermal boundary layers; Forced and free convection, external and internal flow, laminar and turbulent flow, convective mass transfer, non-dimensional analysis. (9 + 3)

RADIATION AND PHASE CHANGE HEAT TRANSFER : Emissive power, grey body, irradiation, radiosity, Radiation heat transfer between surfaces, shape factor, radiation shield, gas radiation; Boiling heat transfer: bubble growth, freezing and melting; Condensation: Film wise condensation and drop wise condensation. (9 + 3)

APPLICATIONS OF HEAT TRANSFER : Heat transfer enhancement techniques in various applications; Fins: Types of fins, effectiveness and efficiency of fins; Heat exchangers: Types, tube and shell arrangements, single and multi-pass types, parallel flow, counter flow, cross flow and compact heat exchangers, LMTD and effectiveness method (NTU). (9 + 3)

Total L: 45 +T: 15 = 60

TEXT BOOKS:

1. Theodore L. Bergman, Adrienne S Lavine, Frank P. Incropera, David P. DeWitt , "Fundamentals of Heat and Mass Transfer", Wiley India Private Limited, 2017.
2. Yunus A Cengel , "Heat Transfer: A Practical Approach", Tata McGraw Hill Inc., 2017.

REFERENCES:

1. John H Lienhard, John H Lienhard , "Heat Transfer Text Book", Phlogiston Press, 2017.
2. Kothandaraman C P , "Fundamentals of Heat and Mass Transfer", New Age International (P) Limited, 2014.
3. Nag P K , "Heat and Mass Transfer", McGraw Hill Education, 2011.
4. Ramesh K Shah, Dusan P Sekulic , "Fundamentals of Heat Exchanger Design", John Wiley & Sons, 2003.

19M603 METROLOGY AND INSTRUMENTATION

3 0 0 3

BASICS OF MEASUREMENT SYSTEM AND DEVICES : Definition of metrology, accuracy, precision and sensitivity, Abbe's principle; Three stages of generalized measurement system, mechanical loading, factors considered in selection of instruments, commonly used terms, uncertainty, traceability, error analysis and classification, sources of error; Principle of interferometry, Michelson interferometer, NPL flatness interferometer, laser interferometer. (8)

CALIBRATION OF INSTRUMENTS AND QUALITY STANDARDS : Calibration of measuring instruments, principles of calibration, calibration of vernier caliper, micrometer, feeler gauges, dial indicator, surface plates, slip gauges; Care of gauge blocks-general rules in measurement and preservation methods; ISO 9000 quality standards and ISO 14001 environmental management standards. (9)

COMPARATORS AND GEOMETRICAL MEASUREMENT : Comparators - mechanical, electrical, optical and pneumatic; Angular measurement: Optical protractors, sine bar; Roundness measurement, limit gauge, design of plug gauge, Taylor's principle, three basic types of limit gauges; Components of surface texture: Roughness, lay, waviness, Ra and Rz, surface roughness meter; Computer controlled CMM. (9)

MEASUREMENT OF SCREW THREAD AND SPUR GEAR TERMINOLOGY : ISO metric thread, measurement of major, minor and effective diameters; Gear terminology, spur gear measurement, checking of composite errors, base pitch measurement. (9)

INDUSTRIAL MEASUREMENTS : Position sensors: Potentiometer, LVDT; Proximity sensors- types; Vibration sensors - seismic instrument; Torque sensors; Strain gauges; Temperature sensors: Resistance temperature detector, thermistor, thermocouples, J&K type and thermopiles, optical pyrometer; Pressure sensor: Elastic transducers, pressure cell, bulk modulus pressure gauge; Low pressure measurement; Thermal conductivity gauge; Flow measurement: Turbine type meter, hotwire anemometer, magnetic flow meter. (10)

Total L: 45

TEXT BOOKS:

1. Gupta I C , "A text book of Engineering Metrology", Dhanpat Rai Publications, New Delhi, 2007.
2. Beckwith T G, Roy D, Marangoni, John H Lienhard , "Mechanical Measurements", Prentice Hall, 2006.

REFERENCES:

1. Alan S Morris, Reza Langari , "Measurement and Instrumentation: Theory and Application", Academic Press, 2012.
2. Venkateshan S P , "Mechanical Measurements", John Wiley & Sons, 2015.
3. Holman J P , "Experimental Methods for Engineers", Tata McGraw Hill Publications Co Limited, 2004.
4. Alan S Moris , "ISO 14000 Environmental Management Standards", John Wiley & Sons, .

19M604 DESIGN FOR MANUFACTURE AND ASSEMBLY**3 1 0 4**

DFMA GUIDELINES AND TOLERANCE ANALYSIS : DFM approach: DFMDFA guidelines, DFA index, comparison of materials on cost basis; Process capability metrics: Cp, Cpk. feature tolerances, geometric tolerances, surface finish, review of relationship between attainable tolerance grades and different machining processes; Cumulative effect of tolerances: sure fit law, normal law and truncated normal law. (9 + 3)

SELECTIVE ASSEMBLY : Interchangeable and selective assembly - deciding the number of groups; Model-I - group tolerances of mating parts equal; Model-II - Total and group tolerances of shaft equal; Number of shafts/holes in each group, control of axial play - introducing secondary machining operations, laminated shims. (9 + 3)

DATUM SYSTEMS : Degrees of freedom, grouped datum systems, two and three mutually perpendicular grouped datum planes, grouped datum system with spigot and recess, pin and hole, tongue and slot pairs, computation of translational and rotational accuracy, geometric analysis and applications; Datum features - functional and manufacturing; Component design - machining considerations, redesign for manufacture, examples. (9 + 3)

TRUE POSITION TOLERANCING THEORY : Comparison between co-ordinate tolerancing and true position tolerancing, virtual size concept, floating and fixed fasteners, projected tolerance zone, zero true position tolerance, functional gauges, paper layout gauging, compound assembly, composite tolerancing, examples. (9 + 3)

FORM DESIGN OF CASTINGS, WELDMENTS AND TOLERANCE CHARTING : Redesign of castings based on parting line considerations, minimising core requirements; Redesign of cast members using weldments, use of welding symbols – case studies; Operation sequence for typical shaft type of components, preparation of process drawings for different operations, tolerance worksheets and centrality analysis, examples. (9 + 3)

Total L: 45 +T: 15 = 60**TEXT BOOKS:**

1. Spotts M F , "Dimensioning and Tolerancing for Quantity Production", 1st Edition, Prentice Hall Inc, New Jersey, 1983.
2. ASME Y 14.5M-2009 , "Dimensioning and Tolerancing - Engineering Drawing and Related Documentation Practices", ASME, New York, 2009.

REFERENCES:

1. Harry Peck , "Designing for Manufacture", 1st Edition, Pitman Publications, London, 1983.
2. Oliver R Wade , "Tolerance Control in Design and Manufacturing", 1st Edition, Industrial Press Inc, New York, 2008.
3. James G Bralla , "Hand Book of Product Design for Manufacturing", McGraw Hill Publications, 1986.
4. Creveling .C. M , "Tolerance Design - A Hand Book for Developing Optimal Specifications", Addison Wesley Longman Inc, USA, 1997.

19M610 METROLOGY AND DYNAMICS LABORATORY**0 0 2 1****METROLOGY LABORATORY :**

1. Gear roll testing (i) Tooth to tooth composite error (ii) Tooth thickness measurement using gear tooth vernier caliper.
2. Measurement of screw thread parameters using optical profile projector.
3. (i) Angular measurement using sine bar (ii) Internal taper measurement using two ball method.
4. Tool geometry measurement using toolmakers microscope.
5. Measurement of effective diameter of external parallel screw threads using floating carriage micrometer.
6. Study of Coordinate Measuring Machine (CMM) and surface roughness measurement.

(15)

DYNAMICS LABORATORY :

1. Static and dynamic balancing using dynamic balancing machine.
2. Preparation of cam displacement curve and determination of jump speed of cam.
3. Determination of natural frequencies of transverse, torsional vibrations and critical speed of shaft.
4. Determination of pressure distribution in journal bearing.
5. Determination of mass moment of inertia of connecting rod and comparison with software results.
6. Study of friction and wear measurement using Pin-on-Disc method.

(15)

Total P: 30**REFERENCES:**

1. Department of Mechanical Engineering , "Metrology Laboratory Manual", PSG College of Technology, 2019.
2. Department of Mechanical Engineering , "Dynamics Laboratory Manual", PSG College of Technology, 2019.

19M611 HEAT TRANSFER LABORATORY**0 0 4 2****LIST OF EXPERIMENTS :**

1. Determination of thermal conductivity using guarded hot plate apparatus
2. Study of unsteady state heat conduction
3. Determination of thermal conductivity of insulating powder
4. Heat Transfer analysis using pin-fin apparatus
5. Determination of natural convective heat transfer coefficient for a vertical cylinder
6. Determination of forced convective heat transfer coefficient for a hollow tube
7. Determination of Stefan-Boltzmann constant
8. Determination of emissivity of grey surface
9. Determination of effectiveness of parallel /counter flow heat exchanger
10. Determination of heat transfer coefficient in film and drop wise condensation

Total P: 60**REFERENCES:**

1. Yunus A Cengel , "Heat Transfer: A practical Approach", Tata McGraw Hill Inc, 2017.
2. Department of Mechanical Engineering , "Heat Transfer Laboratory Manual", PSG College of Technology, 2019.

19M612 INNOVATION PRACTICES**0 0 4 2**

INNOVATION PRACTICES LABORATORY : Project-based laboratory that enables students to ideate, develop and test small application prototypes. Student teams can work with potential users in order to gain in-depth knowledge of how to design, manufacture and test a creative solution in the real world.

SYSTEMATIC PRODUCT DEVELOPMENT : The procedure involves idea generation, development of concept model, design optimization, prototype development and technical documentation.

AUGMENTATION OF PRODUCT INNOVATION PROCESS : An overview of 3D scanning, Design optimization, 3D printing, Concepts of IoT and Intellectual Property Rights will be provided.

Total P: 60**REFERENCES:**

1. Karl T Ulrich and Steven D Eppinger , "Product Design and Development", Tata McGraw Hill, New Delhi, 2017.
2. A. K. Chitale, R. C. Gupta , "Product Design and Manufacturing", 6th Edition, PHI Learning Pvt. Ltd, 2013.
3. Kevin Otto and Kristin Wood , "Product Design", 2nd Edition, Pearson, New Delhi, 2013.
4. Innovation Advisory Council , "Innovation Black Book on Exponential Technologies", Wiley India, New Delhi, 2019.

19Q613 QUANTITATIVE AND REASONING SKILLS**0 0 2 1****QUANTITATIVE AND REASONING SKILLS :**

1. Number System, Time and Work
2. Percentages , Simple and Compound Interests
3. Time, Speed and Distance
4. Permutation, Combination and Probability
5. Ratio and Proportion
6. Profit, Loss and Partnership

7. Logarithms, Progressions, Geometry and Quadratic Equations
8. Coding and Decoding
9. Series, Analogy and OddMan Out
10. Visual Reasoning
11. Data Arrangements
12. Blood Relations
13. Clocks, Calendars and Direction Sense
14. Cubes, Logical Connectives and Syllogisms
15. Venn Diagrams, Interpretations and solving

Total P: 30

REFERENCES:

1. Aggarwal R S , "Quantitative Aptitude for Competitive Examinations", 3rd Edition, S Chand Publishing, New Delhi, 2017.
2. ETHNUS , "Aptimithra", 1st Edition, McGraw-Hill Education Pvt Ltd,2013.
3. FACE , "Aptipedia Aptitude Encyclopedia", 1st Edition, Wiley Publications, Delhi, 2016.

SEMESTER - 7

19M701 FINITE ELEMENT ANALYSIS

3 0 0 3

STATIC ANALYSIS USING ONE DIMENSIONAL SPAR ELEMENTS : Basic concepts of FEM, general procedure of FEM, discretization of domain, basic types of elements; Formulation of element stiffness matrices and load vectors: 1D linear spar and quadratic spar elements, plane truss element, treatment of boundary conditions and temperature effects; Solution of problems. (9)

STATIC ANALYSIS USING ONE DIMENSIONAL BEAM ELEMENTS : Beam element : Hermite shape functions, formulation of element stiffness matrix and load vectors; Beams on elastic foundation; Problems using one dimensional beam element. (10)

STATIC ANALYSIS USING TWO DIMENSIONAL ELEMENTS : Isoparametric formulation, 2D triangular and quadrilateral elements, element stiffness matrices and load vectors, problems using two dimensional elements; Introduction to higher order elements. (10)

DYNAMIC ANALYSIS : Equations of motion for dynamic problems using one dimensional spar, truss and beam elements, formulation of consistent and lumped mass matrices, solving free vibration problems using one dimensional elements. (8)

HEAT TRANSFER ANALYSIS : Basic equations of heat transfer and fluid flow, finite element formulation and solution of one dimensional heat transfer problems involving steady state heat conduction and convection. (8)

Total L: 45

TEXT BOOKS:

1. Tirupathi R. Chandrupatla, Ashok D. Belegundu , "Introduction to Finite Elements in Engineering", 4th Edition, Pearson, 2011.
2. Daryl L Logan , "A First Course in Finite Element Method", 6th Edition, Cengage Learning, 2016.

REFERENCES:

1. Robert D. Cook, David S. Malkus, Michael E. Plesha, Robert J. Witt , "Concepts and Applications of Finite Element Analysis", 4th Edition, Wiley India Pvt Ltd, New Delhi, 2007.
2. Bhavikatti S S , "Finite Element Analysis", 1st Edition, New Age International, 2015.
3. Reddy J N , "An Introduction to Finite Element Method", 3rd Edition, McGraw Hill Education, 2015.
4. Dixit U S , "Finite Element Methods for Engineers", 1st Edition, Cengage Learning India Pvt. Ltd, 2009.

19M710 FINITE ELEMENT ANALYSIS LABORATORY

0 0 2 1

LIST OF EXERCISES :

1. Static structural analysis using 1D and 2D elements.
2. Static structural analysis using 3D elements.
3. Dynamic (Modal/harmonic/transient dynamic) analysis of mechanical parts.
4. Stress analysis of mechanisms.
5. Steady state thermal analysis of typical components.
6. Transient thermal analysis of components and processes.

7. Thermo-mechanical analysis of components.
8. Fluid flow analysis of pipes, nozzle, diffuser, etc.
9. Topology optimization of material layout for complex parts.
10. Fatigue analysis to ascertain product durability. (26)

CASE STUDY :

1. Finite element analysis of sub-systems/complex components of typical mechanical systems followed by design sensitivity analysis. (4)

Total P: 30

REFERENCES:

1. Department of Mechanical Engineering , "Finite Element Analysis Laboratory Manual", PSG College of Technology, 2019.
2. Nithin S Gokhale, Sanjay S Deshpande, Sanjeev V Bedekar, Anand N Thite , "Practical Finite Element Analysis", 1st Edition, Finite to Infinite, Pune, 2008.
3. Tirupathi R. Chandrupatla, Ashok D. Belegundu , "Introduction to Finite Elements in Engineering", 4th Edition, Pearson, 2011.
4. Daryl L Logan , "A First Course in Finite Element Method", 6th Edition, Cengage Learning, 2016.

19M720 PROJECT WORK - I

0 0 4 2

- Identification of a real life problem in thrust areas
- Review of literature and identification of gaps
- Framing of objectives and methodology of work considering available resources
- Preparation of time line of activities
- Execution of preliminary work
- Preparation of consolidated report

Total P : 60

SEMESTER - 8

19M820 PROJECT WORK - II

0 0 8 4

Execution of work for the problem identified taking into consideration the following aspects :

1. Development of appropriate analytical/numerical/empirical models
2. Development of prototype wherever applicable
3. Testing and validation of model
4. Analysis and interpretation of results
5. Cost benefit analysis wherever applicable
6. Preparation of consolidated report

Total P:120

PROFESSIONAL ELECTIVES

19M001 GEOMETRIC MODELING

3 0 0 3

OVERVIEW OF CAD SYSTEMS AND GRAPHICS TRANSFORMATION : Conventional and computer aided design processes; Subsystems of CAD: CAD hardware and software, graphics packages, CAD workstations; Networking of CAD systems; Generative, cognitive and image processing graphics, static and dynamic data graphics; Transport of graphics data; Graphic standards, generation of graphic primitives, display and viewing, transformations customizing graphics software. (11)

MATHEMATICAL REPRESENTATION OF CURVES AND SURFACES : Wireframe modeling and its limitations; Parametric representation of analytic curves, parametric representation of synthetic curves - Cubic spline, Bezier, B-spline, NURBS, curve manipulation; Surface models: Types of surfaces, parametric representation of surfaces, design examples. (9)

MATHEMATICAL REPRESENTATION OF SOLIDS : Fundamentals of solid modeling: Boundary representation, constructive solid geometry, solid manipulations, solid modeling based applications. (9)

VISUAL REALISM AND COMPUTER ANIMATION : Model cleanup - hidden line removal algorithms; Shading algorithms; Computer animation: Animation systems, design applications. (8)

MASS PROPERTY CALCULATIONS : Introduction, geometrical property formulation, mass property formulation; Design and engineering applications. (8)

Total L: 45

TEXT BOOKS:

1. Ibrahim Zeid , "CAD/CAM Theory and Practice", 2nd Edition, McGraw Hill Inc, New Delhi, 2009.
2. Groover M.P, Zimmers, E.W. , "CAD/CAM: Computer Aided Design and Manufacture", Prentice Hall, 1984.

REFERENCES:

1. Radhakrishnan P, Subramanyan S and Raju V, "CAD/CAM/CIM", New Age International, 2012.
2. Radhakrishnan P and Kothandaraman C , "Computer Graphics and Design", Dhanpat Rai and Sons, 2015.
3. Rogers D F, Adams, J. A , "Mathematical Elements for Computer Graphics", 2nd Edition, McGraw Hill Education, New Delhi, 2002.
4. Michael E Mortenson , "Geometric Modeling", John Wiley and Sons Inc, 1997.

19M002 ADVANCED STRENGTH OF MATERIALS

3 0 0 3

CURVED BEAMS : Circumferential stress at a point in a curved beam- Winkler Bach formula and limitations; Curved beam with restrained ends; Closed ring subjected to concentrated load and uniform load. (8)

TORSION OF NON CIRCULAR SECTIONS : Torsion of bar having rectangular section; Elastic membrane analogy for hollow thin walled tubes. (9)

BEAMS ON ELASTIC SUPPORTS : Beam with a concentrated load; Use of principle of superposition- beam supported on equally spaced elastic supports, UDL over part of the beam. (9)

FLAT PLATES IN BENDING : Flat plates subjected to small deflections; Stresses in a circular plate with UDL - simply supported and fixed edges-concentrated load; Stresses in square and rectangular plates with UDL, concentrated load at center. (9)

THICK WALLED CYLINDERS AND ROTATING DISKS : Lamé's solution for principal stresses, maximum stresses, radial deflection, failure theories, applications; Methods of increasing the elastic strength by pre-stressing, analysis of effects of stresses of shrinking a hollow cylinder made of thin walled laminations, auto fretting; Solid disk, disk with a central hole with external and internal pressures, disks of uniform strength, plastic collapse of rotating disks; Rotating circular cylinders, disk of varying thickness. (10)

Total L: 45

TEXT BOOKS:

1. Boresi AP and Schmidt R J , "Advanced Strength of Materials", John Wiley and Sons, New Delhi, 2002.
2. Sadhu Singh , "Theory of Elasticity", 4th Edition, Khanna Publishers, New Delhi, 2015.

REFERENCES:

1. Cook R D and Young , "Advanced Mechanics of Materials", 2nd Edition, John Wiley, New Delhi, 1999.
2. Den Hartog , "Advanced Strength of Materials", 2nd Edition, McGraw Hill Inc, New Delhi, 1987.
3. Rajput R K , "Strength of Materials", 5th Edition, S. Chand & Co. Ltd, New Delhi, 2010.
4. Saul K Fenster, Ansel C Ugarwal , "Advanced Mechanics of Materials and Applied Elasticity", 5th Edition, Pearson Education, New Delhi, 2011.

19M003 ADVANCED FINITE ELEMENT ANALYSIS

3 0 0 3

AXISYMMETRIC AND HIGHER ORDER ELEMENTS : Axisymmetric triangular element: Formulation of stiffness matrix and load vectors, problem modelling and boundary conditions, solution of problems; Higher order triangular and quadrilateral elements; Overview of three dimensional elements. (9)

BENDING OF PLATES AND SHELLS : Review of elasticity equations; Bending of plates and shells – finite element formulation of plate and shell elements, conforming and non-conforming elements, C0 and C1 continuity elements, degenerated shell elements, application and examples. (10)

NON-LINEAR ANALYSIS - MATERIAL NON-LINEARITY : Introduction, non-linear differential equation, solution procedures for non-linear problems, linearization and directional derivative; Material non-linearity: Analysis of axially loaded bars, significance of sampling rate, material models for isotropic, orthotropic, anisotropic and hyper-elastic materials, hardening rules. (10)

NON-LINEAR ANALYSIS - GEOMETRIC NON-LINEARITY : Geometric non-linearity: Basic continuum mechanics concepts, governing differential equations and weak forms; Introduction to contact problems. (8)

TIME-DEPENDENT ANALYSIS : Numerical integration in time, natural frequencies of one dimensional bar, time dependent one-dimensional bar analysis; Time dependent heat transfer -transient thermal analysis; Solution of one dimensional problems. (8)

Total L: 45

TEXT BOOKS:

1. Logan D L , "A First Course in the Finite Element Method", 6th Edition, Cengage Learning, 2015.
2. M. Asghar Bhatti , "Fundamental Finite Element Analysis and Applications", 1st Edition, John Wiley & Sons, USA, 2005.

REFERENCES:

1. K J Bathe , "Finite Element Procedures", 2nd Edition, Prentice Hall, 2007.
2. Timoshenko S, Woinowsky Krieger , "Theory of Plates and Shells", 2nd Edition, McGraw-Hill, 2017.
3. Cook R D, Malkus D S and Plesha M E , "Concepts and Applications of Finite Element Analysis", Wiley India Pvt Ltd, New Delhi, 2007.
4. Bhavikatti S S , "Finite Element Analysis", New Age International, 2015.

19M004 FAILURE ANALYSIS AND DESIGN

3 0 0 3

MATERIALS AND DESIGN : Factors affecting the behavior of materials in components, effect of component geometry and shape factors, designing with high strength and low toughness materials, designing for hostile environments, the design process; Materials selection in design; Processes and their influence on design, systematic process selection. (10)

FRACTURE MECHANICS : Ductile fracture, brittle fracture, cleavage-fractography, ductile-brittle transition, fracture mechanics approach to design-energy criterion, stress intensity approach; Time dependent crack growth and damage; Linear elastic fracture mechanics: Griffith theory, energy release rate, instability and R-curve, stress analysis of cracks-stress intensity factor, K-threshold, crack growth instability analysis, crack tip stress analysis; Elastic plastic fracture mechanics: Crack tip opening displacement (CTOD), J-integral, relationship between J and CTOD. (10)

DYNAMIC FRACTURE AND DETERMINATION OF FRACTURE TOUGHNESS VALUES : Dynamic fracture, rapid loading of a stationary crack, rapid crack propagation, dynamic contour integral, creep crack growth-C Integral, viscoelastic fracture mechanics, viscoelastic J integral; Determination of fracture toughness values: Experimental determination of plane strain fracture toughness, K- R curve testing, J measurement, CTOD testing. (9)

WEAR FAILURES : Types of wear, different methods of wear measurement, analysis of wear failures, wear at elevated temperatures, wear of different materials, role of friction on wear, stick slip friction, creep, stress rupture, elevated temperature fatigue, environment induced failure. (8)

FAILURE ANALYSIS TOOLS : Reliability concept and hazard function, life prediction, life extension, application of Poisson, exponential and Weibull distributions for reliability, bath tub curve, parallel and series systems, MTBF, MTTR, FMEA-design FMEA, process FMEA, analysis of causes of failure modes, ranks of failure modes; Fault tree analysis; Industrial case studies on FMEA (8)

Total L: 45

TEXT BOOKS:

1. Anderson T L , "Fracture Mechanics: Fundamentals and Applications", 4th Edition, Taylor and Francis, 2017.
2. Michael F Ashby , "Materials Selection in Mechanical Design", 3rd Edition, Butterworth – Heinemann, 2016.

REFERENCES:

1. ASM Metals Handbook Volume 11 , "Failure Analysis and Prevention", 10th Edition, ASM International, 2002.
2. Shigley and Mische , "Mechanical Engineering Design", 5th Edition, McGraw Hill, 2011.
3. John M Barsoom and Stanley T Rolte , "Fracture and Fatigue Control in Structures", 3rd Edition, American Society For Testing & Materials, 1999.
4. Balbir S. Dhillon , "Applied Reliability and Quality: Fundamentals, Methods and Procedures", 1st Edition, Springer Series in Reliability Engineering, 2010.

19M005 VIBRATION AND NOISE ENGINEERING

3 0 0 3

VIBRATION CONCEPTS AND SINGLE DEGREE OF FREEDOM SYSTEMS : Relevance of and need for vibrational analysis; Mathematical modeling of vibrating systems: Discrete and continuous systems; Single degree of freedom systems; Free and forced vibrations; Various damping models. (9)

TWO DEGREES OF FREEDOM SYSTEMS : Generalized co-ordinates, principal co-ordinates: Derivation of equations of motion for two degree of freedom systems, co-ordinate coupling, Lagrange's equation. (9)

MULTI DEGREES OF FREEDOM SYSTEMS : Derivation of equations of motion, influence coefficients, orthogonality principle; Determination of natural frequencies: Rayleigh, Stodala, Dunkerley, Holzer and matrix iteration methods; Branched systems, geared systems. (9)

TRANSIENT VIBRATION : Impulse and arbitrary excitation, base excitation; Laplace transform formulation, response spectrum. (8)

VIBRATION AND NOISE MEASUREMENTS AND CONTROL : Free and forced vibration tests; Measurement of vibration: FFT analyzer; Methods of vibration control: Excitation reduction at source, balancing of rigid, flexible and variable mass rotors; Dynamic properties and selection of structural materials: Viscoelastic polymers, vibration absorbers- tuned absorber, tuned and damped absorber (qualitative treatment only), untuned viscous damper, vibration isolation; Noise: Properties of sound, sound level meter, sound isolation – machine enclosures, silencers and mufflers. (10)

Total L: 45

TEXT BOOKS:

1. Thomson W T , "Theory of Vibration with Applications", 5th Edition, CBS Publishers and Distributors, New Delhi, 2008.
2. Singiresu S. Rao , "Mechanical Vibrations", 6th Edition, Pearson Education, 2008.

REFERENCES:

1. Tse, Morse and Hinkle , "Mechanical Vibration –Theory and Applications", CBS Publishers & Distributors, 2004.
2. Grover G K , "Mechanical Vibrations", New Chand and Brothers, Roorkey, 2009.
3. S Graham Kelly , "Mechanical Vibrations, Schaum's Outline Series", McGraw Hill Book Company, New Delhi, 1996.
4. A.G. Ambekar , "Mechanical Vibrations and Noise Engineering", 2nd Edition, PHI Learning Private Limited, 2006.

19M006 MECHANICAL DESIGN OF CNC MACHINE TOOLS

3 0 0 3

DESIGN OF MACHINE TOOL STRUCTURES : Concepts of CNC machine tools, types of CNC machine tools; Design criteria for machine tool structures: Stiffness and rigidity of the individual structural elements and their combined behavior under static and dynamic loads; Basic design procedure for machine tool structures: Bed, column and housing. (10)

DESIGN OF SPINDLES : Types of spindles: belt driven spindles, gear driven spindles, direct drive spindles and integral rotor spindles; Functions and requirements of spindles, spindle materials, design of spindles and selection of spindle bearings. (8)

DESIGN OF GUIDEWAYS AND DRIVE ELEMENTS : Functions and requirements of guide ways, guideway types; Selection of ball screws; Sizing of servomotor and linear motor. (8)

MACHINE TOOL PERFORMANCE AND PRECISION : Accuracy, repeatability and resolution; Sources of errors in machine tools: Thermal errors, CNC interpolation errors, calibration of CNC machines, error compensation; Overview of ISO and Indian standards for calibration of machine tools. (9)

PROTOTYPE TESTING AND EVALUATION : Purpose of machine tool testing: Static and dynamic measurements; Experimental modal analysis: Frequency response function measurement, modal curve fitting and modal parameter extraction; Type of geometrical checks on machine tools, use of laser for alignment testing, final alignment inspection. (10)

Total L: 45

TEXT BOOKS:

1. Mehta N K , "Machine Tool Design and Numerical Control", 3rd Edition, Tata McGraw Hill publishing Co.Ltd, New Delhi, 2012.
2. Lopez de Lacalle L N and Lamikiz A , "Machine Tools for High Performance Machining", 1st Edition, Springer- Verlag London Limited, 2009.

REFERENCES:

1. Basu S K and Pai D K , "Design of Machine Tools", 5th Edition, Oxford and IBH publishing Co. Pvt Ltd, New Delhi, 2009.
2. Radhakrishnan P , "Computer Numerical Control (CNC) Machines", 1st Edition, New Central Book Agency (P) Limited, 1992.
3. Sen G C and Bhattacharya A , "Principles of Machine Tools", 2nd Edition, New Central Book Agency (P) Limited, Kolkata, 2009.
4. Koenigsberger F , "Design Principles of Metal-Cutting Machine Tools", 1st Edition, Pergamon Press, 1964.

19M007 THEORY OF ELASTICITY AND PLASTICITY

3 0 0 3

ANALYSIS OF STRESS AND STRAIN : Stress at a point; Stress tensor, stress transformations, principal stresses, octahedral stresses, equations of equilibrium; Strain tensor, principal strains, strain-displacement relations, compatibility conditions; Strain gages and rosettes. (9)

CONSTITUTIVE EQUATIONS: General theory: Generalized Hooke's law, theorems of elasticity, equations of elasticity; Plane stress and plane strain conditions. (8)

ELASTICITY PROBLEMS : Formulation of general elasticity problem, boundary conditions, two dimensional problems in rectangular and polar coordinates; Airy's stress function and relations. (8)

PLASTICITY: Plastic flow: Microscopic and macroscopic descriptions, stress-strain curves of real materials, definition of yields criterion, and concept of a yield surface in principal stress space; Yield criteria - Tresca and Von Mises criteria. (10)

PLASTIC STRAIN ANALYSIS : Prandtl-Reuss and Levy-Mises equations; Deformation in plane stress: Yielding of thin sheet in biaxial and uniaxial tension; Plane strain deformation: Stress tensor, hydrostatic and deviatoric components, plastic potential, plastic instability, effect of strain rates and temperature on flow stress; Introduction to slip line field theory. (10)

Total L: 45

TEXT BOOKS:

1. Timoshenko S P, Goodier J N. T , " Theory of Elasticity", 3rd Edition, Tata McGraw Hill Publications, 2010.
2. Chakrabarthy J , "Theory of Plasticity", 3rd Edition, Butterworth-Heinemann, 2012.

REFERENCES:

1. Durelli A J, Phillips E A and Tsao C H , "Introduction to Theoretical and Experimental Analysis of Stress and Strain", 1st Edition, McGraw Hill Publications, 1958.
2. Martin H Sadd , "Elasticity: Theory, Applications and Numerics", 3rd Edition, Elsevier, 2014.
3. Dieter G E , "Mechanical Metallurgy", McGraw Hill, 2017.
4. Calladine C R , "Plasticity for Engineers Theory and Applications", 2nd Edition, Woodhead publishing series, 2000.

19M008 MECHANICS OF COMPOSITE MATERIALS

3 0 0 3

INTRODUCTION : Modern materials in design: Types, metals, polymers, ceramics, composites; Polymers: Classification, properties of thermo plastics, properties of thermo setting plastics, applications, merits and demerits; Classification of composites: advantages, applications; Matrices and reinforcements: roles, classification, properties and composite structures. (8)

PROCESSING AND CHARACTERISTICS OF COMPOSITES : Manufacture of polymer matrix composites: Layup and curing, open and closed mould processes, bag moulding, filament winding, pultrusion, pulforming, thermoforming, advantages and limitations of different processes; Manufacture of metal matrix and ceramic matrix composites, advantages, limitations and characteristics of ceramic and metal matrix composites. (9)

MICRO MECHANICAL BEHAVIOUR OF A LAMINA: Volume and mass fractions: Density and void content, evaluation of elastic moduli, ultimate strengths of unidirectional lamina; Coefficients of thermal and moisture absorption. (8)

MACRO MECHANICAL BEHAVIOUR OF A LAMINA : Stress strain relationships: Generalized Hook's Law for different types of materials, 2D unidirectional and angular lamina, co-ordinate transformation, material symmetry; Evaluation of elastic moduli, engineering constants for unidirectional and angular lamina; Strength failure theories of unidirectional and angular lamina. (10)

MACRO MECHANICAL BEHAVIOUR OF A LAMINATE: Laminate code, stress - strain behavior in a laminate; Resultant forces and moments in a laminate, inter laminar stresses in laminates; Design of composite structures - Case studies. (10)

Total L: 45

TEXT BOOKS:

1. Autar K Kaw , "Mechanics of Composite Materials", 2nd Edition, CRC Press, 2007.
2. Manoj Kumar Buragohain , "Composite Structures: Design, Mechanics, Analysis, Manufacturing, and Testing", 1st Edition, CRC Press, 2017.

REFERENCES:

1. Valery V Vasiliev and Evgeny V Morozov , "Advanced Mechanics of Composite Materials and Structural Elements", 3rd Edition, Elsevier Ltd, 2013.
2. Mallick P K , "Fiber Reinforced Composites", 2nd Edition, CRC Press, 2007.

3. George Z. Voyiadjis and Peter I. Kattan , "Mechanics of Composite Materials with MATLAB", 1st Edition, Springer, 2005.
4. Robert M Jones , "Mechanics of Composite Materials", 2nd Edition, CRC Press, 2018.

19M009 INTRODUCTION TO AIRCRAFT SYSTEMS

3 0 0 3

INTRODUCTION TO AIRCRAFTS : Evolution and history of flight; Basic components of an aircraft: Structural members, aircraft axis system, aircraft motions, control surfaces and high lift devices; Types of aircrafts: Conventional design configurations based on power plant location, wing location, intake location, tail unit arrangements, landing gear arrangements. (9)

BASIC PRINCIPLES OF FLIGHT : Significance of speed of sound, air speed and ground speed, properties of atmosphere, Bernoulli's equation, forces on the airplane, airflow over wing section, pressure distribution over a wing section, generation of lift and drag, pitching moments, types of drag, lift curve, drag curve, lift/drag ratio curve, factors affecting lift and drag. (9)

AIRCRAFT SYSTEMS : Environmental control systems(ECS), pneumatic systems, hydraulic systems, fuel systems, landing gear systems, engine control systems, ice and rain protection systems, cabin pressurization and air conditioning systems, steering and brakes systems, auxiliary power unit; Electrical and electronic systems: Avionics, flight controls, autopilot and flight management systems, navigation systems, communication, information systems, radar system. (10)

AEROFOIL STABILITY AND CONTROL: Aerofoil nomenclature, types of aerofoil, center of pressure and its effects; Wing section: Aerodynamic center, aspect ratio, effects of speed, air density on lift and drag; Degree of stability: Lateral, longitudinal and directional stability and controls of aircraft; Effects of flaps and slats and lift coefficients, control tables, stalling, landing, gliding turning, speed of sound, mach number, shock waves. (9)

AIRCRAFT PERFORMANCE AND MANEUVRES : Power curves, maximum and minimum speeds of horizontal flight, effects of changes of engine power, effects of altitude on power curves, forces acting on an aeroplane during a turn, loads during a turn, correct and incorrect angles of bank. (8)

Total L: 45

TEXT BOOKS:

1. Kermod A C , "Flight without Formulae", Pearson Education, Singapore, 2008.
2. Kermod A C, D. R. Philpott, R. H. Barnard , "Mechanics of Flight", Prentice Hall, 2006.

REFERENCES:

1. Anderson John D. Jr , "Introduction to Flight", McGraw Hill Publishers, 2007.
2. Kermod A C, D. R. Philpott, R. H. Barnard , "Aircraft Systems: Mechanical, Electrical and Avionics Subsystems Integration", John Wiley, 2008.
3. Houghton, E. L., & Carpenter, P. W , "Aerodynamics for engineering students", Elsevier, 2003.
4. Shevell , "Fundamentals of Flight", Pearson Education, 1989.

19M010 SYSTEM MODELING AND CONTROL

3 0 0 3

CONTROL SYSTEM FUNDAMENTALS : Basic elements of control systems: Open loop and closed loop control, elements of closed loop control system, SISO, MIMO systems, sampled data, digital control systems; Mathematical foundation: Matrix theory, differential equations and Laplace transform. (9)

MATHEMATICAL BASICS OF CONTROL SYSTEMS: Block diagrams: Block diagram reduction, signal flow graphs, Mason's gain formula; Transfer function: Translational and rotational mechanical transfer function, electrical and electro-mechanical system transfer functions, DC motor transfer function. (9)

BASIC CONTROL THEORY : Poles and zeros: First order systems, second order systems, more than 2 poles and zeros; Nonlinearities and linearization; PID controllers. (9)

TIME DOMAIN ANALYSIS : Stability: Routh-Hurwitz criterion, stability analysis, steady state error analysis; Introduction to Root locus: Root locus example, design of transient response using root locus, positive feedback, design through root locus; Error compensation: Steady state error compensation, transient error compensation, transient and steady state error compensation, compensation examples; Feedback compensation and its physical realization, feedback design examples. (9)

FREQUENCY DOMAIN ANALYSIS: Frequency response: Bode plots, gain margin and phase margin; Design using the frequency response: Lead, lag, lead-lag compensators; The state-space representation: Solving the state equations in the time and space domains, state equation examples, stability and steady-state error in state space. (9)

Total L: 45

TEXT BOOKS:

1. Norman S Nise , "Nise's Control Systems Engineering", 7th Edition, John Wiley, 2018.
2. Katsuhiko Ogata , "Modern Control Engineering", 5th Edition, Pearson, India, 2015.

REFERENCES:

1. Benjamin C Kuo and Farid Golnaraghi , "Automatic Control Systems", 9th Edition, Wiley, 2014.
2. Gopal M , "Control systems: Principles and Design", 4th Edition, McGraw-Hill education, 2012.
3. William J Palm III , "System Dynamics", 2nd Edition, McGraw-Hill education, 2012.
4. Katsuhiko Ogata , "System Dynamics", 4th Edition, Pearson, 2014.

19M011 FOUNDATION SKILLS IN INTEGRATED PRODUCT DEVELOPMENT**3 0 0 3**

PRODUCT LIFECYCLE MANAGEMENT : System architecture, scope, characteristics, drivers, stages - introductory stage, growth stage, maturity stage and decline stage, S-Curve, Bathhtub curve; Product data structure. (10)

REQUIREMENT ENGINEERING AND ANALYSIS : Requirement engineering: Types of requirement, requirement pyramid; PESTEL analysis; SWOT analysis; Product development models. (8)

CONCEPTUALIZATION AND PROTOTYPING : Customer needs, problem statement, bench marking and establishing engineering specifications; Idea generation: Brainstorming, mind-map; Concept generation: Systematic exploration, 6-3-5 method, morphological analysis; Prototyping: Methods, types; Case studies. (10)

PRODUCT DEVELOPMENT APPROACHES AND TOOLS : Challenges and constraints in product development; Quality function deployment (QFD); Theory of inventive problem solving (TRIZ); Establishing product function: FAST method, subtract and operate procedure; Failure mode and effects analysis (FMEA); Case studies. (9)

SUSTENANCE ENGINEERING AND IPR : Maintenance: Activities, objectives, classification; Obsolescence management: Objectives, mitigation measures, design for obsolescence; IPR: Types of IPR, patentability criteria, steps in patenting, formulating claims, pursuing application. (8)

Total L: 45**TEXT BOOKS:**

1. Karl T Ulrich and Steven D Eppinger , "Product Design and Development", 5th Edition, Tata McGraw Hill, New Delhi, 2017.
2. Michael Grieves , "Product Life Cycle Management", 1st Edition, Tata McGraw Hill, New Delhi, 2005.

REFERENCES:

1. Chitale A K and Gupta R C , "Product Design and Manufacturing", 6th Edition, Prentice Hall of India, 2014.
2. Kevin Otto and Kristin Wood , "Product Design", 5th Edition, Pearson Education, 2013.
3. Nigel Cross , "Engineering Design Methods: Strategies for Product Design", 3rd Edition, John Wiley and Sons, 2008.
4. Jonathan Cagan and Craig M. Vogel , "Creating Breakthrough Products: Revealing the Secrets that Drive Global Innovation", 2nd Edition, Pearson Education, 2013.

19M012 DESIGN OF AUTOMOTIVE SYSTEMS**3 0 0 3**

DESIGN OF PROPULSION SYSTEMS : Review of design considerations for components under static and dynamic loading; Design of I.C engine components - cylinder, piston, connecting rod, crankshaft, flywheel, valves and valve springs; Design principles of electric vehicle, sensors in automobiles, engine management system. (10)

DESIGN OF TRANSMISSION ELEMENTS AND BRAKES : Design of single and multi-plate clutches, diaphragm clutch, cone clutch and centrifugal clutch; Design of gear box and drive lines; Concepts of variable transmission systems; Design of power train for vibration; Brakes: Brake power requirements, design of drum and disc brakes, principles of regenerative and anti-lock braking systems. (8)

DESIGN OF STEERING AND SUSPENSION SYSTEMS : Design of steering systems, power assisted steering; Suspension systems: Classification of suspension, design of springs – coil springs, leaf springs, air springs; Design of steering and suspension systems for vibration. (7)

DESIGN OF FRONT AND REAR AXLES : Design of propeller shaft, design of final drive gearing, design of full floating, semi floating and three quarter floating rear shafts and rear axle housings, analysis of loads-moments and stresses at different sections of front axle, determination of optimum dimensions and proportions for steering linkages, design of front axle beam. (10)

AUTOMOTIVE BODY DESIGN : Automotive body structural elements: Design of automotive beam sections, torsion of thin-wall members, thin-wall beam section design in automobiles, buckling of thin-walled members, design for body bending and body torsion- strength and stiffness requirements. (10)

Total L: 45

TEXT BOOKS:

1. Giancarlo Genta, Lorenzo Morello , "The Automotive Chassis Volume 1, Components Design", 1st Edition, Springer International Edition, US, 2014.
2. Donald E. Malen , "Fundamentals of Automobile Body Structure Design", 1st Edition, SAE International, US, 2011.

REFERENCES:

1. Heinz Heisler , "Vehicle and Engine Technology", 2nd Edition, SAE International, 2011.
2. Smith J.H , "An Introduction to Modern Vehicle Design", Anniversary edition, Butterworth-Heinemann, US, 2002.
3. Robert C. Juvinall and Kurt M. Marshek , "Fundamentals of Machine Component Design", 6th Edition, Wiley, 2017.
4. Wolfgang Matschinsky , "Road Vehicle Suspensions", 1st Edition, Wiley, US, 1997.

19M013 AUTOMOBILE ENGINEERING

3 0 0 3

AUTOMOBILE ARCHITECTURE AND PERFORMANCE : Automobile: Definition, overview, subsystems of automobile; Frame: Functions of frame, types; Body: Terminology, types; Engine location and drive system, vehicle performance: Traction, resistance to vehicle motion, solving of simple problems. (9)

ENGINE ARCHITECTURE AND FUEL INJECTION : Types of engine: Multi-valve engine, in-line engine, vee-engine; Fuel Injection: Comparison of carburetor and fuel injection system, MPFI, CRDI, GDI; Supercharger and turbocharger; Hybrid vehicle. (9)

TRANSMISSION SYSTEMS : Clutch: Single plate clutch, multiplate clutch; Gear box: Sliding mesh, constant mesh and synchromesh gear box; Overdrive, automatic transmission, differential, hydraulic coupling, rear axle arrangement. (9)

STEERING AND SUSPENSION SYSTEM : Steering principle: Ackerman and Davis steering mechanisms; Wheel geometry: Caster, camber, toe-in and toe-out; Power steering; Suspension system: Rigid axle, independent suspension system, stabilizer bar, damper, air suspension system. (9)

WHEELS AND BRAKES : Wheel construction: Disc and wired wheel; Tyre: Belted bias, radial bias, tubeless tyre; Brake construction: Drum and disc brakes; Brake operating system: Hydraulic and air brakes; Antilock braking system; Stopping distance. (9)

Total L: 45

TEXT BOOKS:

1. Gupta R B , "Automobile Engineering", 1st Edition, Satya Prakashan Publishers, New Delhi, 2016.
2. Kirpal Singh , "Automobile Engineering Vol I and II", 13th Edition, Standard Publishers, New Delhi, 2017.

REFERENCES:

1. Julian Happian Smith , "An Introduction to Modern Vehicle Design", 1st Edition, Butterworth-Heinemann, US, 2001.
2. William Crouse, Donald Anglin , "Automotive Mechanics", 10th Edition, McGraw Hill Education, US, 2017.
3. Heinz Heisler , "Vehicle and Engine Technology", 2nd Edition, SAE International, 1998.
4. Giri N K , "Automobile Mechanics", 8th Edition, Khanna Publishers, India, 2008.

19M026 MANUFACTURE AND INSPECTION OF GEARS

3 0 0 3

PRODUCTION OF CYLINDRICAL GEARS : Types of cylindrical gears and applications, blank preparation, overview of gear production methods, procedure for cutting gears and attainable quality in hobbing and gear shaping, cutter selection, work holding methods and setting calculations; Rack type gear shaping machine-description and applications; Internal gear cutting methods, CNC gear hobbing and gear shaping machines; Gear skiving: concept, cutting process and applications. (9)

PRODUCTION OF CONICAL GEARS : Types of conical gears and applications; Production methods for straight bevel gears: Bevel gear generator, Duplex rotary cutter method; Production methods for spiral bevel and hypoid bevel gears: Gleason spiral bevel generator, Klingelnberg method, machine description, cutter and machine setting. (9)

GEAR MATERIAL SELECTION AND HARDENING METHODS : Properties of gear materials; Non-metallic, non-ferrous and plastic gears; Selection of material for power transmission and high speed applications; Selection of materials for worm

and wheel; Hardening methods: Through hardening, case hardening; Carburizing-liquid and gas carburizing, low pressure carburizing; High pressure quenching, nitriding, induction hardening, flame hardening; Hardening defects. (9)

GEAR FINISHING AND INSPECTION : Gear finishing: Advantages, finishing of gears by grinding, shaving, lapping and honing methods-process, machine, cutters and setting of process parameters; Gear inspection: Types of error in gears, gear quality standards and allowable limits, tooth thickness and base tangent length measurement, pitch error, radial run out, involute profile error, composite error measurement; Computerized gear inspection; Gear failure reasons and remedies. (9)

MASS PRODUCTION METHODS AND PRODUCTION SYSTEMS : Mass production methods: Gear production by stamping, die casting, powder metallurgy process, injection and compression moulding of plastic gears, cold and hot rolling, gear broaching; Gear production systems: Batch production, gear production cells, lean and agile production practices; Automobile gear and gear boxes; Production of heavy engineering gears. (9)

Total L: 45

TEXT BOOKS:

1. Watson , "Modern Gear Production", 1st Edition, Pergamon Press, US, 1984.
2. HMT , "Production Technology", 1st Edition, Tata McGraw Hill, 2001.

REFERENCES:

1. SAE , "Gear Design Manufacturing Inspection Manual", SAE, 1990.
2. Weck M. , "Hand Book of Machine Tools", Technology & Sons, 1984.
3. Faydor L. Litvin, Alfonso Fuentes-Aznar, Ignacio González-Perez, , Kenichi Hayasaka , "Noncircular Gears: Design and Generation", Cambridge University Press, 2009.

19M027 PNEUMATIC AND HYDRAULIC SYSTEMS

3 0 0 3

FUNDAMENTALS OF FLUID POWER SYSTEMS : Concepts of fluid power, properties of hydraulic fluid and air, comparison between hydraulics and pneumatics; Actuators: Types and constructional details; Pressure, flow and directional control valves: Types and constructional details. (9)

PNEUMATIC SYSTEM DESIGN : Design of sequential multi-actuator circuits: Intuitive, cascade and step counter methods; Integration of start selection, start restriction and emergency stop modules. (9)

ELECTRO-PNEUMATICS AND PROGRAMMABLE LOGIC CONTROLLERS (PLC) : Electro-pneumatic circuit design using Karnough Veitch map method; PLC: Construction, programming methods, timers and counters; Programming using ladder logic diagrams. (9)

HYDRAULIC SYSTEM DESIGN AND TYPICAL INDUSTRIAL APPLICATIONS : Sizing and selection of power pack elements, conduits, actuators, valves and accumulators; Heat generation and estimation of losses; Industrial reliability and noise control; Deceleration circuit, regenerative circuits, high-low circuits, sequencing circuits, synchronizing circuits and fail-safe circuits. (10)

ADVANCEMENTS IN FLUID POWER ENGINEERING : Servo and proportional valves: Construction, types and applications; Overview of hydro pneumatics; Industrial internet of things for monitoring, control and diagnostics of systems for fluid power applications. (8)

Total L: 45

TEXT BOOKS:

1. Anthony Esposito, " Fluid Power with Application", 7th Edition, Pearson Education, 2013.
2. Srinivasan R , "Hydraulic and Pneumatic Controls", 2nd Edition, Vijay Nicole Imprints Pvt. Ltd, New Delhi, 2010.

REFERENCES:

1. Majumdar, S.R, "Oil Hydraulic Systems: Principles and Maintenance", 28th Edition, McGraw-Hill, 2017.
2. Werner Deppert, Kurt Stoll , "Pneumatic Controls : An Introduction to Principles", Vogel-Druck Wurzburg, 1975.
3. Peter Rohner , "Fluid Power Logic Circuit Design – Analysis, Design Method and Worked Examples", Macmillan Press, 1979.

19M028 NON-TRADITIONAL MACHINING

3 0 0 3

MECHANICAL ENERGY BASED MACHINING PROCESSES : Overview of Non-Traditional Machining (NTM): Need, comparison between traditional and non-traditional machining, classification, performance constraints and selection of NTM process; Ultrasonic machining: Mechanics of machining and working principle; Abrasive jet, water jet and abrasive water jet machining, modeling of mixing process of abrasives and water jet; Process parameters, process capabilities, material removal rate; Limitations and applications. (10)

THERMAL ENERGY BASED MACHINING PROCESSES : Laser beam machining: Types of lasers, laser characteristics, working principle; Plasma arc machining: Working principle, various plasma arc torches, comparison with oxy fuel cutting; Electron beam machining: Working principle, electron beam gun, vacuum systems; Components of system and their functions, process parameters, process capabilities; Limitations and applications. (8)

ELECTRICAL ENERGY BASED MACHINING PROCESSES : Electrical discharge machining (EDM): Working principle, dielectric fluid flushing techniques, material removal rate; Electrical discharge wire cutting; Focused ion beam machining: Working Principle, machining system; Process parameters; Limitations and applications. (9)

CHEMICAL AND ELECTRO-CHEMICAL ENERGY BASED MACHINING PROCESSES AND HYBRID PROCESSES : Chemical machining and Electro chemical machining (ECM): Working principle, components and their functions, process parameters, material removal rate; Hybrid processes: Electro chemical and electro chemical discharge grinding, vibration assisted EDM, ultrasonic assisted ECM and wire electrical discharge grinding; Limitations and applications. (9)

MICROMACHINING PROCESSES : Abrasive jet micromachining, electrochemical micromachining, electrical discharge micromachining; Micro finishing processes: Abrasive flow finishing, magnetic abrasive finishing, magnetorheological abrasive flow finishing; Applications. (9)

Total L: 45

TEXT BOOKS:

1. Jain V K , "Advanced Machining Processes", 2nd Edition, Allied Publishing Pvt. Ltd., 2007.
2. Pandey P C , "Modern Machining Processes", Tata McGraw Hill Education Pvt. Ltd., 2012.

REFERENCES:

1. Gary F Benidict , "Non Traditional Manufacturing Process", 1st Edition, CRC Press, 2019.
2. Hong Hocheng , "Advanced Analysis of Nontraditional Machining", Kindle Edition, 2013.
3. Hassan Abdel and Gaward El-Hofy , "Advanced Machining Processes", McGraw Hill Publications, 2005.
4. Carl Sommer , "Non-traditional Machining Handbook", 2nd Edition, Advance Publishing Inc, Texas, 2009.

19M029 ADDITIVE MANUFACTURING

3 0 0 3

CONCEPTS AND CLASSIFICATION OF AM : Definition, terminology, generic AM process chain, difference between AM and subtractive processes; Application levels: Direct and indirect processes; New AM classification scheme, development of AM technology. (8)

AM PROCESSES FOR POLYMERS : Vat photopolymerization processes: Vector scan, mask projection, two-photon approach, materials, scan patterns; Sheet lamination processes: Bond-Then-Form processes, Form-Then-Bond processes, materials; Fused deposition modeling: Process parameters, influence of process parameters on mechanical properties of the prototype. (10)

METAL ADDITIVE MANUFACTURING : Ultrasonic additive manufacturing: Working principle, process parameters, microstructures and mechanical properties; Powder bed fusion processes: Electron beam melting, selective laser melting, selective laser sintering, binder jetting process for metals; Directed energy deposition processes (DED): Laser-based and electron beam-based DED processes, process parameters, materials and microstructures. (10)

AM PROCESS SELECTION AND APPLICATIONS: Selection methods for a part: Decision theory, approaches to determining feasibility, challenges in selection; Applications: Automotive industries, aerospace industries, foundry and casting technologies, mold and die making applications, medical applications. (8)

POST-PROCESSING AND SOFTWARE FOR AM : Post-processing: Support material removal, surface texture improvements, aesthetic improvements, property enhancement using thermal and non-thermal techniques; Design for additive manufacturing; Software for AM and case studies using AM software. (9)

Total L: 45

TEXT BOOKS:

1. Ian Gibson, David Rosen, Brent Stucker , "Additive Manufacturing Technologies: 3D Printing, Rapid Prototyping, and Direct Digital Manufacturing", 2nd Edition, Springer, 2014.
2. Andreas Gebhardt , "Understanding Additive Manufacturing: Rapid Prototyping, Rapid Tooling, Rapid Manufacturing", Hanser, 2012.

REFERENCES:

1. John O Milewski , "Additive Manufacturing of Metals: From Fundamental Technology to Rocket Nozzles, Medical Implants, and Custom Jewellery", Springer, 2017.
2. Pham D T and Dimov S S , "Rapid Manufacturing: The Technologies and Applications of Rapid Prototyping and Rapid Tooling", Springer Science & Business Media, 2012.
3. Chee Kai Chua, Kah Fai Leong, Chu Sing Lim , "Rapid Prototyping: Principles and Applications", World Scientific, 2010.
4. Srivatsan T S and Sudarshan T S , "Additive Manufacturing: Innovations, Advances, and Applications", CRC Press, 2015.

19M030 FLEXIBLE MANUFACTURING SYSTEMS

3 0 0 3

PRODUCTION SYSTEMS : Types of production: Job shop, batch and mass production; Functions in manufacturing; Plant layouts: Process, product, fixed position, cellular layouts; Automated production systems; Automation principles and strategies, automated assembly lines. (8)

FMS IMPLEMENTATION : Characteristics, types, equipments and its functions; Types of flexibility and performance measures; Planning phases, integration, system configuration; FMS layouts, simulation, FMS project development steps; Project management: Equipment development, host system development, functions of FMS host computer, FMS host and area controller function distribution, hardware and software development. (10)

GROUP TECHNOLOGY AND PROCESS PLANNING : Group technology: Formation of part families-part classification, coding system, OPITZ and multi class coding systems; Production flow analysis-machine cell design, clustering methods, modern algorithms, benefits of GT, system planning; Process planning- approaches to automated process planning, study of a typical process plan; Manufacturing planning and control. (10)

AUTOMATED MATERIAL HANDLING AND STORAGE : Automated material handling: Functions, types, analysis of material handling equipment; Design of conveyor and AGV systems; AS/RS; Storage: System performance, carousel storage system, WIP storage system; Interfacing material handling and storage with manufacturing. (8)

MODELING AND ANALYSIS OF FMS : Simulation and petrinet modeling techniques; Lean and agile manufacturing concepts: JIT, Kanban, Poke Yoke. (9)

Total L: 45

TEXT BOOKS:

1. Mikell P Groover , "Automation, Production Systems and Computer Integrated Manufacturing", 4th Edition, Pearson Education, US, 2016.
2. Parrish D J , "Flexible Manufacturing", Butter Worth Heinemann Ltd., Oxford, 1993.

REFERENCES:

1. Shivanand H K, Benal M M, Koti V , "Flexible Manufacturing System", 1st Edition, New Age International Pvt. Ltd., 2006.
2. Radhakrishnan P, Subramanyan S, Raju V , "CAD/CAM/CIM", 4th Edition, New Age International Pvt. Ltd., 2018.
3. Black J T , "The Design of the Factory with a Future", McGraw-Hill, 1991.
4. Joshi S B and Smith J S , "Computer Control of Flexible Manufacturing Systems", Springer, 2012.

19M031 ARTIFICIAL INTELLIGENCE AND DEEP LEARNING

3 0 0 3

INTELLIGENT AGENTS : Agents and environments; Structure of agents: Goal-based agents, utility-based agents; Problem-solving agents; Formulating problems; Infrastructure for search algorithms; Measuring problem-solving performance. (5)

SEARCH ALGORITHMS : General tree-search and graph-search algorithms; Uninformed search strategies: Breadth-first search, uniform-cost search, depth-first search, bidirectional search; Informed search strategies; Types: Greedy best-first search, A* search, graph-search algorithm; Case studies. (10)

META-HEURISTIC ALGORITHMS : Types: Genetic algorithms, simulated annealing, ant colony optimization, particle swarm optimization, bee algorithms; Case studies. (8)

MACHINE LEARNING TECHNIQUES : Supervised learning: Classification, support vector machines, linear discriminant analysis, naive bayes, k-nearest neighbor; Regression analysis; Unsupervised learning: k-Means clustering, hierarchical clustering; Case studies. (10)

DEEP LEARNING WITH NEURAL NETWORKS : Nodes and layers of neural network, training of single layer neural networks, training of multi-layer networks, architectures of deep networks, building deep networks; Case studies. (12)

Total L: 45

TEXT BOOKS:

1. OmidBozorg-Haddad, Mohammad Solgi, Hugo A. Loáiciga , "Meta-heuristic and Evolutionary Algorithms for Engineering Optimization", 1st Edition, Wiley, 2017.
2. Phil Kim , "MATLAB Deep Learning: With Machine Learning, Neural Networks and Artificial Intelligence", 1st Edition, Apres, 2017.

REFERENCES:

1. Josh Patterson , "Deep Learning: A Practitioner's Approach", 1st Edition, O'Reilly, 2017.
2. Stuart Russell, Peter Norvig , "Artificial Intelligence: A Modern Approach", 3rd Edition, Pearson Education Limited,

England, 2016.

3. Ethem Alpaydm , "Introduction to Machine Learning", MIT Press, 2014.

4. Peter Harrington , "Machine Learning in Action", Manning Publications Co, 2012.

19M032 SOLID STATE JOINING PROCESSES

3 0 0 3

OVERVIEW OF JOINING PROCESSES : Fundamental principles and classifications of fusion and solid-state joining processes, ultrasonic welding, ultrasonic spot welding, explosion welding process, Magnetically Impelled Arc Butt (MIAB) welding; Resistance welding processes: Spot welding, seam welding, projection welding, high-frequency resistance welding, resistance butt welding, flash butt welding; Brazing, adhesive bonding, clinching, self-pierce riveting. (8)

DIFFUSION JOINING PROCESSES : Principles and applications; Diffusion brazing, braze welding, diffusion welding; Diffusion bonding of metals to ceramics; Solid-state deposition welding processes; Pressure non-fusion welding processes: Cold welding, electromagnetic pulse welding, pressure gas welding, hot pressure welding, forge welding; Roll bonding. (7)

FRICION WELDING (FW) PROCESS : Process parameters, applications, metallurgical, mechanical and tribological characterizations; Spin welding, rotary drive FW , inertia welding, friction taper stitch welding, radial FW, friction plunge welding, third-body FW; Friction seam welding, linear and angular FW, orbital FW, friction brazing, friction stud welding; Study of friction welds and joint quality of FW. (10)

FRICION STIR WELDING : Fundamentals and taxonomy, materials; Heat generation, metallurgical and mechanical characterizations, inspection; Material flow, material change during solid-state joining and its impact, environmental and energy benefits, micro FSW and its applications; Friction stir riveting, friction stir spot welding (FSSW) - process parameters, hybrid FSW, underwater FSW, ultrasonic assisted FSW, and electrically assisted FSW; Friction stir diffusion welding, thermal stir welding; Weld defects; Friction stir processing and friction surfacing. (10)

TOOL MATERIALS AND INDUSTRIAL APPLICATIONS : FSW tools: Material selection, tool geometry, pin geometry, load bearing ability, tool wear, deformation and failure, tool cost; FSW of aluminum alloys, magnesium alloys, titanium, steels; Dissimilar metal FSW; Welding of plastics and welding of non-metals; Industrial applications: Shipbuilding, automotive, aerospace, railways and other industry sectors. (10)

Total L: 45

TEXT BOOKS:

- 1.R.S.Paramar , "Welding Processes and Technology", 3rd Edition, Khanna Publishers, New Delhi, 2010.
- 2.Daniela Lohwasser, Zhan Chen , "Friction Stir Welding From Basics To Applications", Woodhead Publishing, 2010.

REFERENCES:

- 1.Rajiv Sharan Mishra, ParthaSarathi De, Nilesh Kumar , "Friction Stir Welding and Processing: Science and Engineering", 1st Edition, Springer International Publishing, 2014.
- 2.Bekir Sami Yilbas, Ahmet Z. Sahin , "Friction Welding: Thermal and Metallurgical Characteristics", Springer Science, 2014.
- 3.P.Asadi, M.K. Besharati-Givi , "Advances in Friction-Stir Welding and Processing", Woodhead Publishing, 2014.
- 4.Nilesh Kumar, Rajiv S. Mishra, Wei Yuan , "Friction Stir Welding of Dissimilar Alloys and Materials", Elsevier, 2015.

19M033 INTERNET OF THINGS FOR MECHANICAL APPLICATIONS

3 0 0 3

CONCEPTS OF IOT : IoT: Characteristics, applications, enablers; Comparison between IoT, M2M, and WoT; IoT interdependence; IoT network configurations - comparison between IPv4 and IPv6; IoT components, interoperability, IoT challenges; Comparison between industrial IoT and IoT. (8)

DATA COLLECTION : Sensing: Sensors, transducers, sensor resolution, types of sensors; Actuation: Actuator, types of actuators; Communication protocols: 802.15.4, ZigBee, 6lowpan, RFID, NFC, Bluetooth, Z-wave; Embedded systems - Arduino, Raspberry Pi. (10)

DATA PROCESSING AND DATA HANDLING : Data processing: MQTT, MQTT components and methods; Data handling: Big data, types of data, flow of data; Cloud computing: Recent trends, service models, managing data in cloud. (9)

DATA ANALYTICS AND DATA SECURITY : Data analytics: Types, lifecycle- discovery, preparation, model planning, model building; Data collection; Streaming data analytics: hadoop, hive, hbase; Data security: Data protection, challenges. (9)

MECHANICAL APPLICATIONS : Manufacturing: Machine diagnostics and prognosis, robotics and autonomous vehicles and part tracing; Inventory and logistics: Route generation and scheduling, fleet tracking, shipment monitoring, remote vehicle diagnostics; Energy: Smart grids, waste management; Safety and security: Indoor air quality monitoring, noise level monitoring, smoke/gas detections, structural health monitoring. (9)

Total L: 45

TEXT BOOKS:

1. Alasdair Gilchrist , "Industry 4.0: The Industrial Internet of Things", 1st Edition, Apress, 2016.

2. Ulrich Sendler , "The Internet of Things: Industrie 4.0 Unleashed", 1st Edition, Springer, New York, 2019.

REFERENCES:

1. Sabina Jeschke, Christian Brecher, Houbing Song, Dana B. Rawat , "Industrial Internet of Things: Cyber- manufacturing Systems", Springer, 2016.
2. Dieter Uckelmann, Mark Harrison, Florian Michahelles , "Architecting the Internet of Things", Springer, New York, 2011.
3. Adrian McEwen, Hakim Cassimally, "Designing the Internet of Things", John Wiley and Sons Ltd, UK, 2014.
4. Thomas Er, Dr. Zaigham Mahmood, Professor Ricardo Puttini , "Cloud Computing: Concepts, Technology & Architecture", PHI, 2013.

19M034 PRODUCTION TOOLING

3 0 0 3

SINGLE POINT CUTTING TOOLS : Materials and their properties, classification, selection, insert and coated tools, tool wear and tool life; Recent developments in cutting tool technology; Nomenclature, types and styles, design and manufacture of HSS and carbide insert type tools for turning, boring, shaping, planning and slotting operations; Design of form tools; Tools and holders for CNC applications. (8)

MULTIPOINT CUTTING TOOLS : Nomenclature, classification and selection, construction methods, cutter setting, design and manufacture of drills, reamers, milling cutters, broaches and gear hobs; Grinding-wheel specification and selection. (8)

JIGS AND FIXTURES : Degrees of freedom, principles of location and clamping, principles of jig design, fool proofing, elements of jigs, classification of jigs, design of jigs for drilling and reaming; Principles of fixture design, locators and different types of clamps, elements of fixtures, provision for tool setting, design of fixtures for milling, turning, boring and grinding operations; Fixtures for turning centers and machining centers; Modular fixturing-concepts and applications. (10)

PRESS TOOLS : Design of sheet metal press tool parts, Design and manufacture of die sets for sheet metal components-Simple, compound and progressive dies for punching and blanking operations; Dies for drawing and bending operations; Selection of press tools. (10)

DESIGN OF DIE CASTING DIES , INJECTION MOULDING DIES AND LIMIT GAUGES : Product and mould, thermal considerations, design of two plate mould, runner and gate design, mould cooling and ejection; Overview of shrinkage and warpage analysis; Design of plug, ring and snap gauges. (9)

Total L: 45

TEXT BOOKS:

1. Donaldson.C, and LeCain.C.H , "Tool Design", Tata McGraw Hill Publishing Company Limited, New Delhi, 2012.
2. Bhattacharyya.A , "Metal Cutting Theory and Practice", New Central Books Agency (P) Limited, Calcutta, 2012.

REFERENCES:

1. Arshinov.V, Alekseev.G , "Metal cutting Theory and Cutting Tool Design", MIR Publishers, Moscow, 1976.
2. Kempster , "Introduction to Jig and Tool Design", VIVABooks, New Delhi, 1998.
3. Cracknell.P.C, Dyson.R.W , "Handbook of Thermoplastics Injection Mould Design", Chapman and Hall, 1993.
4. Paquin.J.R, Crowley , "Die Design Fundamentals", Industrial Press, Newyork, 2006.

19M051 LEAN MANUFACTURING

3 0 0 3

LEAN MANUFACTURING CONCEPTS : Origins and objectives of lean manufacturing : Ford and Toyota production systems, lean process, 3M concept, key principles and implications; Characteristics of traditional manufacturing and lean manufacturing, lean building blocks, road map for lean implementation, lean benefits, value creation and waste elimination, seven types of waste; Pull production : Models, kanban, continuous flow, single piece flow, kaizen. (9)

GROUP TECHNOLOGY AND CELLULAR LAYOUT : Part families, production flow analysis, composite part concept, machine cell design, quantitative analysis, case studies. (9)

VALUE STREAM MAPPING : Value stream, benefits, mapping process; Current state map, mapping icons, mapping steps, takt time calculations; VSMcase studies. (8)

LEAN MANUFACTURING TOOLS AND METHODOLOGIES : Standardized work, standard work sequence, timing and work in progress; Quality at source, autonomation / Jidoka, visual management system, mistake proofing / Poka-yoke; 5S technique: Elements and waste elimination through 5S, advantages and benefits, 5S audit; Visual control aids for improvement. (10)

TOTAL PRODUCTIVE MAINTENANCE : Goals and benefits, hidden factory, the six big losses, types of maintenance, overall equipment effectiveness, pillars of TPM and implementation; Changeover and setup time reduction techniques, temple of quality, OEE calculations. (9)

Total L: 45

TEXT BOOKS:

1. Micheal Wader , "Lean Tools: A Pocket guide to Implementing Lean Practices", 2nd Edition, Productivity and Quality Publishing, 2013.
2. Lonnie Wilson , "How to Implement Lean Manufacturing", 2nd Edition, McGraw Hill Education, 2015.

REFERENCES:

1. Gopalakrishnan N , "Simplified Lean Manufacture : Elements, Rules, Tools and Implementation", PHI Learning Pvt Ltd, 2012.
2. Taiichi Ohhno , "Toyota Production Systems; Beyond Large Scale Production", Productivity Press, 1992.
3. S R Devadasan, V. Sivakumar , "Lean and Agile Manufacturing; Theoretical, Practical and Research Futurities", PHI, 2012.
4. Askin R G, Goldberg J B , "Design and Analysis of Lean Production Systems", John Wiley and Sons, 2007.

19M052 SUPPLY CHAIN MANAGEMENT

3 0 0 3

SUPPLY CHAIN NETWORK DESIGN : Definition, global optimization, objectives of SCM, drivers of supply chain; Logistics networks : Data collection, model and data evaluation, solution techniques. (8)

INVENTORY MANAGEMENT AND FORECASTING : Introduction to inventory and multi order opportunities, inventory policy; Periodic review, continuous review, effect of demand uncertainty; Risk pooling, centralized and decentralized system, managing inventory in the supply chain; Forecasting: Role of forecasting in a supply chain, risk management in forecasting; Case studies. (10)

SIGNIFICANCE OF INFORMATION IN SC : Bullwhip effect, information and supply chain technology; Supply chain integration: Push, pull and push-pull systems; Demand driven strategies, impact of internet on SCM, distribution strategies. (9)

STRATEGIC ALLIANCES AND SUSTAINABILITY IN SUPPLY CHAIN : Framework for strategic alliance, third party logistics, retailer - supplier partnership, distributor- integration, procurement and out sourcing strategies, role of sustainability in a supply chain, key pillars of sustainability, closed-loop supply chain. (9)

INFORMATION TECHNOLOGY IN GLOBAL SCM : Role of IT in supply chain, IT framework, internal supply chain management, supplier relationship management, future of IT in the supply chain, risk management in IT, supply chain IT in practice, DSS for supply chain management; Overview of application of block chain and IoT in supply chain. (9)

Total L: 45

TEXT BOOKS:

1. Simchi – Levi Davi, Kaminsky Philip and Simchi-Levi , "Designing and Managing the Supply Chain Concepts Strategies and Case Studies", 3rd Edition, McGraw-Hill Education, US, 2017.
2. Sunil Chopra, Peter Meindl and DharamVirKalra , "Supply Chain Management: Strategy, Planning, and Operation", 3rd Edition, Pearson, New Delhi, 2017.

REFERENCES:

1. Erik Hofmann, Nicola Bosia and Urs Magnus Strewe , "Supply Chain Finance and Blockchain Technology -The Case of Reverse Securitisation", Springer International Publishing AG, 2018.
2. Roberta S Russell, Bernard W Taylor III , "Operations and Supply Chain Management", Wiley India pvt Ltd, 2017.
3. Jay Heizer, Barry Render, Chuck Munson , "Operations Management: Sustainability and Supply Chain Management", Pearson, 2017.
4. Hsiao Fan Wang, Surendra M Gupta , "Green Supply Chain Management: Product Life Cycle Approach", Mc Graw hill, 2011.

19M053 QUALITY ENGINEERING

3 0 0 3

CONCEPT OF QUALITY ENGINEERING : Quality value and engineering, overall quality system, quality engineering in product design, quality engineering in design of production processes, quality engineering in production, quality engineering in service. (8)

LOSS FUNCTION : Loss function for products and system - derivation, improvements and justification, loss function and inspection, quality evaluations and tolerances; Types of tolerances - S type, L type. (8)

ON-LINE QUALITY CONTROL : Online feedback quality control : Variable characteristics, control with measurement interval, one unit, multiple units control systems - lot and batch production; Online process parameter control : Variable

characteristics, tolerances, feedback control systems, measurement error. (10)

QUALITY ATTRIBUTES AND PROCESS IMPROVEMENT METHODS : Checking intervals, frequency of process diagnosis; Production process improvement method, process diagnosis improvement method; Process adjustment and recovery improvement methods. (10)

PREVENTIVE MAINTENANCE : Preventive maintenance schedule: Functional characteristics , large scale systems; Quality tools, fault tree analysis, event tree analysis, failure mode and effect analysis quality systems. (9)

Total L: 45

TEXT BOOKS:

1. De Feo J A and Barnard W W , "Six Sigma: Breakthrough and Beyond", 1st Edition, Tata McGraw-Hill, US,2005.
2. Pyzdek T and Berger R W . , "Quality Engineering Handbook", 2nd Edition, Tata-McGraw Hill, 2000.

REFERENCES:

1. Kaniska Bedi , "Quality Management", Oxford University Press, 2007.
2. Brue G , "Six Sigma for Managers", 2nd Edition, Tata-McGraw Hill, 2002.
3. Taguchi G, Elsayed E A and Hsiang., T.C , "Quality Engineering in Production Systems", 1st Edition, Mc-Graw- Hill, 1989.
4. Dale. H. Besterfield , "Total Quality Management", 4th Edition, Pearson Publications, 2017.

19M054 ENGINEERING ECONOMICS

3 0 0 3

INTEREST AND TIME VALUE OF MONEY : Reasons for interest, simple interest, compound interest, time-value equivalence, compound interest factors, nominal and effective interest rates, use of interest tables, continuous compounding, calculation of time-value equivalents for single and multiple-payment cash flows involving uniform continuous payment and uniform gradient. (10)

COMPARISON OF ALTERNATIVES : Present worth comparisons: Situations for present-worth comparisons - equal, unequal lived assets, study period, assets with infinite life, bond valuation; Equivalent uniform annual-worth comparison method: Situations for EUAC, asset life, unequal life, perpetual life, sinking fund; Rate of return comparisons: IRR, MARR. (10)

REPLACEMENT ANALYSIS : Items deteriorating with time and items that fail completely, replacement with and without time value of money, replacement policy for new and old machines with infinite horizon, group replacement. (8)

DEPRECIATION AND BREAK-EVEN ANALYSIS : Depreciation: Reasons, depreciation methods; Break-even analysis: Cost and competitiveness, breakeven comparisons, breakeven charts, linear and non-linear breakeven analysis, breakeven analysis with time value of money, multi product breakeven analysis. (9)

PROJECT FEASIBILITY AND RISK ANALYSIS : Project feasibility: Marketing, technical, financial feasibilities; Risk analysis: Risk, decision trees, formulation of discounted decision trees. (8)

Total L: 45

TEXT BOOKS:

1. James L Riggs, David D Bedworth, Sabah U Randhawa , "Engineering Economics", 4th Edition, Tata McGraw Hill, New Delhi, 2017.
2. Prasanna Chandra , "Projects", 9th Edition, Tata McGraw Hill, New Delhi, 2002.

REFERENCES:

1. Chan S Park , "Contemporary Engineering Economics", 5th Edition, Pearson, Chennai, 2015.
2. Leland Blank, Anthony Tarquin , "Engineering Economy", 7th Edition, Tata McGraw Hill, New Delhi, 2013.
3. William G Sullivan, Elin M Wicks, Patrick Koelling C , "Engineering Economy", 14th Edition, Pearson, New Delhi, 2011.
4. Gerald Thuesen J, Fabrycky W J , "Engineering Economy", 9th Edition, Prentice Hall, New Delhi, 2002.

19M055 ENTERPRISE RESOURCE PLANNING

3 0 0 3

MRP AND INTRODUCTION TO ERP : Introduction - overview of MRP I and MRP II, capacity requirements planning, history of ERP, evolution of ERP, comparison of ERP with traditional systems, benefits of ERP, need for ERP, overview of modules in ERP. (8)

ERP IMPLEMENTATION: Traditional approach to information system design, new approach to system development; ERP implementation : Requirement analysis, alternatives, life cycle, implementation methodology; Selection of an ERP package for suitability for manufacturing, hidden costs; Case studies. (10)

BUSINESS MODULES IN ERP : Accounts, production planning, human resources, plant maintenance, materials management, quality management, sales and distribution, ware house and supply chain; Case studies. (10)

ERP MARKET : Market place, dynamics, SAP R3 , Oracle, JD Edwards, QAD Inc, SSA Global; Open source ERP software: OODO, ERP Next, cloud computing with ERP, SAP HANA. (9)

ERP CASE STUDIES : HRM, finance and costing, production planning, materials management, sales and distribution, integration of modules. (8)

Total L: 45

TEXT BOOKS:

1. Alexis Leon , "ERP Demystified", 2nd Edition, Tata McGraw Hill, India,2008.
2. Mary Sumner , "Enterprise Resource Planning", 2nd Edition, Pearson Education, 2007.

REFERENCES:

1. Jim Mazzullo , "SAP R/3 for Everyone", 1st Edition, Pearson, 2007.
2. Jose Antonio Fernandz , "The SAP R /3 Handbook", 1st Edition, Tata McGraw Hill, India, 1998.
3. Biao Fu , "SAP BW: A Step-by-Step Guide", 1st Edition, Pearson Education, 2004.
4. David L OLSON , "Managerial Issues of ERP Systems", 1st Edition, Tata-McGraw Hill, India,2004.

19M056 SIX SIGMA IN MANUFACTURE AND SERVICE

3 0 0 3

FOUNDATION PHASE : Six sigma: Definition, need, laws , types - DMAIC vs. DMADV; Six sigma as strategic initiative, internal communication strategy and tactics, formal launch, organizational structure, training plan, project selection, selection of team members, team stages, roadmap for implementation, common pitfalls. (9)

DEFINE PHASE: Meaning and purpose, types of customers, problem identification, voice of customer, collect VOC data, CTQ, applications of seven QC tools, SIPOC, QFD, project charter. (8)

MEASURE PHASE : Meaning and purpose, types of measures, types of data, data collection; Quality cost, cost of poor quality; Measure tools- measurement system analysis, process capability calculations. (9)

ANALYSE PHASE : Meaning and purpose, process analysis, statistical testing for normal data, failure mode and effects analysis, root cause analysis, case studies. (9)

IMPROVE AND CONTROL PHASE : Meaning and purpose, process redesign, methods of generating improvement alternatives, TRIZ, pilot experiments, Taguchi DOE, cost benefit analysis, implementation plan; Control phase: Meaning and purpose, selection of control charts – visual controls, control plan, process score card. (10)

Total L: 45

TEXT BOOKS:

1. Betsi Harris Ehrlich , "Transactional Six Sigma and Lean Servicing", 1st Edition, St. Lucia Press, US,2002.
2. Jay Arthur , "Lean Six Sigma – Demystified", 2nd Edition, Tata McGraw Hill Companies Inc, 2017.

REFERENCES:

1. Daniel J. Zrymiak, Govindarajan Ramu, Roderick A. Munro , "The Certified Six Sigma Green Belt Handbook", 2nd Edition, 2015.
2. Donald W Benbow and Kubiak T M , "Certified Six Sigma Black Belt Handbook", 2nd Edition, Pearson Education, 2013.
3. Michael L George , "Lean Six Sigma for Service", McGraw-Hill Education, 2003.
4. Joseph Defeo , "Juran's Quality Handbook", 6th Edition, McGraw Hill Education,2010.

19M057 STATISTICAL PROCESS ANALYSIS AND OPTIMIZATION

3 0 0 3

STATISTICAL PROCESS CONTROL : Definition of quality and its evolution, causes of variation in quality, statistics and parameters, variables and attributes, frequency distribution, histogram; Construction and interpretation, use of software; Statistical basis of control chart, anatomy of control charts, selection and implementation of control charts, control charts for variables and attributes, simple case studies on applications of various types of control charts, use of software. (10)

PROCESS CAPABILITY ANALYSIS: Process capability: Definition, assumptions, metrics, methodology of process capability assessment, case studies, use of software. (8)

REGRESSION : Definition and need, simple linear probabilistic model, assumptions, method of least squares, ANOVA for linear regression, coefficient of determination, multiple regression, general linear model and assumptions; ANOVA for multiple regression, interpretation of results, polynomial regression, limitations of regression, simple applications, use of software.

(9)

EXPERIMENTAL DESIGN : Classical design of experiments, single factor and multi-factor experiments, analysis of experimental results; Taguchi design of experiments - phases, analysis and interpretation; Case studies, use of software. (9)

RESPONSE SURFACE METHODOLOGY : Response surfaces, two-level factorial designs, addition of centre points, method of steepest ascent, central composite and Box-Behnken designs, analysis of first order response surface; Case studies, use of software. (9)

Total L: 45

TEXT BOOKS:

1. Grant E M and Leavenworth R L , "Statistical Quality Control", 7th Edition, Tata McGraw Hill, New Delhi, 2010.
2. Hines W W, Montgomery D C, Goldsman D M and Borror C M , "Probability and Statistics in Engineering", 4th Edition, Wiley, US,2009.

REFERENCES:

1. Myers R H, Montgomery D C and Anderson-Cook , "Response Surface Methodology: Process and Product Optimization using Designed Experiments", 4th Edition, Wiley,2016.
2. Ross P J , "Taguchi Techniques for Quality Engineering", Tata McGraw Hill,2005.
3. Duncan A J , "Quality Control and Industrial Statistics", Irwin, 1986.
4. Davies O L , "Design and Analysis of Industrial Experiments", Oliver and Boyd,1978.

19M058 VALUE ANALYSIS AND VALUE ENGINEERING

3 0 0 3

CONCEPTS OF VA AND VE : Meaning and purpose, historical background, status of VE in India, types of values; Function: Types, function identification on product, feature function matrix, function analysis; Cost: Elements of costs, calculation of costs, cost allocation to function, examples. (8)

WORTH ANALYSIS : Meaning and importance of worth, evaluation of worth, determining worth, guide lines to find worth, case studies; Team dynamics: Structure, team transformation, interpersonal relationship. (8)

GENERAL VE TOOLS : Brainstorming, Gordon technique, feasibility ranking, morphological analysis, ABC analysis, probabilistic approach, make or buy decision, case studies. (9)

SPECIAL TECHNIQUES : Function cost, worth analysis, function analysis system techniques, technically oriented FAST, customer oriented FAST, weighted evaluation method, forced decision technique, quantitative method, predetermined minimum method, evaluation matrix, break even analysis, life cycle cost, case studies. (10)

VE JOB PLAN : Orientation phase- ABC analysis, information phase - observation checklist, function phase - function cost worth analysis, creative and evaluation phase - evaluation of alternatives, cost benefit analysis, recommendation phase and implementation phase - recommendation plan, audit phase - operational audit, financial audit, applications of VE Job Plan; Case studies. (10)

Total L: 45

TEXT BOOKS:

1. R G Chaudhari , "Techniques of Training in Value Engineering - Trainers Manual", 2nd Edition, Notion Press Inc, 2018.
2. Mukhophadhya A K , "Value Engineering", 1st Edition, Sage Publications Pvt. Ltd, New Delhi, 2003.

REFERENCES:

1. Richard J Park , "Value Engineering – A plan for inventions", St.Lucie Press, London, 1998.
2. Kassa Abate O , "Value Analysis and Engineering Reengineered", Taylor & Francis Inc, 2015.
3. Larry W Zimmelman. P E , "Value Engineering-A Practical approach for owners designers and contractors", CBS Publishers, New Delhi, 1992.
4. Del Younker , "Value Engineering Analysis and Methodology", 1st Edition, CRC Press, 2003.

19M076 COMPUTATIONAL FLUID DYNAMICS

3 0 0 3

GOVERNING EQUATIONS OF FLUID FLOW AND HEAT TRANSFER : Derivation of governing equations of fluid flow: Conservation of mass, momentum and energy, relationship between mathematical terms and characteristics of fluid flow; Mathematical classification of flow: Hyperbolic, parabolic, elliptic and mixed flow. (9)

DISCRETIZATION SCHEMES AND METHODS OF FLUID FLOW ANALYSIS : Choice of grid, finite difference method, finite volume method, forward, backward and central difference schemes, explicit and implicit methods, properties of numerical solution methods, stability analysis, error estimation. (9)

SOLUTION TECHNIQUES IN CFD ANALYSIS : Impact of non-conservation terms over the solution, artificial viscosity, up-

wind schemes, cell Reynolds number, Courant number, Lax Wendroff technique, MacCormack's technique, relaxation technique, ADI technique. (9)

CFD ANALYSIS OF INCOMPRESSIBLE FLOWS : Checker board distribution, staggered grid, pressure correction technique, SIMPLE algorithm. (9)

APPLICATIONS : 2D steady and unsteady heat transfer and fluid flow problems. (9)

Total L: 45

TEXT BOOKS:

1. John D Anderson , "Computational Fluid dynamics – The Basics with Applications", TATA McGraw Hill, 2016.
2. Versteeg H K, Malalasekara W , "An Introduction to Computational Fluid Dynamics - The Finite Volume Method", Longman, 2008.

REFERENCES:

1. Jiri Blazek , "Computational Fluid Dynamics: Principles and Applications", Butterworth-Heinemann, 2015.
2. Muralidhar K, Sundararajan T , "Computational Fluid Flow and Heat Transfer", Narosa Publications, 2014.
3. Chung T J , "Computational Fluid Dynamics", Cambridge University Press, 2010.
4. Joel Freziger H, Milovan Peric , "Computational Methods for Fluid Dynamics", Springer Publications, 2002.

19M077 REFRIGERATION AND AIR CONDITIONING

3 0 0 3

VAPOUR COMPRESSION REFRIGERATION : Creation of low temperature: Methods and application; Refrigerants: Properties , selection of refrigerants, alternative refrigerants; Aircraft refrigeration, single stage cycle, performance analysis for various operating conditions, use of P-h chart, multi stage cycle, multi compressor, multi evaporator and cascade system. (9)

VAPOUR ABSORPTION REFRIGERATION : Ammonia-water system, lithium bromide-water system, use of P-x-T and h-x-T chart, performance calculation, steam jet refrigeration and solar refrigeration systems. (9)

AIR CONDITIONING : Psychrometry for air conditioning processes, bypass factor, apparatus dew point, grand and room sensible heat factor, selection of inside and outside design conditions, effective temperature; Psychrometric calculation for cooling loads. (9)

DUCT DESIGN AND AIR DISTRIBUTION : Dynamic and frictional pressure drop in ducts, fan total pressure, methods of duct design, fan characteristics in duct systems, air conditioning systems control. (9)

BALANCING OF COMPONENTS : Condensers: Air cooled, water cooled and evaporative condensers and selection; Evaporator: Flooded, dry expansion, shell and tube and double pipe; Compressors: Reciprocating, rotary and centrifugal types, expansion devices; Cooling towers; Sensors used in R&AC systems. (9)

Total L: 45

TEXT BOOKS:

1. Stoecker W F, Jones J W , "Refrigeration and Air Conditioning", McGraw-Hill India, 2014.
2. Manohar Prasad , "Refrigeration and Air Conditioning", New Age International Publishers, 2011.

REFERENCES:

1. Arora C P , "Refrigeration and Airconditioning", Tata McGraw Hill, 2017.
2. Carter Stanfield, David Skaves , "Fundamentals of HVACR", Pearson, 2012.
3. Roy J Dossat, Thomas J Moran , "Principles of Refrigeration", Pearson, 2001.
4. Jones W P , "Air Conditioning Engineering", Butterworth-Heinemann, 2001.

19M078 RENEWABLE ENERGY

3 0 0 3

SOLAR ENERGY : Basic concepts on solar radiation, potential of solar energy; Solar collectors: Flat plate collectors, evacuated tubes, concentrators; Solar plant configurations, photovoltaic systems, environmental aspects of solar energy. (9)

WIND ENERGY : Principles of wind power, wind turbine operation, site characteristics, horizontal and vertical axis types, aerodynamics of wind turbine, performance analysis, design principles of wind turbine blades, tower design, small and large machines, storage systems. (9)

BIO-ENERGY : Concepts and systems, biomass production, energy plantations, biomass resources and processing, environmental factors; Pyrolysis, gasification and liquefaction, types of gasifiers; Bioconversion: Biogas, fermentation and wet processes; Biofuels: Manufacturing methods and properties. (9)

OCEAN ENERGY : Wave energy: Offshore and shoreline energy systems, tidal energy, types of OTEC power plants, design and performance evaluation. (9)

OTHER ENERGY SOURCES : Geothermal energy, magneto hydrodynamic system (MHD), thermionic and thermos- electric

generator, micro-hydel systems, hybrid systems and applications; Fuel cells: Classification, reactions and performance; Hydrogen production and storage methods. (9)

Total L: 45

TEXT BOOKS:

1. Aldo Vieira da Rosa , "Fundamentals of Renewable Energy Processes", 3rd Edition, Elsevier Academic Press, 2012.
2. Rai G D , "Non-Conventional Sources of Energy", 6th Edition, Khanna Publishers, New Delhi, 2017.

REFERENCES:

1. Bent Sorensen , "Renewable Energy", 5th Edition, Academic Press, 2017.
2. Kothari P, Singal K C, Rakesh Ranjan , "Renewable Energy Sources and Emerging Technologies", 2nd Edition, PHI Learning, 2011.
3. Sukhatme S P, Nayak J K , "Solar Energy - Principles of Thermal Collection and Storage", 3rd Edition, Tata McGraw Hill, 2009.
4. Abbasi S A, Naseema Abbasi , "Renewable Energy Sources and their Environmental Impact", Prentice-Hall of India, 2004.

19M079 SOLAR ENERGY CONVERSION SYSTEMS

3 0 0 3

SOLAR RADIATION: Solar constant, solar charts, sun path diagram, diffuse, global and direct solar radiation, pyranometer, pyrliometer, sunshine recorders, greenhouse effect. (7)

SOLAR COLLECTORS: : Classification: Air, liquid heating collectors, testing of flat plate collectors; concentrator collectors: classification, analysis of concentric tube collector, focusing solar concentrators, heliostats, parabolic and dish. (10)

PHOTO-VOLTAIC SYSTEMS : Physics, material and characteristics, cell arrays, circuits for output of solar panels, choppers, inverters, batteries, charge regulators, stand alone and off/on grids, hybrid systems, performance analysis and applications. (8)

APPLICATIONS: : Solar powered absorption air conditioning system, solar cooler, solar power station, water pump, chimney, dryer, dehumidifier, still, desalination, furnace, solar energy economics, performance analysis. (12)

SOLAR ENERGY STORAGE : Sensible heat, latent heat and thermo-chemical storage materials for phase change, solar ponds, economic analysis. (8)

Total L: 45

TEXT BOOKS:

1. Sukhatme S P, Nayak J P , "Solar Energy- Principles of Thermal Collection and Storage", TATA McGraw-hill, 2017.
2. Yogi Goswami D, Frank Kreith, Jan Kreider F , "Principles of Solar Engineering", Taylor & Francis, 2015.

REFERENCES:

1. Edward E Anderson , "Fundamentals for Solar Energy Conversion", Addison Wesley Publ. Co, 1983.
2. Duffie J A, Beckman W A , "Solar Engineering of Thermal Process", John Wiley, 2013..
3. Tiwari G N, Ghosal M K , "Fundamentals of Renewable Energy Sources", Narosa Publishing House,, 2007..
4. Shepherd W, Shepherd D W , "Energy Studies", Imperial College Press, 2014.

19M080 ENERGY CONSERVATION AND MANAGEMENT

3 0 0 3

ENERGY MANAGEMENT : Scope of energy audit, types of energy audit, energy audit methodology, role of energy managers; Energy management system (EnMS): ISO standards, implementing energy efficiency measures, detailed project report, energy monitoring and targeting, identification of energy conservation measures / technologies, economic and cost benefit analysis, energy service companies (ESCOS). (9)

MECHANICAL ENERGY SYSTEMS : Energy sources, classification, fuel supply and demand, energy conversion efficiencies; Mechanical energy conversion: Hydraulic, steam and gas turbines-performance characteristics and evaluation. (9)

ENERGY EFFICIENCY IN THERMAL UTILITIES : Steam engineering in thermal and cogeneration plants; Efficient utilization of steam: Piping, traps, flashing, condensate recovery, pinch analysis; Boiler: Losses and efficiency calculation methods, controls; Furnaces: Heat balance and efficiency calculations, energy conservation opportunities, insulation and refractories. (9)

ENERGY EFFICIENCY IN ELECTRICAL UTILITIES : Electrical system efficiency improvements: Motor, diesel generator, centrifugal pumps, fans, blowers, lighting systems; Air compressor: Line loss, leakage test, optimum pressure. (9)

PERFORMANCE ASSESSMENT : Industrial case studies: Assessment of energy generation/consumption in thermal station, steel industry, cement industry, textile industry. (9)

Total L: 45

TEXT BOOKS:

1. Alan P R, Beth P J , "Energy Management and Efficiency for the Process Industries", Wiley Publications,, 2015.
2. Abbi Y P, Shashank , "Handbook on Energy Audit and Environment Management", , The Energy and Resources Institute, 2009.

REFERENCES:

1. Donald R Wulfinghoff , "Energy Efficiency Manual", Energy Institute Press, 2011.
2. Bureau of Energy Efficiency , "Energy Manager Training Manual", Government of India, 2015.
3. Eastop T D, Croft D R , "Energy Efficiency for Engineers and Technologists", Logman Scientific and Technical, 1990.
4. Reay D A , "Industrial Energy Conservation", Pergamon Press, 1979.

19M081 ADVANCED HEAT AND MASS TRANSFER

3 0 0 3

CONDUCTION AND DIFFUSION : Review of steady state governing equations and boundary conditions; Transient conduction: Method of separation of variables, similarity variable method, Laplace transforms, Heisler charts, Green's functions and Duhamel's Theorem; Numerical methods: Implicit, explicit and Crank Nicholson methods, finite element method; Introduction to inverse heat conduction. (12)

CONVECTION HEAT AND MASS TRANSFER : Derivation of the full energy equation, boundary layer approximations for momentum, heat and mass transfer, similarity of boundary layers, momentum, heat and mass transfer analogy, Blasius similarity solution, Karman-Pohlhausen integral solution; Internal flow: Fully developed flow for constant heat flux and constant temperature boundary conditions, viscous dissipation and compressibility effects, developing flow, Graetz problem, free convection, heat transfer from vertical and horizontal surfaces, similarity solution. (15)

BOILING AND CONDENSATION : Pool boiling heat transfer, nucleate boiling and bubble growth, critical heat flux, film boiling and Leidenfrost point, convective boiling; Condensation: Film wise condensation and drop wise condensation, Nusselt model. (5)

DESIGN OF HEAT AND MASS TRANSFER EQUIPMENT : Selection and design of heat exchangers, cooling towers and scrubbers; Heat transfer enhancement methods. (4)

RADIATION HEAT TRANSFER : Rayleigh and Wien distribution, Planck's distribution, Stefan Boltzmann law and derivation; Spectral, total, hemispherical and directional emission; Irradiation, reflection, absorption and transmission; Emissive power, black body and grey body, radiation heat transfer between surfaces, shape factor, radiation shield; Introduction to gas radiation. (9)

Total L: 45

TEXT BOOKS:

1. K. Cole, J. V. Beck, A. Haji-Sheikh, B. Litjkouhi , "Heat Conduction using Green's Functions", CRC Press, 2011.
2. Schlichting H , "Boundary Layer Theory", Springer, Berlin, Heidelberg, 2017.

REFERENCES:

1. Frank M White , "Viscous Fluid Flow", McGraw-Hill Education, 2011.
2. Frank P Incropera David P Dewitt , "Fundamentals of Heat and Mass Transfer", Wiley India Private Limited, 2017.
3. Shah RK, Sekulic D , "Fundamental of Heat Exchanger Design", John Wiley, 2011.
4. Necati Ozisik M, "Heat Transfer: A Basic Approach", McGraw Hill, 1985.

19M082 ENERGY AND CLIMATE CHANGE

3 0 0 3

ENERGY AND ECONOMY : Energy production, consumption and economic growth, current energy scenario, trends in energy usage, peak oil, economics of non-renewable resources, energy balance, Sankey diagram, Fish-bone diagram. (9)

ENERGY AND ENVIRONMENT : Fossil fuels and carbon emissions, air pollution, global warming; Non carbondioxide GHGs , thermal pollution, environmental impact assessment, need for energy efficiency, energy paradox, energy, economy and environment interaction. (9)

CLIMATE CHANGE : Carbon emissions and greenhouse effect: Sources, trends, warming potential of gases, impacts of global warming, life cycle assessment of greenhouse gas emissions, climate change modeling and general circulation models, positive and negative feedback loops. (9)

CLIMATE CHANGE MITIGATION : Carbon neutral and carbon negative cycles, emission reduction and its impacts, carbon sequestration and geo-engineering technologies, solar radiation management (SRM), carbon dioxide removal (CDR), green energy concept. (9)

MITIGATION POLICIES : Kyoto protocol, UNFCCC, IPCC, geopolitics of GHG control, CDM and other emission trading mechanisms, relevance for India and developing countries. (9)

Total L: 45

TEXT BOOKS:

1. Wei-Yin Chen, Toshio Suzuki, Maximilian Lackner , "Handbook of Climate Change Mitigation and Adaptation", Springer, 2017.
2. Botkin D B, Keller E A, "Environment Science: Earth as a Living Planet", John Wiley & Sons Inc, 2014.

REFERENCES:

1. Philander S G , "Encyclopedia of Global Warming and Climate Change", SAGE Publications, 2012.
2. Bhattacharyya S C , "Energy Economics: Concepts, Issues, Markets and Governance", Springer, 2011.
3. Chris Martenson , "The Crash Course: The Unsustainable Future of Our Economy, Energy, and Environment", John Wiley & Sons, 2011.
4. Miller Jr G T , "Environmental Science: Working With the Earth", Wadsworth Publishing Company, 2005.

19M083 POWER PLANT ENGINEERING

3 0 0 3

CONVENTIONAL POWER PLANTS : Layouts of steam, diesel, hydroelectric, gas turbine and nuclear power plants; Hydroelectric power plant: Runoff river plants, pumped storage plants, underground stations; Hydel plant auxiliaries and plant operation; Nuclear power plant: Nuclear fuels, elements and types of nuclear reactor, radiation hazards, radioactive waste disposal. (9)

INDUSTRIAL POWER PLANTS : Gas and steam power cycles, super critical and ultra-super critical cycle, combined cycle, binary cycles, cogeneration, tri-generation. (9)

COMBUSTION AND HEAT RECOVERY EQUIPMENT : Types of combustion equipment, fuel and ash handling equipment, selection of fans; Emission control: Flue gas, particulate and gaseous emission; Draft: Forced, induced and balanced; Heat recovery equipment: Economizers, air preheaters and re-heaters, superheaters and de-superheaters. (9)

STEAM GENERATOR AND CONDENSER : Steam generators: Natural circulation, forced circulation, high pressure boilers and super critical boilers, fluidized bed boiler, boiler accessories and mountings, boiler testing, process flow diagram; Condensers: Types, design factors, air removal, performance calculation; Cooling towers: Natural and mechanical systems. (9)

RENEWABLE ENERGY SOURCES AND PLANT ECONOMICS : Concentrating collectors, photovoltaic cell, horizontal and vertical types of wind turbines, geothermal plants, tidal power plant, biomass and biogas plants, OTEC plants; Power plant economics: Plant load factor, utilization factor, tariff rates, demand charges, load distributions, energy conservation and audit. (9)

Total L: 45

TEXT BOOKS:

1. Nag P K , "Power Plant Engineering", Tata McGraw Hill, 2016.
2. El-Wakil MM , "Power Plant Technology", McGraw Hill Book Company Inc, 2017.

REFERENCES:

1. Rajput R K , "Power Plant Engineering", Laxmi Publications (p) Ltd, 2016.
2. Rudramoorthy R , "Thermal Engineering", Tata McGraw Hill, 2010.
3. Arora S C and Domkundwar S , "Power Plant Engineering", Dhanpat Rai and Sons, 2013.
4. Ashok V Desai , "Non-Conventional Energy", Wiley Eastern Limited, 2011.

19M084 ADVANCED FLUID DYNAMICS

3 0 0 3

FLUID MECHANICS AND KINETICS : Properties of fluids: Viscosity, compressibility, stress in a fluid and relation to pressure; Stability of floating and immersed bodies, Lagrangian and Eulerian analysis: Velocity field, stream lines, streak lines, path lines. (8)

INTEGRAL AND DIFFERENTIAL ANALYSIS : Control mass and control volume analysis; Integral and differential analysis, Reynolds transport theorem, material derivative, moving control volume; Conservation of mass, conservation of momentum, conservation of energy in integral and differential forms, Bernoulli's equation and restrictions. (8)

POTENTIAL FLOW : Bernoulli's equation for irrotational flow, velocity potential, stream function and stream lines, complex potential for a flow, Cauchy - Riemann conditions, basic potential flows, circulation, lift, drag, Blasius integral formula, superposition of potential flows, D'Alembert paradox, conformal mapping, Joukowski transformation, Schwarz-Christoffel transformation; Flow over cylinders and ellipses, basic aerofoil analysis. (12)

VISCOUS FLOW AND BOUNDARY LAYER THEORY : Viscous flow: Derivation of Navier-Stokes Equation, closed form solutions, Plane Poiseuille flow, Couette flow, Hagen-Poiseuille flow, boundary layer theory- Prandtl's boundary layer equations, Blasius solution, Karman-Pohlhausen integral momentum equation, boundary layer separation and

control; Stream lined and bluff bodies: Flow around circular bodies and aerofoils, calculation of lift and drag. (12)

INTRODUCTION TO TURBULENCE : Turbulence: Introduction, derivation of time averaged equations, turbulence models, simple analysis of the turbulent boundary layer velocity profile. (5)

Total L: 45

TEXT BOOKS:

1. Currie I G , "Fundamental Mechanics of Fluids", CRC Press, 2012.
2. Young D F, Okiishi T H, Munson B R , "Fundamentals of Fluid Mechanics", John Wiley & Sons, 2015.

REFERENCES:

1. Gersten K, Schlichting H , "Boundary Layer Theory", Springer, 2017.
2. Frank M White , "Viscous Fluid Flow", McGraw-Hill Education, 2011.
3. Krishnamurthi Karamcheti , "Principles of Ideal Fluid Aerodynamics", John Wiley and Sons, 1966.
4. Ascher H Shapiro , "National Committee for Fluid Mechanics Films, Cambridge", University of Cambridge, .

ONE-CREDIT COURSES

19MF01 SIMULATORS FOR INTEGRATED PRODUCTS

1 0 0 1

SIMULATOR COMPONENTS : Introduction to simulator; definition, objectives of simulator, elements of a simulator; Types of simulators - product simulator, process simulator, functional simulator, training simulator (4)

DESIGN AND INTEGRATION OF SIMULATOR : Design principles of a simulator; Tools; Hardware and software; Resources; Integrated product development approach; interfaces - mechanical, electrical, electronic and software; Configuring a simulator to a specific application; Testing; Trouble shooting. (5)

APPLICATIONS OF SIMULATOR : Importance, advantages, cost reduction in various areas viz, training, operations, testing; Safety and entertainment; Environmental simulation; Use in academic, research and defense fields – case studies. (6)

Total L: 15

REFERENCES:

1. Annalisa Milella Donato Di Paola, Grazia Cicirelli , "Mechatronic Systems: Simulation Modeling and Control", InTech, 2010.
2. Sankar Sengupta , "System Simulation and Modeling", Pearson Education India, 2014.
3. Klee Harold , "Simulation of Dynamic Systems with Matlab and Simulink", CRC Press Inc, New York, 2007.
4. Peter A. Hancock, Dennis A. Vincenzi, John A. Wise, Mustapha Mouloua , "Human Factors in Simulation and Training", CRC Press, New York, 2008.

19MF02 CORROSION SCIENCE AND ENGINEERING

1 0 0 1

BASIC ASPECTS OF CORROSION : Introduction, classification, economics, emf series, Galvanic series. corrosion theories : Derivation of potential – current relationships of activation controlled and diffusion controlled corrosion processes; Potential – pH diagrams Fe-H₂O system, application and limitations; Passivation. (5)

FORMS OF CORROSION : Definition, factors and control methods of various forms of corrosion : Uniform, galvanic, pitting, inter granular, crevice, dezincification, stress corrosion, corrosion fatigue, hydrogen embrittlement. (5)

CORROSION CONTROL METHODS : Atmospheric corrosion – classification, factors influencing atmospheric corrosion, temporary corrosion preventive methods ; Organic coating, corrosion inhibitors, cathodic protection, anodic protection. (5)

Total L: 15

REFERENCES:

1. E.E. Stansbury, R.A. Buchanan , "Fundamentals of electrochemical corrosion", ASM International, 2000.
2. M.G. Fontana, N.D. Greene , "Corrosion Engineering", 3rd Edition, McGraw Hill, New York, 2005.
3. S.N. Banerjee , "An Introduction to Science of Corrosion and its Inhibition", Oxonian Press, New Delhi, 1985.
4. Zaki Ahmad , "Principles of Corrosion Engineering and Corrosion Control", Butterworth Heinemann, London, 2006.

19MF03 NON-DESTRUCTIVE TESTING OF AIRCRAFT STRUCTURES

1 0 0 1

INTRODUCTION TO NON DESTRUCTIVE TESTING : Brief history; Terminologies; Common methods; Quality of inspection and reliability; Essentials of NDT system; Advantages and Limitations. (4)

DESCRIPTION OF NDT METHODS : Liquid penetrant testing; Magnetic particles testing; Ultrasonic testing; Eddy current

testing; Radiography; Thermography; Vibration monitoring; Holography and speckle methods; Acoustic emission technique. (7)

EMERGING METHODS : NDT of composites; NDT in manufacturing and maintenance; NDT and damage tolerance philosophy. (4)

Total L: 15

REFERENCES:

1. Halmshaw R , "Non-destructive Testing", Edward Arnold, London, 1991.
2. American Society for Non-Destructive Testing , "Nondestructive Testing Handbooks", 3rd Edition, American Society for Non-Destructive Testing, 2012.
3. Grandt Jr. A F , "Fundamentals of Structural Integrity: Damage Tolerant Design and Nondestructive Evaluation", Wileys, 2003.
4. Dowling N. E , "Mechanical Behaviour of Materials", 4th Edition, Pearson Education, 2014.

19MF04 COOLING OF ELECTRONIC EQUIPMENT

1 0 0 1

ELECTRONICS COOLING AND AIR FLOW MANAGEMENT: Needs, goals and levels; Fundamentals of heat transfer: Extended surfaces, contact resistance; Air flow management: Fan characteristics, system characteristics and fan performance. (5)

HEAT ANALYSIS, HEAT EXCHANGES AND COLD PLATES : Heat analysis: System level, board level and package level thermal analysis; Heat sink technologies: Air cooled components and boards; Experimental methods; Heat exchanges and cold plates: Thermal design process, analytical techniques and thermal design of multi-chip module. (5)

HEAT SINK DESIGN AND OPTIMIZATION : Free convection, liquid cooling and advanced cooling; Numerical methods: Case study. (5)

Total L: 15

REFERENCES:

1. Incropera.F.P, DeWitt.D.P , "Fundamentals of Heat Transfer", John Wiley and Sons, 2007.
2. Steinberg.D.S , "Cooling Techniques for Electronic Equipment", John Wiley and Sons, 1980.
3. Lian- Tuu Yeh, Richard C Chu, Dereje Agonafer , "Thermal Management of Microelectronic Equipment: Heat Transfer Theory, Analysis Methods and Design Practices", ASME Press, 2002.
4. Tony Kordyban , "Hot Air Rises and Heat Sinks: Everything You Know about Cooling Electronics is Wrong", ASME Press, 1998.

19MF05 EXPERIMENTAL METHODS IN THERMAL AND FLUID SCIENCES

1 0 0 1

INTRODUCTION TO EXPERIMENTAL METHODS: Experimental program, calibration, measurement of uncertainty, flow visualization methods and techniques, fluid property measurement. (3)

TEMPERATURE MEASUREMENT : Design and selection of thermocouples to measure temperatures of a fluid, observation of sensitivity, accuracy, uncertainty in observations. (3)

FLOW MEASUREMENT : Particle image velocimetry, Laser induced fluorescence, Schlieren technique - Components, integration and processing of the raw images. (9)

Total L: 15

REFERENCES:

1. Ronald J. Adrian and Jerry Westerweel , "Particle Image Velocimetry", Cambridge University Press, 2011.
2. Smits A.J. and Lim T.T , "Flow Visualization: Techniques and Examples", Imperial College Press, 2000.
3. Holman J P , "Experimental Methods for Engineers", Mcgraw-Hill Series in Mechanical Engineering, 2011.
4. M.D. Kelleher, R.K. Shah, K.R. Sreenivasan, Y. Joshi , "Experimental Heat Transfer, Fluid Mechanics and Thermodynamics", Elsevier Science Publisher B.V,1993.

19MF06 CHALLENGES IN IMPLEMENTING LEAN MANUFACTURING

1 0 0 1

LEAN TOOLS : Value stream mapping-Sections of VSM ,symbols of VSM, applications of VSM for an industrial process; Establishing lean metrics: Identifying the wastes, applying lean principles, measure productivity. (4)

FAILURE MODE AND EFFECTS ANALYSIS : Applying the principles of FMEA: Understand severity, detection and occurrence, develop FMEA based on process flow, prioritize the activities; Principles of control plan- understand sections of control plan, establish parameters driven by product and process; Need for verification before start of process. (8)

ERROR PROOFING : Error proofing techniques, principles and applications.

(3)

Total L: 15

REFERENCES:

1. APQP , "Automotive Industry Action Group", Pearson Education, New Delhi, 2008.
2. Stephen A Ruffa , "Going Lean. How the Best Companies Apply Lean Manufacturing Principles", 2nd Edition, AMACOM, A division of American Association, New York, 2008.
3. Womach , "Lean Tools and Techniques", Pearson, 2001.
4. Jones , "Lean Tools: A Pocket Guide", Wiley, 1996.

19MF07 PROCESS ENGINEERING AND COSTING

1 0 0 1

PROCESS ENGINEERING : General manufacturing process and its types, selection of manufacturing process - size and dimensional accuracy of parts. (4)

MANUFACTURING PROCESS SELECTION AND PLANNING : Fundamental rules of the manufacturing process, basic design of the product, influence of process engineering on product design, rechecking specifications, influence of material type on product cost - economical usage of materials, material cost balance sheet, process planning and its types. (6)

SELECTION OF PROPER TOOLING : Classification, sources of tooling, tool holders, work piece holders, molds, patterns, core boxes, dies and gauges; Availability of equipment, effect of process parameters on product performance and cost. (5)

Total L: 15

REFERENCES:

1. Serope Kalpakjian and Seven R Schmid , "Manufacturing Processes for Engineering Materials", Pearson Education, New Delhi, 2000.
2. Donald F Eary and Gerald E Johnson , "Process Engineering for Manufacturing", Prentice Hall, New York, 2003.
3. Groover , "Principles of Modern Manufacturing", Wilsy, 1999.
4. Sharma , "Manufacturing Processes", Pearson, 2000.

19MF08 APPLICATIONS OF VALUE ENGINEERING

1 0 0 1

CONCEPTS OF VALUE ENGINEERING : Introduction and impact of VE application, types of values, types of function; Function identification on product, feature function matrix, function analysis. (5)

COST : Elements and components of product cost, calculation of various fabrication cost, determining worth, guidelines to find worth, feasibility ranking. (5)

VALUE ENGINEERING IN JOB PLAN : Phases: Orientation phase, information phase, function analysis, creative phase, evaluation phase, presentation phase, implementation phase and audit phase; Case studies. (5)

Total L: 15

REFERENCES:

1. Larry W Zimmesman. P E , "VE ,A Practical approach for owners designers and contractors", CBS Publishers, Delhi, 1992.
2. Arthus E Mudge , "Value Engineering", McGraw Hill Book Company, 1971.
3. Richard J Park , "Value Engineering: A plan for inventions", St.Lucie Press, London, 1998.
4. Arthus E Mudge , "Value Engineering", McGraw Hill Book Company, 1971.

19MF09 PRESSURE VESSEL AND PIPING

1 0 0 1

INTRODUCTION : Rationale behind development of codes and standards, highlights of national and international codes, theoretical background of pressure vessel and piping design as per ASME codes and RCC-MR codes; Engineering aspects in pressure vessel design - failure criteria, material selection, geometrical considerations and weld inspection. (4)

STRESSES IN PRESSURE VESSEL AND PIPING : General theory of membrane stresses in vessel under internal pressure and its application to shells - cylindrical, conical and spherical and end closures, stress concentration, thermal stresses, pressure vessel fatigue, stresses in pipes. (6)

DESIGN OF PRESSURE VESSEL AND PIPING : Pressure vessel and piping design considering excessive elastic deformation, plastic instability, buckling, ratcheting, rupture and creep; High temperature design; Problems and case studies. (5)

Total L: 15

REFERENCES:

1. John F. Harvey, "Theory and Design of Pressure Vessels", 1st Edition, CBS Publishers, New Delhi, 2001.
2. ASME - BPVC, "Pressure Vessel and Boiler code", ASME, USA, 2019.
3. Henry H Bednar, "Pressure Vessel Design Handbook", 2nd Edition, Krieger Publishing Company, USA, 1990.
4. Peter Smith, "The Fundamentals of Piping Design", 1st Edition, Gulf Publishing Company, USA, 2007.

19MF10 DESIGN VALIDATION AND QUALIFICATION: TESTING AND EVALUATION**1 0 0 1**

OVERVIEWS OF DESIGN VALIDATION AND QUALIFICATION: Classes of structures, systems, components and equipment; Generic mechanical design basis and method; Design by analysis methodology; Design by experimental methodology; Verification, validation and qualification methods. (4)

EXPERIMENTAL STRESS ANALYSIS: Strain gauges: Types, sensitivity, rosettes, performance, temperature compensation, two-wire and three-wire circuits, selection; Photo-elastic methods, case studies. (5)

VIBRATION TESTING AND EVALUATION : Introduction to vibration analysis and synthesis, mode superposition, experimental modal analysis, sources of vibration-mechanically induced and flow induced vibrations; Dynamic amplification; Basics of dynamic instability; Signature analysis, random vibration, case studies. (6)

Total L: 15**REFERENCES:**

1. James W. Dally and William F. Riley, "Experimental Stress Analysis", 3rd Edition, McGraw-Hill Publication, USA, 1991.
2. Thomas G. Beckwith, Roy D. Marangoni, John H. Lienhard, "Mechanical Measurements", 6th Edition, Pearson Education, India, 2013.
3. William T. Thomson, "Theory of Vibrations with Applications", 5th Edition, Pearson Education, 2008.
4. L. Meirovitch, "Elements of Vibration Analysis", 2nd Edition, McGraw Hill, USA, 1986.

19MF11 HIGH TEMPERATURE MATERIALS FOR ENERGY APPLICATIONS**1 0 0 1**

HIGH TEMPERATURE MATERIALS, CREEP RESISTANCE AND THERMAL FATIGUE : Characteristics of high temperature materials (HTMs): Ferrous and non ferrous materials; Creep, creep resistant materials in energy related components; Fatigue, thermal fatigue, ageing, structural changes at elevated temperature, material damage, crack propagation, damage mechanics, life time analysis. (5)

OXIDATION AND HOT CORROSION : Oxidation, high temperature corrosion, erosion and effect of alloying elements on hot corrosion. (5)

SUPER ALLOYS AND OTHERS MATERIALS IN POWER PLANT APPLICATIONS: Iron, nickel and cobalt base super alloys, high temperature ceramics and polymer for high temperature applications; Role in power plant applications and extreme environments. (5)

Total L: 15**REFERENCES:**

1. Evans, R.W and Wilshire, "Creep of metals and alloys", Institute of metals, 1985.
2. J.R. Davis, "ASM Specialty Handbook: Heat-resistant materials", ASM International, 2001.
3. Raj. R, "Flow and Fracture at Elevated Temperatures", American Society for Metals, 1985.
4. Neil Birks, Gerald H. Meier, Frederick S. Pettit, "Introduction to the High Temperature Oxidation of Metals", 2nd Edition, Cambridge University Press, 2009.

19MF12 NANOTECHNOLOGY FOR CLEAN ENERGY APPLICATIONS**1 0 0 1**

ENERGY STORAGE AND FUEL CELLS : Introduction to battery materials and batteries: Lithium Ion based batteries; Super capacitor characterization, types of super capacitor and applications; Fuel cell: Principle, types - Polymer electrolyte membrane fuel cell (PEMFC), direct methanol fuel cells (DMFC), solid oxide fuel cell (SOFC). (5)

NANOTECHNOLOGY IN RENEWABLE ENERGY SYSTEMS : Developments and implementation of nanotechnology based renewable energy technologies, solar cell structures, quantum well and quantum dot solar cells, photo-thermal cells for solar energy harvesting. (5)

COMMERCIALIZATION OF NANOTECHNOLOGY : Process in nanotechnology, commercialization model, innovation, challenges and opportunities for nanotechnology. (5)

Total L: 15

REFERENCES:

1. J.Twidell, T. Weir , "Renewable Energy Resources", 3rd Edition, Routledge, 2015.
2. W. Vielstich, A. Lamm, H. A. Gasteiger , "Handbook of Fuel Cells: Fundamentals, Technology, and Applications", 1st Edition, John Wiley and Sons, 2003.
3. Martin A Green , "Solar cells: Operating principles, technology and system applications", Prentice Hall Inc, 1987.
4. Ling Zang , "Energy Efficiency and Renewable Energy Through Nanotechnology", Springer - Verlag Ltd, London, 2011.

ENGLISH

19GF01 INTERPERSONAL AND ORGANIZATIONAL COMMUNICATION

1 0 0 1

INTRA ORGANIZATIONAL COMMUNICATION : Communication Networks in an Organization; Intra- organizational communication (2)

INTER ORGANIZATIONAL COMMUNICATION : Flow Nomenclature; Workplace diversity and intercultural aspects of communication (2)

COMMUNICATION FUNCTIONS IN ORGANIZATIONS : Teamwork and team dynamics; Conflict resolution strategies and styles; Leading and influencing others-facilitation skills (3)

WRITTEN COMMUNICATION : Email Writing, Professional Reports, and Memos (4)

INTERPERSONAL SKILLS : Nature and Dimensions of Interpersonal Communication; Personality and Communication styles; Active listening and intentional responding; Working with emotional intelligence (4)

Total L: 15

REFERENCES:

1. Bagchi Subroto , "The Professional", Penguin Publications, UK, 2011.
2. PMBOK guide , "A Guide to the Project Management Body of Knowledge", Project Management Institute Inc, USA, 2013.

19GF02 HUMAN VALUES THROUGH LITERATURE

1 0 0 1

PROSE : Kalam's vision of college education in Wings of fire - Emerson's advocacy of independence of Human will in Self-reliance - Harmony in Education-views of Betrand Russel (4)

POETRY : Maintaining Human relations in Robert Frost's Mending Wall - Quest for identity and freedom in Kamala Das's An Introduction (2)

DRAMA : Statesmanship and friendship in Girish Karnad's Tughlaq (3)

ONE-ACT PLAY : The theme of love in Chekhov's The Bear (3)

SHORT STORY : Empathy in Somerset maugham's Mr. Know-all - Family bond in Anita Desai's Devoted son (3)

Total L: 15

TEXT BOOKS:

1. Faculty - Department of English , "Course materials", PSG College of Technology, Coimbatore, 2019.

REFERENCES:

1. Abrams M .H, Harpham , "A Glossary of Literary Terms", Cengage, Boston, 2015.
2. Scholes R, et.al. , "Elements of Literature", IV, Indian Rpt. OUP, New Delhi, 2013.

HUMANITIES

19OFA1 EXPORT – IMPORT PRACTICES

1 0 0 1

- INTRODUCTION** : Export – Import Business – Preliminaries for starting Export – Import Business Registration. (3)
- EXPORT PROCEDURES** : Obtaining an Export License – Export Credit Insurance – Procedures and Documentation (4)
- FOREIGN EXCHANGE** : Finance for Exports – Pricing - Understanding Foreign Exchange Rates. (3)
- IMPORT PROCEDURES** : Import Policy – License - Procedure and Documentation. (3)
- EXPORT INCENTIVES** : Incentives - Institutional support (2)

Total L: 15

REFERENCES:

1. Ramagopal C , "Export Import Procedures - Documentation and Logistics", New Age International, 2014.
2. Cherian and Parab , "Export Marketing", Himalaya Publishing House, New Delhi, 2008.
3. Parul Gupta , "Export Import Management", MC-Graw Hill, 2017.
4. Justin Paul, Rajiv Aserkar , "Export Import Management", Oxford, 2013.

19OFA2 INSURANCE - CONCEPTS AND PRACTICES

1 0 0 1

- INTRODUCTION TO INSURANCE AND RISK MANAGEMENT** : Origin, History, Nature and Scope of insurance – Meaning, types and significance of risk. (3)
- INSURANCE LAWS AND REGULATIONS** : Insurance Act, IRDA Act, Consumer Protection Act, Ombudsman Scheme. (2)
- INSURANCE UNDERWRITING AND RISK MANAGEMENT** : Meaning of underwriting and underwriter, guidelines and steps in the process of underwriting – characteristics, significance and principles of risk management. (4)
- FINANCIAL ASPECTS OF INSURANCE MANAGEMENT** : Role and functions of financial institutions, determination of premium for various insurance products. (3)
- SETTLEMENT OF INSURANCE CLAIMS** : Documents needed during various claims, Factors affecting insurance claims (3)

Total L: 15

REFERENCES:

1. Scott Harrington, Gregory Niehaus , "Risk Management and Insurance", McGraw Hill Education, 2017.
2. George E Rejda , "Principles of Risk Management & Insurance", Pearson Education, 2017.
3. John Hull , "Risk Management & Financial Institution", John Wiley and Sons, 2018.
4. Arjun Mittal, D D Chaturvedi , "Insurance and Risk Management", Scholar Tech Press, 2017.

19OFA3 PUBLIC FINANCE

1 0 0 1

- INTRODUCTION**: Nature and Scope of public finance – Principles of taxation. (2)
- PUBLIC REVENUE AND TAXATION**: Sources of Revenue – Tax and non-tax revenue – Classification of Taxes, GST. (4)
- PUBLIC EXPENDITURE**: Importance – Types – Causes of increase in public expenditure – Effects of public expenditure in India. (3)
- DEFICIT FINANCING AND BUDGET**: Sources of public debt – Debt redemption – Budget – Types – Preparation of Budget in India. (3)
- FEDERAL FINANCE**: Centre-State financial relations – Finance commissions. (3)

TOTAL: 15

REFERENCE BOOKS:

1. Richard A Musgrave and Peggy B Musgrave, "Public Finance in Theory and Practice" – Tata McGraw Hill Education, New Delhi, 2004.

2. Bhatia H.L, "Public Finance" – Vikas Publishing House, 29th Edition, New Delhi, 2012.
3. David N Hyman, "Public Finance: A contemporary application of theory and policy", Cengage Publication, 11th Edition, Noida, 2014.
4. Santhosh Dalvi and Krishnan Venkatasubramanian, "An introduction to Goods and Service Tax: The biggest tax reform in India", CCH Publisher, New Delhi, 2015.

190FA4 SECURITY ANALYSIS AND PORTFOLIO MANAGEMENT

1 0 0 1

- INVESTMENT ENVIRONMENT** : Financial Markets - Classification - Financial Instruments – Security Trading. (2)
- TYPES OF SECURITIES** : Trading – Orders, Margin Trading – Clearing and Settlement Procedures. (5)
- SECURITY ANALYSIS I** : Industry Analysis –Estimation of Rates of Return. (2)
- SECURITY ANALYSIS II** : Company Analysis — Estimation of Rates of Return. (2)
- PORTFOLIO MANAGEMENT** : Measuring Risk and Returns and Treatment in Portfolio Management. (4)

Total L: 15

REFERENCES:

1. William F Sharpe, Gordon J. Alexander, Jeffery V Bailey , "Investments", Prentice Hall, 2012.
2. Prasanna Chandra , "Investment Analysis and Portfolio Management", TATA McGraw Hill Publishing, 2011.
3. Ranganathan , "Investment Analysis and Portfolio Management", Pearson, 2004.
4. Bhalla V K , "Investment Management", TATA McGraw Hill Publishing, 2011

190FA5SOCIAL ENTREPRENEURSHIP

1 0 0 1

- INTRODUCTION TO SOCIAL ENTREPRENEURSHIP:** Social Entrepreneur - Meaning, qualities and skills. Social Entrepreneurship – Characteristics, process and ecosystem – Case Studies. (3)
- SOURCES OF FUNDING FOR SOCIAL ENTREPRENEURSHIP:** The Social Entrepreneurship Frame work. Start-ups and funding - Internal and External. Schemes for social entrepreneurship. (4)
- STRATEGIES IN SOCIAL ENTREPRENEURSHIP:**Industry and Market Analysis, Business planning, concepts of value creation,new ideas and risk taking. (4)
- PROSPECTS AND PROBLEMSIN SOCIAL ENTREPRENEURSHIP:** Opportunities for Social entrepreneurs, an overview of legal structure, tax structure and other liabilities. (4)

TOTAL: 15

REFERENCE BOOKS:

- 1.S.S.Khanka, "Creativity and Innovation in Entrepreneurship", Sultan Chand & Sons, 2021.
- 2.C. Paramasivan, "Social Entrepreneurship", New Century Publications, 2016.
- 3.Robert A. Philips Margret Bonefiel Ritesh Sharma, "Social entrepreneurship, the next big business opportunity", Global Vision Publishing House, 2011.
- 4.Drucker, Peter, "Innovation and Entrepreneurship", Harper Business, 2006.

LANGUAGE ELECTIVES

19G001 COMMUNICATION SKILLS FOR ENGINEERS

0 0 4 2

COMMUNICATION CONCEPTS :

Process of Communication
Inter and Intrapersonal Communication
Inter and Intrapersonal CommunicationActivities

(9)

FOCUS ON SOFT SKILLS :

Etiquette — Work Place etiquette — Telephone etiquette
 Body Language
 Persuasive Communication
 Public Speaking
 Critical Reasoning and Conflict Management based on Case Studies
 Group Communication
 Meetings
 Interview Techniques

(14)

TECHNICAL WRITING :

Technical Writing Principles
 Style and Mechanics
 Technical Definitions – Physical, Functional and Process Descriptions
 Technical Report Writing
 Preparing Instructions and Manuals
 Interpretation of Technical Data

(15)

BUSINESS CORRESPONDENCE :

Writing Emails
 Preparing Resumes
 Memos
 Technical and Business Proposals

(7)

TECHNICAL COMMUNICATION :

Seminars
 Process Description and Group Discussions
 Use of Visual Aids

(15)

Total P: 60**TEXT BOOKS:**

1. Faculty Incharge "Course Material on "Communication Skills for Engineers"", PSG College of Technology., Coimbatore, 2019

REFERENCES:

1. Jeff Butterfield "Soft Skills for Everyone", Cengage Learning., New Delhi, 2013
2. Jean Naterop B and Rod Revell "Telephoning in English", Cambridge University Press., Cambridge, 2011
3. David A Mc Murrey and Joanne Buckley "Handbook for Technical Writing", Cengage Learning., New Delhi, 2011
4. Simon Sweeney "English for Business Communication", Cambridge University Press., New Delhi, 2012

19G002 GERMAN- LEVEL A1.1**0 0 4 2****GUTEN TAG! :**

1. To greet, learn numbers till 20, practice telephone numbers & e mail address, learn alphabet, speak about countries & languages
2. Vocabulary: related to the topic
3. Grammar: W — Questions, Verbs & Personal pronouns I.

(10)

FREUNDE, KOLLEGEN UND ICH :

1. To speak about hobbies, jobs, learn numbers from 20; build dialogues and frame simple questions & answers
2. Vocabulary: related to the topic
3. Grammar: Articles, Verbs & Personal pronouns II, sein & haben verbs, ja/nein Frage, singular/plural

(10)

IN DER STADT :

1. To know places, buildings, question, know transport systems, understand international words; build dialogues and write short sentences
2. Vocabulary: related to the topic
3. Grammar: Definite & indefinite articles, Negotiation, Imperative with Sien verbs

(12)

GUTEN APPETIT! :

1. Tospeak about food, shop, converse; Vocabulary: related to the topic; build dialogues and write short sentences

2. Grammar: Sentence position, Accusative, Accusative with verbs, personal pronouns & prepositions, Past tense of haben & sein verbs

(13)

TAG FÜR TAG/ZEIT MIT FREUNDEN :

1. To learn time related expressions, speak about family, about birthdays, understand & write invitations, converse in the restaurant; ask excuse, fix appointments onphone
2. Vocabulary: related to the topic
3. Grammar: Time related prepositions, Possessive articles, Modalverbs

(15)

Total P: 60

TEXT BOOKS:

1. Dengler Stefanie "Netzwerk A1.1", Klett-Langenscheidt GmbH., München, 2013
2. Sandra Evans, Angela Pude "Menschen A1", Hueber Verlag., Germany, 2012

REFERENCES:

1. Stefanie Dengler "Netzwerk A1", Klett-Langenscheidt GmbH., München, 2013
2. Hermann Funk, Christina Kuhn "Studio d A1", Goyal Publishers & Distributors Pvt. Ltd., New Delhi, 2009
3. Rosa-Maria Dallapiazza "Tangram Aktuell 1 (Deutsch als Fremdsprache)", Max Hueber Verlag., Munchen, 2004
4. Christiane Lemcke und Lutz Rohrmann "Grammatik Intensivtrainer A 1", Goyal Publishers & Distributors Pvt. Ltd., New Delhi, 2012

19G003 FRENCH LANGUAGE LEVEL 1

0 0 4 2

PARTS OF SPEECH :

1. inviter et répondre à une invitation, Pronoms sujets
2. L'article définis, l'article indéfinis
3. Conjugation : présent, adjectifs possessifs
4. interrogation, décrire les personnes
5. La vie de quatre parisiens de professions différentes

(12)

ELEMENTS OF GRAMMAR :

1. Exprimer l'ordre et l'obligation demander et commander
2. l'adjectif possessifs, l'article partitif, l'article démonstratif, négation ne
3. pas, l'article contracté
4. verbe pronominaux
5. prepositions

(12)

SENTENCE STRUCTURE :

1. Raconter et reporter-donner son avis
2. Futur simple, pronom complètement d'objet direct, passé composé
3. plusieurs région de France, imparfait, pronom y/en, imparfait

(12)

TENSES AND NUMBERS :

1. Demander l'autorisation-passé récent, futur proche
2. La vie administrative et régionale, Pluriel des noms, moyens de transport

(12)

DISCOURSE :

1. le discours rapporté, décrire un lieu, exprimer ses préférences
2. décrire la carrière, discuter d'un système éducation de France
 - a. parler de la technologie de l'information

(12)

Total P: 60

TEXT BOOKS:

1. Christine Andant étal "À propos (livre de l'élève", LANGER., NEW DELHI, 2012
2. Myrna Bell Rochester "Easy French Step By Step", MCGrawhill Companies., USA, 2008

REFERENCES:

1. Michael D. Oates "Entre Amis: An Interactive Approach", Houghton Mifflin., 2005 , 5th
2. Bette Hirsch, Chantal Thompson "Moments Literaries : An Anthology for intermediate French", ..
3. Simone Renaud, Dominique van Hooff "En bonne forme", ..

19G004 BASIC JAPANESE

0 0 4 2

JAPANESE PEOPLE AND CULTURE :

1. Basic greetings and responses
2. Basic script — Method of writing hiragana and katakana — Combination sounds and simple words
3. Selfintroductions: "Hajimemashite" -Demonstratives "Kore", "Sore", "Are" — Demonstrative "Kono", "Sono", "Ano"
4. Possessive noun particle "no" — Japanese apartments: Greeting your neighbor

(12)

PARTICLE "NI (AT)" FOR TIME :

1. kara (from) ~ made(until) — Particle "to (and)"
2. Time periods: Days of the week, months, time of day —Verbs (Present / future and pasttense)
3. Telephone enquiry: Asking for a phone no. And business hours- Destination particle "e".

(12)

LIKES AND DISLIKES :

1. Potential verbs (wakarimasu and dekimasu) — "Kara (~ because)"
2. Adverbs — Asking some one out over the phone-Verbs denoting presence
3. Introduction to Adjectives (na and ii type) -Verb groups — I, II and III — Exercises to group verbs- Please do (te kudasai)
4. Present continuous tenses (te imasu) — Shall I? (~ mashou ka) — Describing a natural phenomenon (It is raining)

(12)

DIFFERENT USAGES OF ADJECTIVES :

1. Comparison — Likes and dislikes — Going to a trip- Need and desire (ga hoshii) — Wanting to . . . (Tabeti desu)- Going for a certain purpose (mi -ni ikimasu)
2. Choosing from a menu-Adjectives ("i" and "na" type) — Adjectives (Positive and negative useage)

(12)

ROLE PLAYS IN JAPANESE :

1. Framing simple questions & answers
2. Writing Short paragraphs & Dialogues
3. A demonstration on usage of chopsticks and Japanese tea party

(12)

Total P: 60

TEXT BOOKS:

1. Minna no Nihongo, Honsatsu Roma "ji ban (Main Textbook Romanized Version)", . International publisher — 3A Corporation., Tokyo, 2012

REFERENCES:

1. Eri Banno et.al "Genki I: An Integrated Course in Elementary Japanese I -Workbook", .. 1999
2. Tae Kim "A Guide to Japanese Grammar: A Japanese Approach to Learning Japanese Grammar", .. 2014
3. Minna No Nihongo "Translation & Grammatical Notes In English Elementary", ..