Birla Institute of Technology & Science, Pilani

Department of Mechanical Engineering

Goa Campus

Course Content

Index

innovate   achieve   lead

Course Content for B.E. – Mechanical Engineering

Science Foundation Courses

BIO F110   Biology laboratory   0 2 1

An introductory level course where students would perform selected experiments of biology in the laboratory so that they appreciate the concepts learnt in theory course. Experiments related to Microscopy and micrometry, quantification of biological macromolecules, chlorophyll estimation, measurement of solvent potential of plant tissue, measurement of parameters related to cell cycle, Experiments related to hematology, DNA quantification from the plant organs; Water analysis.

BIO F111   General Biology   3 0 3

Living systems and their properties; major biological compounds; basic physiological processes; introduction to genetics; environment and evolution.

Text Book: 1. Enger, E.D., Ross, F.C. and David B. Bailey. Concepts in Biology (14th edition, BITS-Pilani Custom edition 2012). New Delhi: Tata McGraw-Hill Publishing Company Ltd.

CHEM F110   Chemistry Laboratory   0 2 1

This laboratory course consists of experiments based on fundamental principles and techniques of chemistry emphasizing on physical-chemical measurements, quantitative & qualitative analysis and preparations.

CHEM F111   General Chemistry   3 0 3

Principles of thermodynamics, phase and chemical equilibrium, electrochemistry, kinetics; Atomic structure, chemical bonding, solid state and structural chemistry, molecular spectroscopy; organic compounds, functional groups,   structure   and   isomerism, stereochemistry, reactions and mechanisms, aromaticity, coordination chemistry, chemistry of representative elements.

Text Book: 1. P.W. Atkins, Elements of Physical Chemistry 5th Ed, Oxford University press, 2009.
    2. T. W. Graham Solomons and Craig B. Fryhle, Organic Chemistry, 10th Edition, John Wiley &Sons Inc., New York, 2008.
    3. J. D. Lee, Concise Inorganic Chemistry, 5th Edition, Blackwell Science, Oxford, 1999.

PHY F110   Physics Laboratory   0 2 1

An introductory experimental course covering experiments in Mechanics, Oscillations and Waves. In addition to performing classic experiments in physics, the course aims at strengthening experimental skills and ability to take proper measurements. The course should motivate students to enter the exciting world of experimental physics.

PHY F111   Mechanics, Oscillations and Waves   3 0 3

Conservation Principles, Rotational Dynamics, Oscillations, Wave Motion, Reflection and Refraction, Interference, Diffraction, Polarization.

Text Book: 1. Kleppner, Daniel &R.J.Kolemkow, *An Introduction to Mechanics*, TMH, 2007.

               2. French, Anthony P, *Vibrations and Waves*, CBS, 1987.

Mathematics Foundation Courses

MATH F111   Mathematics I   3 0 3

Functions and graphs; limit and continuity; applications of derivative and integral.Conics; polar coordinates; convergence of sequences and series.Maclaurinand Taylor series.Partial derivatives.Vector calculus in R^n; vector analysis;theoremsof Green, Gauss and Stokes.

Text Book: 1. Mourice D Weir and others, *Thomas', Calculus*,11[th]edition, Pearson education. 2008

MATH F112   Mathematics II   3 0 3

Complex numbers, analytic functions, Cauchy's theorems; elementary functions; series expansions; calculus of residues and applications.Vector space; basis and dimension; linear transformation; range and kernel of a linear transformation; row reduction method and its application to linear system of equations.

Text Book: 1. S Andrilli and D Hecker, Elementary Linear Algebra, Elsevier, 3rd edition, 2006
                     2. R V Churchil and J W Brown, *Complex Variables and Applications*, McGraw Hill, 8th edn, 2008.

MATH F113   Probability & Statistics   3 0 3

Probability spaces; conditional probability and independence; random variables and probability distributions; marginal and conditional distributions; independent random variables; mathematical expectation; mean and variance; binomial, Poisson and normal distributions; sum of independent random variables; law of large numbers; central limit theorem (without proof); sampling distribution and test for mean using normal and student's t-distribution; test of hypothesis; correlation and linear regression.

Text Book: 1. J. S. Milton and J. C. Arnold, Introduction to Probability and Statistics 'Principles and Applications for engineering and computing sciences' 4th Edition Tata McGraw-Hill.

MATH F211   Mathematics III   3 0 3

Eigen-values and eigen-vectors.Inner product space and orthonormal bases. Elementary differential equations, Hypergeometric equations, Legendre polynomials, Bessel functions; Fourier series; Sturm-Liouville problem, series solution for differential equation, systems of first order equations; Laplace transformation and application to differential equations; one dimensional wave equation, one dimensional heat equation & Laplace equation in rectangular form.

Text Book: 1. Simmons G.F., Differential Equations with Applications and Historical Notes, 2nd ed. TMH, 2002.

Engineering Foundation Courses

BITS F111 Thermodynamics 3 0 3

Concepts and laws of thermodynamics; macroscopic thermodynamic properties; application to closed and open system; microscopic approach to entropy; equations of state; thermodynamics of non-reacting mixtures.

Text Book: 1. Richard E. Sonntag, Claus Borgnakke, "Fundamentals of Thermodynamics", Wiley India, 7th Edition, 2010
2. Richard E. Sonntag, Claus Borgnakke, "Thermodynamics Data Book", 2nd Edition, Wiley India, 2013

EEE F111 Electrical Sciences 3 0 3

Course covers basic passive circuit elements, dependent and independent sources, network theorems, circuit analysis techniques and response of first and second order circuits. Introduction to three - phase circuits, magnetic circuits, transformers, basics of rotating machines. Semiconductors - operation of diodes, zener diodes, bipolar junction transistors and field effect transistors. Biasing techniques and applications of diodes and transistors.Introduction to operational amplifiers and applications.Introduction to Digital Electronics.

Text Book: 1. Bobrow. Leonard S, Fundamentals of Electrical Engineering, OUP, 2nd edn, 1996. 2. Anand. M M S, SinusoidalForcing Function Response & Rectifiers, Notes-EDD, 2002.

Technical Art

BITS F110   Engineering Graphics   1 2 2

Introduction to AutoCAD basic commands; theory of projections; orthographic projections; isometric projections; projection of points, lines, planes and solids; section of solids; developments of surfaces; interpenetration of solids.

Text Book: 1. D.M. Kulkarni, A.P.Rastogi and A. Sarkar., Engineering Graphics with AutoCAD, PHI publisher, revised edition,July 2010

ME F110   Workshop Practice   0 4 2

Laboratory exercises for different manufacturing processes like machining on lathe, drilling, grinding, milling and shaper; sand moulding and casting; metal forming; joining processes likearc welding, gas welding, brazing and soldering; carpentry; fitting; use of metrology equipments in measurement; demonstrations on CNC machines and CNC part programming.

Text Book: 1. B SNagendraParashar and R K Mittal, Elements of Manufacturing Process,Prentice Hall of India, 2003

CS F111   Computer Programming   3 1 4

BasicModel of a Computer; Problem Solving–Basic Computing Steps and Flow Charting (Assignment, Sequencing, Conditionals, Iteration). Programming Constructs–Expressions, Statements, Conditionals, Iterators/Loops, Functions/Procedures; Data Types – Primitive Types, Tuples, Choices (Unions or Enumerations), Lists/Arrays, Pointers and Dynamically Allocated Data. Input output and Files.

Laboratory Component: Programming Exercises involving development and testing of iterative and procedural programs using bounded and unbounded iterations, function composition, random access lists, sequential access lists, dynamically allocated lists, and file access.

Text Book: 1. J.R. Hanly and E.B. Koffman, Problem Solving and Program Design in C., 5th Ed. ,pearson Education 2007

BITS F112   Technical Report Writing   2 0 2

Overview of communication, elements of effective writing, formal reports, types of reports, preparatory steps for writing reports, methods and sources of data, use of illustrations, oral presentation.

Text Book: 1. Sharma R. C. and Krishna Mohan, Business Corres. & Report Writing, 4th ed., Tata McGraw-Hill, 2010.

General Awareness / Professional courses

ECON F211   Principles of Economics   3 0 3

Nature and scope of economic science, its relationship with other social sciences; quantification of economic variables, theories of consumer behaviour and of the firm: linear economic models; market structures; social accounting and basic elements of economic planning.

Text Book: 1. Lipsey and Chrystal- Economics, latest edition

MGTS F211   Principles of Management   3 0 3

Fundamental concepts of management - planning; organizing; staffing; directing and controlling; production, financial, personnel, legal and marketing functions; accounting and budgeting, balance sheets.

Text Book: 1. Stephen P Robbins and Mary Coutler,Management, Eighth Edition,Pearson Education

Core Discipline Courses

ME F211   Mechanics of Solids   3 0 3

Fundamental Principles of mechanics; introduction of mechanics of deformable bodies; force and moment transmitted by slender members; stress and strain; stress-strain-temperature relations; torsion of circular member, stress and deflection due to bending, stability of equilibrium. Static failure criteria, ductile & brittle material; Dynamic failure criteria.

Text Book: 1. S. H. Crandall et al., "An Introduction to Mechanics of Solids (In SI Units)",McGraw-Hill. ThirdEdition

ME F212   Fluid Mechanics   3 0 3

Fluid Statics; fundamentals of mass, momentum and energy transfer, control volume approach and integral equations. Differential analysis of mass, momentum and energy transfer, solutions for one dimensional steady state situations. Viscous and in-viscid flow.Dimensionalanalysis.Introduction to computational fluid dynamics.

Text Book: 1. Munsonet.al. "Fundamentals of Fluid Mechanics" 6th Edition, John Wiley Student Edition, 2006.

ME F213   Materials Science & Engineering   2 0 2

Introduction, Structure of Materials (Metal and Ceramics), Dislocations, heat treatment of steel and strengthening Mechanisms of Metals, Phase diagrams, Iron-carbide phase diagram, Phase transformation in Metals, Mechanical and thermal properties of Metals, Polymers (Structure, processes and properties), powder metallurgy.

Text Book: 1. Callister "*Material science and engineering* ", John Wily & Sons, 8th Edition.

ME F214   Applied Thermodynamics   3 0 3

Availability and irreversibility, thermodynamic relations, gas and vapor cycles, combined power generation cycles, gas mixtures, refrigeration cycles, psychometrics and heat load calculations, gas turbine cycles , compressors, boilers and accessories.

Text Book: 1. P.K.Nag, "*Basic and Applied Thermodynamics*" –Tata McGraw- Hill Pub.Co. Ltd., 3rd ed., 2005.

ME F215   Mechanical Engineering Laboratory   0 2 2

The course shall aim to train the student in the skill of operation of instruments and equipments. Testing of mechanical properties like tensile testing, hardness, impact, bending of beams, spring testing, basic fluid mechanics experiments like measurements of pressure,

temperature, viscosity, flow measurement, basic electrical & electronics like experiments on diodes, rectifiers, OPAMPS, dc motors, transformers, induction and synchronous motors.

Text Book: 1. Lab manual of mechanical engineering laboratory, EDD Notes BITS PILANI GOA CAMPUS

ME F241   Machine Design & Drawing   3 1 4

Fundamentals and principles of Design, Design and selection of Machine elements such as shafts, Screw fasteners, Welded joints, Springs,Brakes & Clutches, Bearings & Gears.Fundamentals of Machine Drawing; practices for Orthographic drawing of machine parts, sectional view, assembly drawing & exploded view.

Text Book: 1. Shigley J. E. and Mischke C. R., "Mechanical Engineering Design" – 8th Edition, Tata-McGraw Hill, NewDelhi, 2008 (Special Indian Edition). [for Machine Design].

ME F242   IC Engines   2 0 2

Working cycles and operation of two stroke, four stroke SI and CI engine cycles. Ignition, combustion, alternative fuels, emission and their control.

Text Book: 1. Ganeshan V. "Internal Combustion Engines" Tata McGraw –Hill Pub. Co. Ltd.

ME F243   Production Techniques I   2 1 3

Metal casting methods, patterns and molding, different types of casting processes, injection molding, die casting and casting defects. Casting analysis. Metal forming, different bulk metal forming processes like rolling, extrusion, forging and wire drawing. Metal forming process analysis and forming defects. Welding, brazing and soldering, different techniques and welding defects. Welding analysis. Simple description of various machining operations, machine tools and cutting tool geometry. Limits & Fits and Metrology. Fabrication project.

Text Book: 1. Sero Kalpakjian and Steven Schmid, "Manufacturing Processes for Engineering Materials", Pearson education, India.
           2. Ghosh A. and Mallik A. K., "*Manufacturing Science*", 2nd Edition, Affiliated East West Press, New Delhi.

ME F244   Kinematics & Dynamics of Machinery   3 0 3

Kinematics of mechanism: introduction to mechanisms, position, displacement, velocity, acceleration analysis, Synthesis of mechanisms (Planer), cam design, Kinematics of gears (spur, helical, bevel and worm), gear trains, Dynamics of machines: static force analysis, dynamic force

analysis (planar), dynamics of reciprocating engines, balancing, cam dynamics, flywheels, governors and gyroscopes.

Text Book: 1. Theory of Machines and Mechanisms: Shigley, Mcgraw Hill

ME F311   Heat Transfer   3 1 4
Fundamental concepts of heat transfer; steady state and unsteady- state heat conduction; analytical and empirical relations for forced and free convection heat transfer; heat exchanger analysis and design, heat transfer by radiation; associated laboratory.

Text Book: 1. F. P. Incropera& D. P. Dewitt, *"Fundamentals of Heat and Mass Transfer*", John Wiley & Sons, 2010, 6th edition

ME F312   Advanced Mechanics of Solids   3 0 3
Generalized Hooke's law; Energy methods; torsion of non-circular members; shear center and asymmetrical bending; curved beams; thick cylinders; plates and shells; contact stress.

Text Book: 1. Arthur P., Boresi and R.J. Schinid, *Advanced Mechanics of Materials*, 6th Edition, John & Wiley, 2003.

ME F313   Production Techniques II   3 1 4
Metal cutting theory, Analysis, economics and quality control of metal cutting, laboratory exercises in metal cutting and fabrication project. Different machine tools their description and operation. Non-traditional machining processes. Micro-manufacturing technologies. Introduction to computer aided manufacturing (CAM), CNC machines and CNC part programming.

Text Book: 1. Amitabha Ghosh and Ashok Kumar Mallik "Manufacturing Science", Affiliated East-West Press, New Delhi
2. Serope Kalpakjian and Steven R. Schmid, "Manufacturing Engineering and Technology," Pearson Education (Low Cost Indian Edition), 4/e,2001, New Delhi

ME F341   Prime Movers & Fluid Machines   2 1 3
Theoretical analysis of energy and momentum transfer between fluid and rotor; principles of axial, mixed and radial flow compressors, turbines and pumps; design considerations; cascade aerodynamics and performance limitations; applications to power plant systems; model similitude for turbo-machines; Introduction to fluid power system, laboratory exercises in testing reciprocating machines, rotary machines and fluid power system.

Text Book: 1. M S Soni, Prime Movers and Fluid Machines, EDD Notes, BITS Pilani;

ME F342   Computer Aided Design   3 1 4

CAD software and CAD hardware. Mathematical modeling of parametric curves, surfaces and solids, and their computer simulation on spreadsheets and using specialized solid modeling packages. CAD/CAM data exchange. Introduction to finite element analysis and FEM practice on a specialized CAE package. Rapid prototyping. Students will be required to do several assignments and one CAD project.

Text Book: 1. Zeid I., "Mastering CAD/CAM", Tata McGraw-Hill, New Delhi, 2005.

ME F343   Mechanical Vibrations   3 0 3

Small oscillations of linear dynamical systems, free and forced vibrations of single and multi-degree-of-freedom systems, normal modes and orthogonality relations, generalized co-ordinates and Lagrange's equations, matrix formulation, eigenvalue problem and numerical solutions, transient response of one-dimensional systems, approximate energy methods, continuous system, vibration of string, rods, bars and beams. Introduction to control systems.

Text Book: 1. Theory of Vibration with Applications: W.T.Thomson, Pearson
                  2. K. Ogata, "Modern Control Engineering" PHI, 5th Edition

ME F344   Engineering Optimization   2 0 2

Linear programming methods, simplex method, transportation model and its variants, queuing systems, PERT/CPM, Optimal problem formulation, engineering optimization problems, single variable optimization algorithms, multivariable optimization algorithms, constrained optimization algorithms.

Text Book: 1. Belegundu A.D. and Chandrupatla T.R., "Optimization Concepts and Applications in Engineering", Cambridge Univ Press, 2nd Ed.(2011), ISBN: 9781107606227

Core Discipline Elective Courses

DE G513   Tribiology   3 2 5

Introduction, lubricants and lubrication, surface texture, bearing materials, fundamentals of viscous flow, Reynolds equation and applications, thrust bearings, journal bearings, squeeze-film bearings, hydrostatic bearings, gas bearings, dry and starved bearings, selecting bearing type and size, principles and operating limits, friction, wear and lubrication.

Text Book: 1. Stachowiak G. W. and Batchelor A. W., Engineering Tribology, 3rd Edition (Indian), Butterworth-Heinnmann (Elsevier), 2010

DE G514   Fracture Mechanics   3 2 5

Introduction, energy release rate, stress intensity factor and complex cases, an-elastic deformation at the crack tip, elastic plastic analysis through J-integral, crack tip opening displacement, test methods, fatigue failure, numerical analysis, mixed mode crack initiation and growth.

Text Book: 1. Prashant Kumar, Elements of Fracture Mechanics, Tata McGraw Hill, 2009

DE G531   Product Design   3 2 5

Introduction to creative design; user research and requirements analysis, product specifications, Computer Aided Design; standardization, variety reduction, preferred numbers and other techniques; modular design; design economics, cost analysis, cost reduction and value analysis techniques, design for production; human factors in design: anthropometric, ergonomic, psychological, physiological considerations in design decision making; legal factors, engineering ethics and society.

Text Book: 1. Otto Kevin and Kristin Wood, Product Design, Pearson Education, 2001.

ME F411   Fluid Power Systems   3 1 4

Introduction to Fluid power, advantages of fluid power, applications, Introduction to Pneumatics, Air preparation and Components, Pneumatics Circuits and Applications, Electro pneumatics, Electrical Controls for fluid power circuits, , Physical properties of hydraulic fluids, Energy and Power in Hydraulic Systems, Frictional Losses in Hydraulic Pipelines, Hydraulic Pumps, Hydraulic Cylinders and Cushioning Devices, Hydraulic Motors, Hydraulic Valves, Hydraulic Circuit Design and Analysis, Ancillary Hydraulic Devices, Hydraulic Conductions and Fittings, Maintenance of Hydraulic Systems, Use of PLC programming for interfacing pneumatics and Hydraulic Circuits.

ME F412   Production Planning and Control   3 0 3

Generalized model of production systems; types of production flows; life cycle concepts; facilities location and layout planning; aggregate and batch production planning; inventory systems; materials requirements planning; elements of monitoring & production control.

Text Book: 1. Rusell, R.S. & Taylor, B.W., "Operations Management Along the Supply Chain, Wiley Student Edition, 7th Ed., 2012.

ME F413   Nonlinear Vibrations   3 0 3

Introduction, sources of nonlinearity, examples, qualitative analysis: phase plane, singular points, stability of singular points, Forced response, Perturbation methods: straightforward expansion, the method of multiple scales, harmonic balance, method of averaging, Nonlinear normal modes, Nonlinear Multiple-DOF Systems, Bifurcations, Centre manifold reduction, Flouquet Theory, Chaos Theory, Melnikov Criterion, Applications to vehicle dynamics, structures and micro-systems etc. Use of software for simulations and numerical solutions.

ME F415   Gas Dynamics   3 0 3

Introduction to Gas Dynamics, Basic equations of compressible flow, Wave propagation, Steady one-dimensional flow (Varying-area adiabatic flow), Normal shock waves, Oblique shock and expansion waves, Prandtl-Meyer Flow, Flow with Friction and Heat Transfer, Potential equation for compressible flow, Similarity rule.

Text Book: 1. Rathakrishnan. E, Gas Dynamics, Prentice-Hall of India Private Limited, 2003

ME F416   Reverse Engineering & Rapid Prototyping   3 0 3

Introduction to reverse engineering, methodologies and techniques for reverse engineering, reverse engineering hardware and software, selecting reverse engineering system, introduction to rapid prototyping, relationship between reverse engineering and rapid prototyping. Reverse engineering in automotive engineering, aerospace engineering, medical device industry. Legal aspects and barriers for reverse engineering .Project work.

ME F417   Advanced Metal Forming   3 0 3

The stress and strain tensors in macroscopic plasticity and failure criteria for metal forming, effective stress and effective strain, flow rules for plastic deformation and principle of normality. Work hardening, determination of work hardening exponent. Plastic instability and effect of inhomogeneity on uniform strain. Strain rate and temperature effects on plastic deformation and flow stress, super-plasticity, temperature rise during metal forming. Ideal work and redundant work. Slab, upper-bound, slip-line field and finite element methods of

analysis of various bulk and sheet metal forming processes. Bulk and sheet metal formability tests and forming limit diagram. Sheet metal properties and plastic anisotropy.

ME F418   Rocket and Spacecraft Propulsion   3 0 3

Thrust and specific impulse. Compressible flows. Detailed analysis of liquid, solid and hybrid propulsion systems. Includes propellants, injection systems, combustion and chemical equilibrium, thrust chambers, nozzles and plumes. Electro-thermal thrusters. Plasmas and electromagnetic thrusters.

ME F419   Total Product Integration Engineering   3 0 3

Quality design across global supply chain. Robust product architecture for market variety and technology advances. Product development risk management.

ME F420   Power Plant Engineering   3 0 3

Classification of power plants. Components and layout of; thermal, nuclear, hydroelectric power plants. Site selection for various power plants. Combined cycle power plants. Magneto Hydro Dynamics (MHD) systems. Economics of power generation, economic loading of power stations. Load curve analysis; load factor, diversity factor. Power plant instrumentation and controls.

Text Book: 1. Nag P.K. "Power Plant Engineering", Tata McGraw-Hill Pub. Co. Ltd, New Delhi (Third edition), 2008

MF F421   Supply Chain Management   3 0 4

Purchase/procurement, stores, material handling systems, inventory analysis, inventory models, disposals, make or buy, outsourcing; vendor selection, development, and relations; Material requirements planning, manufacturing resources planning, ERP, JIT, inbound and outbound logistics, warehousing, transportation, packaging.

ME F423   Micro Fluidics and its Application   3 0 4

Introduction to micro-fluidics, scaling in micro-fluidics, theoretical micro-fluidics, Philosophy of Computational Fluid Dynamics, Concepts of discretization, fabrication techniques for micro-fluidic devices, micro-valves, micro-pumps, micro-flow sensors, micro-fluidics for life sciences: micro-mixers, micro-needles, micro-filters, micro-separators, micro-reactors, modeling and simulation on CAD tool.

ME F432   Computer Aided manufacturing   3 0 3

Introduction, features of NC machine tools, NC part programming, CAM system devices, interpolators for manufacturing systems, control loops of NC systems, computerized numerical

control, adaptive control systems, CAD to CAM, CAPP, industrial robots, computer aided production planning & control, computer aided inspection and quality control, CIM systems.

ME F433   Solar Thermal Process Engineering   3 1 4

Fundamentals of solar energy, earth-sun angles, solar spectrum, solar radiation, measurement and estimation of solar energy on horizontal and tilted surface, conversion routes and technologies, Standards and Performance Testing, thermal utilization of solar energy, modes of heat transfer and equations for performance calculations of systems- conduction, convection and radiation of heat, Flat plate collectors, solar concentrator systems, geometric optics, tracking methods, thermal analysis, energy storage, materials and properties, solar process loads and system calculations for time dependent loads, Life cycle cost analysis and economic analysis for various applications of solar thermal processes, solar water heating, space heating and cooling in Buildings, Industrial process heating, solar air-conditioning and refrigeration, Use of Simulation tools for performance simulation and Project Assignments, solar thermal power generation, Role of Govt., policies and plans.

Text Book: 1. Solar Energy: Fundamentals, Fundamentals & Applications", H.P. Garg, J. Prakash, First Revised Edition, Tata McGraw Hill., (2000)

ME F441   Automotive Vehicles   3 0 3

Internal combustion engines; vehicle performance; analysis and design of vehicle components. Experimental or theoretical investigation of problems selected from the field of automotive vehicles.

ME F443   Quality Control, Assurance & Reliability   3 0 3

Basic concepts of probability and probability distributions, standard probability distribution, sampling and sampling distributions, confidence intervals, testing significance, statistical tolerance, various types of control charts, statistical process control techniques, value analysis, defect diagnosis and prevention, basic concepts of reliability, reliability design evaluation and control, methods of applying total quality management, production process.

Text Book: 1. Mitra Amitava, Fundamentals of Quality Control and Improvement, Prentice Hall of India, 2nd Ed., 1998

ME F451   Mechanical Equipment Design   3 0 3

Design analysis for additional machine elements; retainment of bearings and design of machine housing; introduction to techniques of optimization reliability and value analysis; exercises in detail design; design solutions to meet specified functional requirements.

ME F452　　Composite Materials & Design　　3 0 3

Introduction to composites, concepts of reinforcement, strengthening mechanisms, fibrous reinforcements, matrix materials, micro-mechanical aspects of composites, manufacturing methods, composite production design methods-design of tensile members, pressure vessels, storage tanks, and other chemical process equipment made of FRP, design of joints, damage of composites by impact, FRP grids, recent development in manufacturing of composites and technologies.

Text Book:　1. B.D. Agrawal L.J. Broutman and K. Chandrashekhara "Analysis and Performance of FiberComposites", John Wiley and Sons Inc, 2006
　　　　　　　2. R J Crawford, "Plastics Engineering", Butterworth Heinemann, An imprint of Elsevier science.

ME F461　　Refrigeration and Air conditioning　　3 0 3

Principles, thermodynamic analysis, load estimates and design of various refrigeration and air conditioning systems for comfort and industrial applications. Theoretical or experimental investigation of refrigeration and air-conditioning problems.

ME F472　　Precision Engineering　　3 0 3

Concept of accuracy, accuracy of numerical control systems, tolerances and fits, acceptance tests for machine tools, static stiffness and its influence on machining accuracy, inaccuracies due to thermal effects, influence of forced vibrations on accuracy, dimensional wear of cutting tools and its influences on accuracy, clamping and setting errors, location principles and errors due to location, surface roughness and micro-finishing processes, dimensioning and dimensional chains, methods of improving accuracy and surface finish, thread and gear measuring instruments, coordinate measuring machines, introduction to computer aided tolerance.

ME F482　　Combustion　　3 0 3

Fuels, Combustion, Adiabatic Flame Temperature, Chemical Kinetics, Chain Reactions, Conservation Equations for Reacting Flows, Laminar and Turbulent Premixed Flames, Diffusion Flames, Droplet and Particle Combustion, Emissions, Applications.

ME F483　　Wind Energy　　3 0 3

Historic development of wind energy technology, basic principles of wind energy conversion, different types of wind machines and their performances, wind rotor aerodynamics and its application in the turbine design, statistical methods of measurement and analysis of wind spectra for energy use, developing models for estimating the wind energy potential of a

prospective site, Constructional features of various systems and sub-systems of a Wind Energy Conversion System(WECS), Features of wind farms, performance models of WECS, Optimal matching of WECS, environmental aspects of wind energy conversion, Economics of wind energy conversion.

ME F484   Automotive Technology   3 0 3

Historic development of wind energy technology, basic principles of wind energy conversion, different types of wind machines and their performances, wind rotor aerodynamics and its application in the turbine design, statistical methods of measurement and analysis of wind spectra for energy use, developing models for estimating the wind energy potential of a prospective site, Constructional features of various systems and sub-systems of a Wind Energy Conversion System(WECS), Features of wind farms, performance models of WECS, Optimal matching of WECS, environmental aspects of wind energy conversion, Economics of wind energy conversion.

ME F485   Numerical Techniques for Fluid Flow & Heat Transfer   3 0 3

Introduction to CFD, Partial Differential Equation (PDE): Physical classifications, Mathematical Classifications, Well posed problem. Basic of Discretization Methods: Finite difference method, Truncation error, consistency, error and stability analysis, convergence, various discretization schemes. Introduction commercial software: Open FOAM or Fluent. Application of numerical methods to selected model equations: Wave equation, Heat equation, Laplace's equations. Solution of Navier-Stokes equation for incompressible flows.

Text Book: 1. Computational Fluid Flow and Heat Transfer, K. Muralidhar and T. Sundararajan, Narosa publishing, 2003.

ME G511   Mechanisms & Robotics   2 3 5

Classification of robots & manipulators; fields of application; synthesis of planar & spatial mechanisms; methods of function & path generation; coupler curve synthesis; linkages with open loop; actuators & drive elements; microprocessor application and control of robots.

Text Book: 1. Mittal R K and Nagrath I J, Robotics and Control, TMH, 2003.

ME G512   Finite Element Methods   3 0 5

Fundamental concepts, matrix algebra and Gaussian elimination, one-dimensional problems, trusses, two-dimensional problems using constant strain triangles, axisymmetric solids subjected to axisymmetric loading, two-dimensional isoparametric elements and numerical integration, beams and frames, three-dimensional problems in stress analysis, scalar field problems, dynamic considerations, pre-processing and post processing.

Text Book: 1. Bathe K J "Finite Element Procedures", PHI Learning Pvt Ltd., New Delhi, 2012.

ME G514   Turbomachinery   3 0 5
Introduction, thermodynamics, gas turbine plants,   steam turbine plants, fluid dynamics, dimensional analysis and performance parameters, flow through cascades, axial turbine stages, high temperature turbine stages, axial compressor stages, centrifugal compressor stages, radial turbine stages, axial fans and propellers, centrifugal fans and blowers, and wind turbines.

ME G515   Computational Fluid Dynamics   3 0 5
Philosophy of computational fluid dynamics   (CFD),   governing equations   of   fluid dynamics, mathematical behavior of partial differential equations, basics of the numeric : basic aspects of discretization, grids with appropriate transformations, and simple CFD techniques, applications, numerical solutions of   quasi-one-dimensional nozzle flows, numerical solution of a two-dimensional supersonic flow, incompressible couette flow, and supersonic flow over a flat plate, advanced topics in CFD.

ME G533   Conduction and Radiation Heat Transfer   3 0 5
Conduction: Steady and unsteady problems and their solutions in Cartesian, cylindrical and spherical coordinates. Separation of variables. Duhamel's theorem. Laplace transforms. Problems involving change of phase. Inverse heat conduction, Micro-scale heat transfer, Radiation: Radiative exchange among black and grey and spectral surfaces, Shape factors. Applications to cavities and enclosures. Integral equations approach. Radiation from gases vapours and flames.

ME G534   Convective Heat and Mass Transfer   3 0 5
Conservation equations, boundary layers, free convection, forced convection. Heat transfer in laminar and turbulent, internal as well as external flows, mixed convection. Combined convection and radiation. Boiling and Condensation. Molecular diffusion in fluids, mass transfer coefficient. Simultaneous heat and mass transfer; Applications.

MST G522   Advanced Composites   3 2 5
Definition of composite materials; classification; particulates and dispersion hardened composites, continuous and discontinuous fibre reinforced composites, metal-matrix composites, carbon-carbon composites, molecular composites, micro and multilayer composites, theory of reinforcement; reinforcement by continuous and discontinuous fibres, concept of micro-fibril; effect of orientation and adhesion; mechanical behaviour of composites, stress-strain relationship, strength, fracture toughness and fatigue; properties of fibre reinforcement and production technology of composites.

Text Book:
1. B.D. Agrawal L.J. Broutman and K. Chandrashekhara "Analysis and Performance of FiberComposites", John Wiley and Sons Inc, 2006
2. R J Crawford, "Plastics Engineering", Butterworth Heinemann, An imprint of Elsevier science.

Course Content for M.E. Design Engineering

Core Discipline Courses

DE G631 Materials Testing and Technology   3 2 5

Study of characteristics and technology of metals, plastics, rubbers, ceramics, polymers, composites, optical fibers and other modern engineering materials and their application with particular reference to Railways. Destructive and nondestructive testing techniques and their applications in Railways.

Text Books: 1. William F. Smith, Javed Hashemi and Ravi Prakash, Materials Science and Engineering In SI Units, McGraw-Hill Companies, New Delhi Fourth Edition, Special Indian Edition, 2008

Reference Books: 1. William D Calister Jr. Materials Science and Engineering: An Introduction, John Wiley & Sons, Singapore, Seventh Edition, (2008)

2. E Paul Degarmo, J T Black, Ronald A Kohser Materials and Processes in Manufacturing John Wiley & Sons, Singapore, Ninth Edition, (2004)

3. Michael F. Ashby Materials Selection in Mechanical Design Elsevier, India, Fourth Edition (2011)

4. Joachim Roesler, Harald Harders, Metin Baeker Mechanical Behaviour of Engineering Materials India, Springer (2007)

5. Ravi Prakash Nondestructive Testing Techniques New Age, India, 2007

ME G511   Mechanism and Robotics   3 2 5

Classification of robots & manipulators; fields of application; synthesis of planar & spatial mechanisms; methods of function & path generation; coupler curve synthesis; linkages with open loop; actuators & drive elements; microprocessor application and control of robots.

Text Books: 1. Theory of Machines and Mechanisms, John Joseph Uicker, Joseph Edward Shigley, Gordon R. Pennock, Oxford University Press, 3rd Edition, 2003.

2. Robotics and Control, Mittal R. K. &Nagrath I. J, TMH, 2003 (Reprint 2007 or later).

Reference Books: 1. Kinematics, Dynamics, and Design of Machinery, Kenneth J. Waldron& Gary L. Kinzel, 2nd Ed Wiley India, 2004.

2. Mechanism and Machine Theory, Ashok G. Ambekar, PHI, 2007.

3. Theory of Machines and Machines, AmitabhGhosh and A.K. Malik, Allied East West Press Pvt. Ltd., 3rd Ed.

4. Industrial Robotics, Groover, M. P., et al., MGHISE, 1986.

5. Robotic: Control, Sensing, Vision & Intelligence, Fu, K. S., et al., MGHISE, 1987.

6. Fundamentals of Robotics: Analysis and Control, Robert J., Schilling, Prentice Hall, NJ, 2002.

ME G512   Finite Element Method   3 2 5

Fundamental concepts, matrix algebra and Gaussian elimination, one-dimensional problems, trusses, two-dimensional problems using constant strain triangles, axisymmetric solids subjected to axisymmetric loading, two-dimensional isoparametric elements and numerical integration, beams and frames, three-dimensional problems in stress analysis, scalar field problems, dynamic considerations, pre-processing and post processing.

Text Books: 1. Reddy J. N., An Introduction to Finite Element Method, 3rd Edition, Tata-McGraw Hill Edition, 2006, New Delhi.

Reference Books: 1.   Srinivasa Prakash Regalla, Computer Aided Analysis and Design, IK International Publishers, 2010, New Delhi.

ME G611   Computer Aided Analysis and Design   3 2 5

The course aims at developing complete self-reliance in solving analysis and design problems of engineering with the aid of computers. It stresses upon the use of more powerful tools including system planning, simulation and modeling. The student will take up a design project and will work independently on the project guided by the instructor or resource person as and when required. The effort must culminate with a CAAD program and a project report.

Text Books: 1. Rogers D. F. and J. A. Adams, "Mathematical Elements of Computer Graphics", Tata McGraw-Hill, New York, 2004.

Reference Books: 1. Rao V. Dukkipati, AnandaRao M. and Bhat R., "Computer Aided Analysis and Design of Machine Elements", New Age International Publishers, 2000.

2. Mortenson M. E., Geometric Modeling, John Wiley, New York, 1985.

3. Srinivasa Prakash Regalla., Computer Aided Analysis and Design, IK International Publishing House Pvt.Ltd, New Delhi.

4. Chapra S. and Canale R., Numerical Methods for Engineers, Tata McGraw-Hill, New Delhi.

5. Ibrahim Zeid., Mastering CAD/CAM Tata McGraw-Hill, New Delhi.

6. Getting Started with MATLAB by Rudra Pratap

7. Pro Engineer-Wildfire 5.0 Instructor: David Kelley

DE G531   Product Design   3 2 5

Introduction to creative design; user research and requirements analysis, product specifications, Computer Aided Design; standardization, variety reduction, preferred numbers and other techniques; modular design; design economics, cost analysis, cost reduction and value analysis techniques, design for production; human factors in design: anthropometric, ergonomic, psychological, physiological considerations in design decision making; legal factors, engineering ethics and society.

*Text Book:*1.   Otto Kevin & Kristin Wood, "Product Design", Pearson Edu., 2001

DE G611   Dynamics and Vibration   3 2 5

Steady and transient Vibration of single and multi-degree freedom systems. Systems with distributed mass and elasticity. Non-linear and self-excited vibrations, structural damping, Random vibrations, vibration analysis, vibration control - reduction, isolation and vibration absorbers.

*Text Book:*1.   Advanced dynamics for Engineering Application, EDD Notes by N N SHARMA

2. Elements of Vibration analysis", Leonard Meirovitch, McGraw-Hill, Singapore, 1986.

Reference Books: 1. Classical Dynamics, Donald T. Greenwood, Prentice Hall Inc. Englewood Cliffs, 1977

2. Lagrangian and Hamiltonian mechanics, M.G. Calkin, World Scientific, Singapore, 1996

3. The Theory of classical dynamics, J.B. Griffiths, Cambridge University Press, 1985.

4. Vibration Theory and application, William T. Thomson, CBS Publications, 3rd Ed., 1988.

5. Mechanical Vibrations - Theory and Application, Francis S. Tse, Ivan E. Morse and Rolland T. Hinkle, Allyn and Bacon Inc. London, 1983.

BITS G540   Research Practice   3 0 4

This course is designed to train the students towards acquiring competence in research methodologies. The course will be conducted in terms of actual participation in Research and Development Work. Each student will be assigned to a faculty member to work on specified projects. The student will be required to present a number of seminars in his research area in a structured manner.

BITS G629T   **Dissertation**   **25**

This is a required component for all higher degree students except for those who opt and are selected for practice school programme. The unit requirements will vary from 12 to 25 units. It may be registered for one full semester (12 to 25 units) after completing all courses or may be registered for varied units (4 to 10 units) along with other courses.

BITS G560   **Practice School**   **20**

Core Discipline Elective Courses

DE G513   Tribology   3 2 5

Introduction, lubricants and lubrication, surface texture, bearing materials, fundamentals of viscous flow, Reynolds equation and applications, thrust bearings, journal bearings, squeeze-film bearings, hydrostatic bearings, gas bearings, dry and starved bearings, selecting bearing type and size, principles and operating limits, friction, wear and lubrication.

Text Book: 1. Stachowiak G. W. and Batchelor A. W., Engineering Tribology, 3rd Edition (Indian), Butterworth-Heinnmann (Elsevier), 2010

DE G514   Fracture Mechanics   3 2 5

Introduction, energy release rate, stress intensity factor and complex cases, an-elastic deformation at the crack tip, elastic plastic analysis through J-integral, crack tip opening displacement, test methods, fatigue failure, numerical analysis, mixed mode crack initiation and growth.

Text Book: 1. Prashant Kumar, Elements of Fracture Mechanics, Tata McGraw Hill, 2009

EA C415   Introduction to MEMS   3 1 4

Overview, history and industry perspective; working principles; mechanics and dynamics thermos-fluid engineering; scaling law; micro-actuators, micro-sensors and micro-electromechanical systems; microsystem design, modeling and simulation; materials; packaging; micro-fabrication: bulk, surface, LIGA etc; micro-manufacturing; micro-fluidics; micro-robotics; case studies.

ME F423   Micro Fluidics and its Application   3 0 4

Introduction to microfluidics, scaling in microfluidics, theoretical microfluidics, Philosophy of Computational Fluid Dynamics, Concepts of discretization, fabrication techniques for microfluidic devices, micro-valves, micro-pumps, micro-flow sensors, microfluidics for life sciences: micro-mixers, micro-needles, micro-filters, micro-separators, micro-reactors, modeling and simulation on CAD tool.

ME G535   Advanced Engineering Mathematics   3 2 5

Boundary value problems; wave equations; nonlinear partial differential equations; calculus of variations; Eigen value problems; iteration problems including forward and inverse iteration schemes – Graham Schmidt deflation – simultaneous iteration method – subspace iteration – Lanczo's algorithm – estimation of core and time requirements.

Text Book: 1. Powers David L., "Boundary Value Problems & Partial Diff. Equa**.**", Elsevier, 6th ed., 2010

ME G515   Computational Fluid Dynamics   3 2 5

Philosophy of computational fluid dynamics (CFD), governing equations of fluid dynamics, mathematical behavior of partial differential equations, basics of the numerics: basic aspects of discretization, grids with appropriate transformations, and simple CFD techniques, applications, numerical solutions of quasi-one dimensional nozzle flows, numerical solution of a two-dimensional supersonic flow, incompressible couette flow, and supersonic flow over a flat plate, advanced topics in CFD.

Text Books: 1. John D Anderson, "Computational Fluid Dynamics", Tata-McGraw Hill Publisher, 1st Edition, 1995**.**

2. K Muralidhar& T Sundararajan, "Computational Fluid Flow and Heat Transfer", Narosa Book Distributors Pvt Ltd, 2nd Edition, 2009.

3. H K Versteeg& W Malalasekara, "Introduction to Computational Fluid Dynamics: The Finite Volume Method", Pearson Education (Indian Reprint), 2nd Edition, 2007.

Reference Books: 1. S V Patankar, "Numerical Heat Transfer and Fluid Flow", Taylor & Francis, 1st Edition, 1980.

2. R H Pletcher, J C Tannehill& D A Anderson, "Computational Fluid Mechanics and Heat Transfer", CRC Press, 3rd Edition, 2012.

ME G521   Mechanical System Design   3 2 5

Concept of system design; modeling of structural and kinematic systems, and determination of system characteristics; reliability of systems; design of machine elements for specified reliability; concepts of optimization; techniques of design optimization for linear and non-linear problems.

ME G532   Machine Tool Engineering   3 2 5

Design principles of machine tools; stiffness and rigidity of separate construction elements and their combined behaviour under load; design of stepped and stepless drives; electrical, mechanical and hydraulic drives; design of bearings and sideways; machine tool controls; machine tool dynamics; recent developments in machine tool design.

ME G612   Plastics Engineering   3 2 5

General properties of Plastics, Mechanical Behavior of Plastics, Processing of Plastics like Extrusion, injection moulding, thermoforming, calendaring, rotational moulding, compression

moulding, transfer moulding, analysis of polymer melt flow, rheological models for polymer melt flow, analysis of heat transfer during polymer processing, elastic behavior of polymer melts, testing methods of polymers like DSC, TGA, DMA, XRD etc. FRP composites, Properties of FRP composites in longitudinal and transverse directions, volume and weight fraction relationships of fibers, failure mechanisms, mechanical properties and fiber orientation effects, processing of composite materials, advancement of composite materials in applications like wind mill blades, bullet proof jackets, etc.

ME G641 Theory of Elasticity and Plasticity   3 2 5

Basic equations of theory of elasticity; elementary elasticity problems in two and three dimensions; theories of plastic flow; problems in plastic flow of ideally plastic and strain hardening materials; theory-of metal forming processes.

Text Books: 1. Timoshenko S. P. &Goodier J. N., Theory of Elasticity, 3rd Edition, Mc-Graw Hill, 1982.
2. J. Chakrabarty, Theory of Plasticity, Mc-Graw Hill Book Company, Singapore, 1987.

Reference Books: 1. M. Filonenko-Borodich, Theory of Elasticity, Foreign Language Publishing House, Moscow.
2. T.G. Sitharam , L. GovindaRaju, Applied Elasticity, Interline Publishing ISBN: 81-7296-083-2.
3. Alexander Mendelson Plasticity-Theory & application, The Macmillan Company, New York, 1968.
4. Martin H Sadd, Elasticity: Theory, Applications and Numerics, Elsevier Butterworth–Heinemann, New York.

MSE G511   Mechatronics   3 2 5

Concepts of measurement of electrical and nonelectrical parameters; displacement, force, pressure etc. and related signal conditioning techniques, drives and actuators, concepts of microprocessors/ microcontrollers architecture and programming, memory and I/O interfacing. System design concepts through case studies.

Text Book: 1. Bolton W, "Mechatronics", Pearson Edu, 4th ed, 2008.

MSE G531   Concurrent Engineering   3 2 5

Introduction of concurrent engineering and need, concurrent engineering tools, advances in design and manufacturing engineering, design for manufacture, design for assembly, rapid

prototyping, simulation, concurrent approaches to design, manufacturing and other aspects of engineering.

MST G511   Non-destructive Testing Techniques   3 2 5

Ultrasonic testing, X-radiography, eddy current testing, magnetic methods of crack detection, liquid penetrant inspection, acoustic emission and acousto-ultrasonic testing techniques.

MST G522   Advanced Composites   3 2 5

Definition of composite materials; classification; particulates and dispersion hardened composites, continuous and discontinuous fiber reinforced composites, metal-matrix composites, carbon-carbon composites, molecular composites, micro and multilayer composites, theory of reinforcement; reinforcement by continuous and discontinuous fibers, concept of micro-fibril; effect of orientation and adhesion; mechanical behaviour of composites, stress-strain relationship, strength, fracture toughness and fatigue; properties of fiber reinforcement and production technology of composites.

Textbooks: 1. Krishan K. Chawla, "Composite Materials: Science and Engineering", Second edition. Springer-Verlag, Newyork, 2010
2. Robert M. Jones, "Mechanics of Composite Materials", Second Edition. Taylor and Francis, Special India Edition, New Delhi, 2010

Reference books: 1. Ronald F. Gibson, "Principles of Composite Material Mechanics", Second Edition. Taylor and Francis, Special Indian Edition, New Delhi, 2010.
2. Autar K. Kaw, "Mechanics of Composite Materials", First Edition. Taylor and Francis, Special Indian Edition, New Delhi, 2009.
3. B.D. Agrawal L.J. Broutman and K. Chandrashekhara "Analysis and Performance of Fiber Composites", John Wiley & Sons Inc, 2006.

MST G531   Experimental Stress Analysis Techniques   3 2 5

Strain gauges, photo-elasticity, brittle lacquer, three dimensional photo-elasticity, Moire methods.

*Text Book:*1.   J.W. Dally and W.F. Riley, Experimental Stress Analysis, McGraw- Hill, 1991

Reference Books: 1. L. S. Srinath, M.R. Raghavan, K. Lingaiah, G. Gargesa, B. Pant, and K. Ramachandra,
2. Experimental Stress Analysis, Tata McGraw Hill, 1984.
3. K. Ramesh, Digital Photo-elasticity- Advanced Techniques and Applications, Springer, 2000
4. N. Sharpe (Ed.), Springer Handbook of Experimental Solid Mechanics.

DE G522   Design Projects   5

Practice in engineering design through projects emphasizing creative solutions to engineering design problem. Illustrative case studies of design will be taken up. The course will be conducted through selected group/individual projects.