
**CURRICULUM OF
B.Tech DEGREE PROGRAMME IN
PRODUCTION ENGINEERING**

(Applicable from 2010 Admission onwards)

DEPARTMENT OF MECHANICAL ENGINEERING



NATIONAL INSTITUTE OF TECHNOLOGY CALICUT

Curriculum of B. Tech. Degree programme in Production Engineering
(Proposed for 2010 admission onwards)

Semester 1

No	Code	Subject	L	T	P	C	Category
1	MA1001	Mathematics I	3	1	0	3	BS
2	PH1001/CY1001	Physics / Chemistry	3	0	0	3	BS
3	MH1001/ EE1001	Professional Communication / Electrical Sciences	3	0	0	3	HL/ES
4	ZZ1001/ZZ1002	Engineering Mechanics / Engineering Graphics	3 1	0 0	0 3	3	ES/TA
5	ME1001/ ZZ1004	Introduction to Mechanical Engineering / Computer Programming	2	0	0	2	PT/ES
6	ZZ1091/ZZ1092	Workshop I / Workshop II	0	0	3	2	TA
7	PH1091/PY1094	Physics Lab./ Chemistry Lab.	0	0	2	1	BS
8	ZZ1094/ ZZ1093/ ZZ1095	OT(Value Education(1), Physical Education(1), NSS(1))	-	-	-	3*	OT
		Total	14/ 12	1	3/6	17+3*	

**Three courses of one credit each are to be credited within the first four semesters.*

Semester 2

No	Code	Subject	L	T	P	C	Category
1	MA1002	Mathematics II	3	1	0	3	BS
2	CY1001/PH1001	Chemistry / Physics	3	0	0	3	BS
3	EE1001/MH1001	Electrical Sciences/ Professional Communication	3	0	0	3	ES/HL
4	ZZ1002/ZZ1001	Engineering Graphics/ Engineering Mechanics	1 3	0 0	3 0	3	TA/ES
5	ZZ1004 / ME1001	Computer Programming / Introduction to Mechanical Engineering	2	0	0	2	ES/PT
6	CY1094/PH1091	Chemistry Lab./ Physics Lab	0	0	2	1	BS
7	ZZ1092/ZZ1091	Workshop II / Workshop I	0	0	3	2	TA
		Total	12/ 14	1	3/6	17	

Semester 3

No	Code	Subject	L	T	P	C	Category
1	MA2001	Mathematics III	3	1	0	3	BS
2	EE2009	Electrical Measurements and Machines	3	0	0	3	PT
3	ME2002	Elements of Solid Mechanics	3	0	0	3	PT
4	ME2003	Engineering Mechanics –Dynamics	3	0	0	3	PT
5	ME2004	Fluid Mechanics and Machinery	3	0	0	3	PT
6	ME2101	Materials Science and Metallurgy	3	0	0	3	PT
7	ME2091	Machine Drawing	0	0	3	2	PT
8	ME2191	Production Technology Laboratory I	0	0	3	2	PT
		Total	18	1	6	22	

Semester 4

No	Code	Subject	L	T	P	C	Category
1	MA2002	Mathematics IV	3	1	0	3	BS
2	ME2013	Mechanics of Machinery	3	0	0	3	PT
3	ME2015	Theory of Elasticity and Plasticity	3	0	0	3	PT
4	ME2016	Thermodynamics and Heat Transfer	3	0	0	3	PT
5	ME2111	Essentials of Management	3	0	0	3	HL
6	ME2112	Metal Casting and Joining	3	0	0	3	PT
7	ME2092	Fluid Mechanics and Fluid Machinery Laboratory	0	0	3	2	PT
8	CE2095	Strength of Materials Laboratory	0	0	3	2	PT
		Total	18	1	6	22	

Semester 5

No	Code	Subject	L	T	P	C	Category
1	ME3001	Dynamics of Machinery	3	0	0	3	PT
2	ME3103	Machine Tools	3	0	0	3	PT
3	ME3104	Metrology and Computer Aided Inspection	3	0	0	3	PT
4	ME3105	Production Management	4	0	0	4	PT
5		Elective I	3	0	0	3	PT
6	ME3003	Environmental Studies for Mechanical Engineers	3	0	0	3*	OT
7	ME3192	Metrology and Instrumentation Laboratory	0	0	3	2	PT
8	ME3194	Production Technology Laboratory II	0	0	3	2	PT
		Total	19	0	6	20+3*	

Semester 6

No	Code	Subject	L	T	P	C	Category
1	ME3113	Quantitative Techniques for Management	3	0	0	3	PT
2	ME3114	CAD/CAM/CIM	3	0	0	3	PT
3	ME3013	Thermal Engineering	3	0	0	3	PT
4	ME3014	Design of Machine Elements	4	0	0	4	PT
5		Elective II	3	0	0	3	PT
6	ME3195	CAD/CAM/CIM Laboratory	0	0	3	2	PT
7	ME3092	Thermal Engineering Laboratory	0	0	3	2	PT
		Total	16	0	6	20	

Semester 7

No	Code	Subject	L	T	P	C	Category
1	ME4102	Theory of Metal Cutting	4	0	0	4	PT
2	ME4103	Tool Engineering and Design	4	0	0	4	PT
3		Elective III	3	0	0	3	GE
4	ME4192	Management Science Laboratory	0	0	3	2	PT
5	ME4193	Metal Cutting Laboratory	0	0	3	2	PT
6	ME4098	Project	0	0	3	3	PR
		Total	11	0	9	18	

Semester 8

No	Code	Subject	L	T	P	C	Category
1	ME4111	Industrial Engineering	3	0	0	3	PT
2	MS4004	Industrial Economics	3	0	0	3	HL
3		Elective IV	3	0	0	3	PT
4		Elective V	3	0	0	3	GE
5	ME4097	Seminar	0	0	3	1	PR
6	ME4099	Project	0	0	5	5	PR
		Total	12	0	8	18	

Category-wise Credits

Code	S1	S2	S3	S4	S5	S6	S7	S8	TOTAL
BS	7	7	3	3	0	0	0	0	20
ES	3	5	0	0	0	0	0	0	8
HL	3	0	0	3	0	0	0	3	9
TA	2	5	0	0	0	0	0	0	7
PT	2	0	19	16	20	20	12	6	95
PR	0	0	0	0	0	0	3	6	9
GE	0	0	0	0	0	0	3	3	6
OT	3*	0	0	0	3*	0	0	0	6*
Total	17+3*	17	22	22	20+3*	20	18	18	154+6*

List of Electives

No.	Code	Subject
1	ME3021	Introduction to Finite Element Methods
2	ME3022	Experimental Stress Analysis
3	ME3023	Theory of Plasticity
4	ME3024	Control Systems Engineering
5	ME3025	Nonlinear Dynamics and Chaos
6	ME3026	Engineering Fracture Mechanics
7	ME3027	Fluid Power Controls
8	ME3028	Advanced Thermodynamics
9	ME3029	Computational Methods in Engineering
10	ME3121	Powder Metallurgy
11	ME3122	Introduction to Marketing
12	ME3123	Design and Analysis of Management Information Systems
13	ME3124	Work Design and Measurement
14	ME3125	Cost Analysis and Control
15	ME3126	Supply Chain Management
16	ME3127	Management of Organisational Behaviour
17	ME3128	Production Planning and Control
18	ME3129	Management of Human Resources
19	ME3130	Quality Planning and Analysis
20	ME4021	Industrial Tribology
21	ME4022	Vehicle Dynamics
22	ME4023	Introduction to Robotics
23	ME4024	Design for Manufacturability
24	ME4025	Mechatronics
25	ME4026	Unconventional Energy Systems
26	ME4027	Computational Fluid Dynamics
27	ME4028	Aerodynamics
28	ME4029	Heating, Ventilation and Air Conditioning
29	ME4030	Fundamentals of Combustion
30	ME4031	Refrigerating and Air Conditioning Systems
31	ME4032	Automobile Engineering
32	ME4033	Introduction to Computer Graphics
33	ME4034	Experimental Methods in Fluid Flow and Heat Transfer
34	ME4122	Mechanical Behaviour and Testing of Materials
35	ME4123	Technology Management
36	ME4125	Competitive Manufacturing Management
37	ME4126	Engineering Optimization
38	ME4127	Accounting and Finance for Engineers
39	ME4128	Simulation Modelling and Analysis
40	ME4129	Modelling of Manufacturing Systems
41	ME4130	Human Factors in Engineering and Design

**BRIEF SYLLABI OF
B.TECH DEGREE PROGRAMME IN
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DEPARTMENT OF MECHANICAL ENGINEERING



NATIONAL INSTITUTE OF TECHNOLOGY CALICUT

SEMESTER 3

MA2001 MATHEMATICS III (PROBABILITY & STATISTICS)

Prerequisite: MA 1001

L	T	P	C
3	1	0	3

Probability distributions:- Random variables, Binomial distribution, Hyper-geometric distribution, Chebyshev's theorem, Poisson distribution, Geometric distribution, Normal Distribution, Uniform distribution, Gamma distribution, Beta distribution, Weibull distribution. Joint distribution of two random variables. Sampling distributions and Inference concerning means:- Population and samples, The sampling distribution of the mean, Sampling distribution of the variance, Maximum Likelihood Estimation, Point estimation and interval estimation, Tests of hypothesis, Inference concerning variances proportions:- Estimation of variances, Estimation of proportions, Analysis of $r \times c$ tables, Chi-square test for goodness of fit. Regression Analysis:- Bi-variate Normal distribution- joint, marginal and conditional distributions. Curve fitting, Method of least squares, Estimation of simple regression models and hypothesis concerning regression coefficients, Correlation coefficient- estimation of correlation coefficient, Analysis of variance:- General principles, Completely randomized designs, Randomized block diagram, Latin square designs, Analysis of covariance.

Total Hours: 56

EE2009 ELECTRICAL MEASUREMENTS AND MACHINES

L	T	P	C
3	0	0	3

Prerequisite: Nil

Basics of rotating machinery - principle of operation - e.m.f and torque equation - dc machines -principles of operation, generators and motors – transformers – alternators - synchronous machines - special machines - AC and DC Servomotors - principles of position, velocity and force servo control systems - measurement of resistance, power and energy.

Total Hours: 42

ME2002 ELEMENTS OF SOLID MECHANICS

Prerequisite: ZZ1001 Engineering Mechanics

L	T	P	C
3	0	0	3

General concepts of stress and strain – stress and strain tensors, Axial force, shear force and bending moment diagrams, Bending stresses in beams, Torsion in circular elastic and inelastic bars, Deflection of beams – different methods of assessment, Transformation of stress and strains, Compound stresses, Theory of columns.

Total hours: 42

ME2003 ENGINEERING MECHANICS – DYNAMICS

Prerequisite: ZZ1001 Engineering Mechanics

L	T	P	C
3	0	0	3

Review of particle kinematics and dynamics – work-energy relations for system of particles – impulse-momentum relations for system of particles – impact, Moment-of-momentum equations for particles, Kinematics of rigid bodies – Chasles’ theorem, Velocity and acceleration for different references, Moments and products of inertia – kinetics of plane-motion of rigid bodies, Energy and momentum methods for rigid bodies, Dynamics of general rigid-body motion – Euler’s equations of motion – Euler angles – torque-free motion.

Total Hours: 42

ME2004 FLUID MECHANICS AND MACHINERY

Prerequisite: Nil

L	T	P	C
3	0	0	3

Fluid statics, Pressure measurement, Forces on bodies, Fluid dynamics, One dimensional equations for fluid flow, Bernoulli’s equation and its applications, Introduction to fluid flows, Pumping machinery, Centrifugal pumps and reciprocating pumps, Turbines, Generation of power from fluid flow, Francis, Kaplan and Pelton turbines.

Total Hours: 42 hrs

ME2101 MATERIALS SCIENCE AND METALLURGY

Prerequisite: Nil

L	T	P	C
3	0	0	3

Introduction and overview of engineering materials, Structure of Crystalline Solids, Imperfections/Defects in Solids, Diffusion in Solids, Mechanical Responses of Metals, Dislocations and Strengthening Mechanisms, Plastic deformation, Failure Mechanisms of Materials, Phases and Phase Diagrams, Phase Transformations, Metallic alloys, Structure and Properties of Ceramics, Structure and Properties of Polymers and Composites, Materials Selection and Design Principles.

Total Hours: 42

ME2091 MACHINE DRAWING

Prerequisite: ZZ1002 Engineering Graphics

L	T	P	C
0	0	3	2

Introduction, Principles of orthographic projections in machine drawing, First angle and third angle projections, Methods of dimensioning, Conversion of pictorial projections into orthographic projections, Sectional views, Screwed fastenings, Pipe joints, Shaft joints, Couplings and keys, Bearings, Assembly drawings of parts such as I.C. engine parts, steam engine parts, parts of a lathe and miscellaneous assemblies, Surface texture, Limits, fits and tolerances, Working/Production drawings, Working drawings of simple machine elements, Computer aided drafting, Simple exercises using CAD Packages.

Total Hours: 42

ME2191 PRODUCTION TECHNOLOGY LABORATORY I

Prerequisite: Nil

L	T	P	C
0	0	3	1

Classification of Machine tools and processes, Machining on centre lathes, study of parts and function, cutting tools, types and materials, Grinding, selection of speeds, feeds and depth of cut, Cutting fluids, methods of work holding, Lathe operations like turning, taper turning and eccentric turning, thread cutting, knurling, drilling boring and profile turning, tolerance and surface finish.

Total Hours: 42

SEMESTER 4

MA2002 MATHEMATICS IV

Pre-requisite: MA 1001, MA 1002

L	T	P	C
3	1	0	3

Series Solutions and Special Functions: Power series solutions of differential equations, Theory of power series method, Legendre Equation, Legendre Polynomials, Frobenius Method, Bessel's Equation, Bessel functions, Sturm-Liouville's Problems, Orthogonal eigenfunction expansions. Partial differential Equations: Cauchy's problem for first order equations, Linear Equations of the first order, Nonlinear Partial Differential Equations of the first order, Charpit's Method, Special Types of first order equations, Classification of second order partial differential equations, Wave equation, Heat equation, Laplace equation, Solution of a Partial Differential Equations by Laplace transforms. Complex functions, Derivative, Analytic function, Cauchy- Reimann equations, Laplace's equation, Geometry of Analytic functions: Conformal mapping, Linear fractional Transformations, Schwarz - Christoffel transformation, Transformation by other functions, Line integral in the Complex plane, Cauchy's Integral Theorem, Cauchy's Integral formula, Derivatives of analytic functions. Power series, Functions given by power series, Taylor series and Maclaurin's series. Laurent's series, Singularities and Zeros, Residue integration method, Evaluation of real Integrals.

Total Hours: 56 Hrs

ME2013 MECHANICS OF MACHINERY

Prerequisite: ZZ1001 Engineering Mechanics

L	T	P	C
3	0	0	3

Introduction to mechanisms, Applications, Graphical and analytical method in the analysis of mechanisms, Design of cams – graphical and analytical method, Kinematics of spur gear, Brief idea of cycloidal gear – non-standard gears – bevel – helical and worm gearing, Analysis of gear trains, Kinematic synthesis of mechanisms – graphical and analytical methods, Case studies.

Total Hours: 42

ME2015 THEORY OF ELASTICITY AND PLASTICITY

Prerequisite: ME2002 Elements of Solid Mechanics

L	T	P	C
3	0	0	3

Analysis of Stress and Strain - equilibrium equations - Compatibility Conditions - Stress-Strain Relations, Two dimensional problems, Torsion, Bending of beams, Yield criteria, Stress space representation of Von-Mises and Tresca criteria, Plastic stress-strain relations, Experimental verification, Analysis of Elastic-Plastic problems.

Total hours: 42

ME2016 THERMODYNAMICS AND HEAT TRANSFER

Prerequisite: NIL

L	T	P	C
3	0	0	3

Basic concepts of thermodynamics, The Zeroth law of thermodynamics, Concept of heat and work, The First law of thermodynamics, The second law of thermodynamics, The Carnot cycle, Entropy, Thermodynamic property relations, Steady and transient heat conduction, Differential and integral equations of heat convection, Integral solution for forced convection, Fully-developed flow in tubes, Heat exchangers, Thermal radiation, View factor algebra, Radiative energy exchange between black, diffuse, and gray surfaces.

Total Hours: 42

ME2111 ESSENTIALS OF MANAGEMENT

Prerequisite: Nil

L	T	P	C
3	0	0	3

The management process, Schools of management thought, Kinds of managers, Basic elements of planning Types of plans, Organizing process, Delegation of authority, Motivational strategies, Basic elements of control, Managing human resources in organizations, Functions of financial management, Nature of marketing, Managerial decision making process, Network techniques – critical path method – programme evaluation and review technique.

Total Hours: 42 hours

ME2112 METAL CASTING AND JOINING

Prerequisite: Nil

L	T	P	C
3	0	0	3

Fundamentals of Casting and Expendable Mold processes, Use of cores. Properties of molding sands, Molding Processes. Melting furnaces. Homogeneous and heterogeneous nucleation. Gating and riser design. Cleaning of castings. Casting defects, inspection and QA. New casting methods. Solidification modelling and simulation. Metallurgy of welding, Residual stresses in welds, Hot and cold cracking of welds, Soldering and brazing. Gas welding, arc welding and resistance welding, Evaluation of welds (NDT methods), Diffusion bonding, Adhesive bonding. Casting Defects in Steels, Schaeffler diagram, Carbon Equivalent, Carbide precipitation in Stainless steels.

Total Hours: 42

ME2092 FLUID MECHANICS AND FLUID MACHINERY LABORATORY

Prerequisite: ME2001 Mechanics of Fluids

L	T	P	C
0	0	3	2

Study of plumbing tools and pipe fittings, Study of measuring instruments, Measurement of metacentric height and radius of gyration of a floating body, Calibration of flow measuring devices - venturimeter- orifice meter - notches and weirs - nozzle meters, Determination of loss of head due to friction in pipes, Verification of Bernoulli's theorem, Determination of lift and drag coefficients of cylinder and airfoil, Demonstration of laminar and turbulent flow in pipes - critical velocity, Forces on curved and plane surfaces, Experiments on turbines - performance and operating characteristics, Experiments on pumps - centrifugal pumps - reciprocating pumps - gear pumps, Experiment on torque converter.

Total Hours: 42

CE2095 STRENGTH OF MATERIALS LABORATORY

L	T	P	C
0	0	3	2

Prerequisite: CE2001 Mechanics of Solids or equivalent.

Tension test on MS rod, Shear Test on MS rod, Torsion test on MS Specimen, Hardness tests on metals, Impact tests on metals, Bending test on steel beams, Spring test – open and close coil springs, Compression test on cubes and cylinders – determination of modulus of elasticity, Study of extensometers and strain gauges

Total Hours: 42

SEMESTER 5

ME3001 DYNAMICS OF MACHINERY

Prerequisite: ME2013 Mechanics of Machinery

L	T	P	C
3	0	0	3

Static force analysis of machines, Static force analysis with friction, Force analysis of gears – spur, helical and bevel, Method of virtual work, Dynamic force analysis, Principle of super position, Complex algebra method, Balancing – balancing of rotating masses, engines and linkages, Balancing machines, Gyroscopes and its applications, Cam dynamics, Governors, Flywheels, Recap of the single DOF vibration systems – free and forced vibrations – equivalent viscous damping, Transient vibration, Vibration measuring instruments, Vibration of two DOF systems, Multi DOF systems, Lagrange's equation, Introduction to vibration of continuous systems, Approximate methods – Rayleigh's energy method – Dunkerley's equation, Holzer's method, Geared systems.

Total Hours: 42

ME3103 MACHINE TOOLS

Prerequisite: Nil

L	T	P	C
3	0	0	3

Kinematics of machine tools, various machine tools. Design of machine tool structures. Hydraulic and pneumatic circuits for machine tools. Machining operations, kinematics of gear shapers and gear hobbers, Grinding machines, types, construction features, wheel mounting, etc. Special purpose machine tools. Design of modern CNC machines, Machining centers, 3,4,5 axis machining, design of CNC machine tools. Mechatronic elements. CNC programming. Acceptance testing of machine tools. Machine tools for micro machining. Modern trends in machine tools.

Total Hours: 42

ME3104 METROLOGY AND COMPUTER AIDED INSPECTION

Prerequisite: Nil

L	T	P	C
3	0	0	3

Measurement system elements, Temperature, Pressure and Strain sensors. Experimental Test Plan. Calibration - Sensitivity, Range, Accuracy, Standards, Traceability. Regression analysis. Uncertainty analysis. Metrology: Interferometry, Slip gauges, Comparators, Abbe's principle, Pneumatic transducer, Electronic transducers, Angle measurement. Optical instruments- Surface finish- Parameters, Stylus instruments. Gauge design and tolerancing, Inspection of geometric tolerances and true position tolerances. Screw thread measurements. Coordinate Measuring Machines- Construction, Operation & Programming, Software, Applications. Machine Vision: Sensing, Preprocessing, Segmentation, Description, Recognition and Interpretation.

Total Hours: 42

ME3105 PRODUCTION MANAGEMENT

Prerequisite: Nil

L	T	P	C
4	0	0	4

Characteristics of production systems, Modern production management systems, Operation strategy and competitiveness Product design and process selection, Strategic capacity planning, Procurement of capital equipment, Forecasting, Time series analysis, simple regression, Error measurement, Production planning and control – framework, Material requirement planning (MRP) – technical issues – Production activity control techniques – finite loading – Gantt chart – priority sequencing, Inventory control – inventory problem classification, Selective inventory control, Independent demand systems – deterministic models – introduction to probabilistic models, Basic concepts of supply chain management, Facilities planning, Facilities planning strategies, Layout planning, Types of layout – process layout – product layout – group technology layout, Quality management, Quality costs, Analytical tools for quality control, Introduction to TQM, Introduction to six sigma, Statistical process control, Control charts for variables and attributes, Introduction acceptance sampling.

Total Hours: 42

ME 3003 ENVIRONMENTAL STUDIES FOR MECHANICAL ENGINEERS

Prerequisite: Nil

L	T	P	C
3	0	0	3

Scope and importance of Environmental Studies, Ecosystems – Structure and function, Natural resources and associated problems, Environmental Pollution – Definition – Causes, effects and control measures, Renewable and non-renewable resources, Field work.

Total Hours: 42

ME3192 METROLOGY AND INSTRUMENTATION LABORATORY

Prerequisite: Nil

L	T	P	C
0	0	3	1

Calibration and determination of uncertainties - Measurement of thread parameters - Evaluation of straightness - Measurement of tool angles of single point tool - Measurement of gear parameters - Measurement of surface finish - Study and measurements with CMM - Experiments on limits and fits - Study and use of ultrasonic flaw detector - Measurement system analysis - Usage of thread pitch micrometer, disc micrometer, thread pitch gauge, height gauge, slip gauges, optical flat, three pin micrometer, pyrometer, RTD, Sling psychrometer, zoom microscope, etc.

Total Hours: 42

ME3194 PRODUCTION TECHNOLOGY LABORATORY II

Prerequisite: Nil

L	T	P	C
0	0	3	1

Shaping and slotting Exercises - Flat and bevel surfaces, grooves, Slots, guide ways, key ways etc. Exercises in horizontal and Vertical milling machine - Surface, slot, key way and gear milling. Turning Exercises - Limits and Fits. Grinding Exercises. Non – traditional Machining. NC / CNC Machining.

Total Hours: 42

SEMESTER 6

ME3113 QUANTITATIVE TECHNIQUES FOR MANAGEMENT

Prerequisite: Nil

L	T	P	C
3	0	0	3

Principals of modelling, formulation of linear programming models, Graphical solution of linear programs in two variables, Solving system of linear equations, Principles of the simplex method, Simplex method in Tableau form, Computational problems – degenerate solutions – unbounded solutions, Duality concept – general primal-dual relations, Transportation simplex method, Assignment problems and solution, Theory of games – pure and mixed strategies – principles of dominance, Solutions of games using graphical method and linear programming method, Dynamic programming – principle of optimality – examples, Queuing theory – Basic structure of queuing models – performance measures of a queuing system, Single server queuing models – unlimited queuing – limited queuing.

Total Hours: 42

ME3114 CAD/CAM/CIM

L	T	P	C
3	0	0	3

Prerequisite: Nil

Design process and CAD/CAM; review of basics of interactive computer graphics; 2D and 3D transformations. Representation of solid models; B-rep models; CSG models; CNC machine tools, constructional features, drives and controls, CNC manual part programming and computer assisted programming, computer integrated manufacturing systems, computer aided inspection, group technology, flexible manufacturing systems, industrial robotics and machine vision, rapid prototyping, design for manufacturability, process planning and concurrent engineering, lean production and agile manufacturing, Reconfigurable Manufacturing Systems.

Total Hours: 42

ME3013 THERMAL ENGINEERING

Prerequisite: Thermodynamics and Heat Transfer

L	T	P	C
3	0	0	3

Internal combustion engines, 2 stroke and 4 stroke SI and CI engines, theoretical and actual cycles, different systems of IC engines , combustion process in CI and SI engines, performance and governing of IC engines, Nozzles, throat pressures and areas for maximum discharge , supersaturated flow, Steam turbines, compounding , reheat factor, Gas turbine cycles , Joule- Brayton cycle, regeneration, inter-cooling and reheating, Reciprocating Compressors and Rotary compressors, Refrigeration, vapour compression and vapour absorption refrigeration, Air conditioning, psychrometry, psychrometric processes.

Total Hours: 42

ME3014 DESIGN OF MACHINE ELEMENTS

Prerequisite: ME2002 Elements of Solid Mechanics

L	T	P	C
4	0	0	4

Steps in design process, Selection of materials, Theories of failure, Design for static, impact and fatigue loading, Stresses in threaded members, Bolted joints, Design of welded joints, Stress analysis and design of helical and leaf springs, Design of shafts and keys, Design of spur, helical, bevel and worm gears for static load, dynamic load and surface durability, Lubrication and bearing design, Selection of rolling contact bearings.

Total Hours: 56

ME3195 CAD/CAM/CIM LABORATORY

Prerequisite: Nil

L	T	P	C
0	0	3	1

Exercises on Solid Modelling - Exercises on Finite Element Analysis - Assembly and Mechanism Design - Computer Aided Manufacturing - Programming of Industrial Robots – Study of Coordinate Measuring Machine - Concepts of Reverse Engineering and Rapid Prototyping Technology.

Total Hours: 42

ME3092 THERMAL ENGINEERING LABORATORY

Prerequisite: Nil

L	T	P	C
0	0	3	2

Study of spark ignition (SI) and compression ignition (CI) engine systems - fuel system - lubrication system - cooling system - starting system - ignition system - governing system - power transmission system - types of carburetors - fuel injectors - multi point fuel injection (MPFI) system - common rail direct injection (CRDI) system - gasoline direct injection (GDI) system, Study of different types of boilers and its components, Study of fuel properties measuring systems - bomb calorimeter - gas calorimeter - red-wood viscometer - flash and fire apparatus, Study of dynamometers, Constant speed performance characteristics of SI engine, Morse test at constant throttle and at constant load, Constant speed performance characteristics of SI engine, Constant speed performance characteristics of MPFI engine, Performance characteristics of constant speed CI engine, Constant speed performance characteristics of single cylinder CI engine, Determination of frictional horse power (FHP) by retardation test, Performance characteristics with cooling water temperature (cooling curve experiment) by suitable test, Valve timing diagrams of single and multi cylinder engines, Measurement of thermal conductivity of metal rod, Study of heat transfer in forced convection and to determine convective heat transfer coefficient, Measurement of emissivity, Performance test on vapour compressor refrigeration system, Comparison of heat transfer coefficient of fins of different geometrical shapes, Determination of the effectiveness of shell and tube heat exchanger apparatus.

Total Hours: 42

SEMESTER 7

ME 4102 THEORY OF METAL CUTTING

Prerequisite: Nil

L	T	P	C
4	0	0	4

Tool nomenclatures - ASA, ORS, NRS, etc., Insert - geometries and nomenclature. Mechanics of chip formation. Theories of metal cutting. Tool geometries. Selection of cutting parameters in turning, milling, drilling, etc. Modelling of cutting processes, Cutting tool materials, Advances in cutting tool materials. Theories of tool wear, measurement of tool wear, Tool life and economics of machining. Abrasive machining processes, mechanics of grinding, Tool Dynamometers, features and measuring strategy, Thermal aspects of machining, Optimal machining conditions and productivity, Machinability, Surface integrity, Modern machining processes, Micro/nano machining, Recent developments.

Total Hours: 56

ME4103 TOOL ENGINEERING AND DESIGN

Prerequisite: Nil

L	T	P	C
3	0	0	3

Design of chips forming tools, single point tools, tool geometry, Influence of cutting parameters on cutting force and power, cutting power estimation in Turning, Milling & Drilling. Press Working Tools, power presses, die cutting operations, centre of pressure, punch & die size, scrap - strip layout. die design, drawing dies, press tonnage estimation, blank holding pressure, multiple draws. Design of fixtures, principles of location & clamping, plain & concentric location, clamping elements, quick acting clamps, design of plate fixtures, turning fixtures and indexing fixtures. Design of Jigs, Jigs for drilling & reaming, types of jigs, indexing jigs, design of plate jigs, angle plate jigs, indexing jigs and box jigs.

Total Hours: 42

ME4192 MANAGEMENT SCIENCE LABORATORY

Prerequisite: ME3105 Production Management

L	T	P	C
0	0	3	1

Performance analysis of a serial supply chain – role play game, Problem formulation and solution using LINGO, Simulation exercise using ARENA, Construction of control chart and process capability determination, Design a process layout for the given problem, Preparation of product structure and material planning using MRP, Stop watch time study, Learning curve, Visual acuity test – dark adaptation analysis.

Total Hours: 42

ME4193 METAL CUTTING LABORATORY

Prerequisite: Nil

L	T	P	C
0	0	3	1

Study and programming of CNC machines, Measurement of cutting force in various machine tools; Study of the variation of cutting force with parameters like cutting velocity, feed, depth & tool geometry, Study of influence of cutting fluids on machining, Study of tool and cutter grinder, Surface integrity studies on parts machined in traditional machine tools, Experiments on cylindrical grinding machines, Metal removal rate and tool wear rate studies on die sinking EDM, Study of crank press and preparation of scrap strip layout, Preparation of tool layout for turret lathe

ME4098 PROJECT

Prerequisite: Nil

Total Hours: 42

L	T	P	C
0	0	3	3

Students are required to take up a project (generally in groups) in any topic related to Mechanical Engineering under the guidance of a faculty member. The project work commenced in VII Semester (normally 5 hours/week) shall be continued in VIII Semester too. At the end of the VII semester, an interim report describing the details of the project work has to be submitted to the Department, usually in a prescribed format. Presentation of this part of the work is to be done before an evaluation committee.

SEMESTER 8

ME4111 INDUSTRIAL ENGINEERING

Prerequisite : Nil

L	T	P	C
3	0	0	3

Productivity, Method study, Process and Operation analysis, Motion analysis, Principles of motion economy, Introduction to Ergonomics, Time study, Standard time determination, Incentive plans, Work sampling, Pre-determined Motion Time Systems, Job analysis, Job evaluation, Merit rating, Principles of costing, Methods of costing, Breakeven analysis, Depreciation and replacement analysis Activity based costing.

Total Hours: 42

MS4004 INDUSTRIAL ECONOMICS

L	T	P	C
3	0	0	3

Prerequisite: Nil

Micro Economics, Demand and Supply Forces, Elasticity concepts, Short run and long run costs, Market Structure, Pricing in different markets, Macro Economic Aggregates-Gross Domestic Product, Inflation, Fiscal and Monetary Policies; Monetary system; Money Market, Capital market; Indian stock market; International trade - Foreign exchange market- Balance of Payments (BOP) and Trade, International Trade and development and role of international institutions.

Total Hours: 42 hours

ME4097 SEMINAR

L	T	P	C
0	0	3	1

Prerequisite: Nil

Search technical literature in the form of peer reviewed journals and conference proceedings and identify a current research topic relevant to Mechanical Engineering – Comprehend the topic and prepare a technical report on the topic of presentation in the specified format – Prepare presentation aids and deliver a technical presentation to the class – Appropriate weights will be given for communications skills (both verbal and written) as well as for capacity to impress the audience and ability to handle question and answer session.

Total Hours: 42

ME4099 PROJECT

Prerequisite: ME4098 Project

L	T	P	C
0	0	5	5

The project work commenced in VII Semester shall be continued in VIII Semester, normally 5 hours/week. At the end of the VIII semester, the final report/thesis describing the details of the entire project work has to be submitted to the Department, usually in a prescribed format. Presentation of the entire work is to be done before an evaluation committee and a successful oral defense of the thesis before the committee is required.

Total Hours: 70

ELECTIVES

ME3021 INTRODUCTION TO FINITE ELEMENT METHODS

Prerequisite: Nil

L	T	P	C
3	0	0	3

Linear vector Spaces, Variational methods of approximation – FE analysis of one-dimensional and two-dimensional problems, Applications to heat transfer, elasticity and fluid mechanics problems, FE analysis of Eigen value problems and non-linear problems.

Total Hours: 42

ME3022 EXPERIMENTAL STRESS ANALYSIS

Prerequisite: ME2002 Elements of Solid Mechanics or Equivalent (Consent of teacher)

L	T	P	C
3	0	0	3

Analysis of stress and strain, Formulations of problems in elasticity, Strain measurement methods and related instrumentation – strain gauges and strain rosettes, Basic optics – theory of photoelasticity – polariscope – photo elastic materials, Theory of brittle coating – brittle coating methods.

Total hours:42

ME3023 THEORY OF PLASTICITY

Prerequisite: ME2012 Applied Mechanics of Solids

L	T	P	C
3	0	0	3

Review of the analysis of stress and strain, true stress – true strain plots for uni-axial tension and compression of specimens, Yield criterion and its representation in stress space, Important stress-strain relations in plasticity, Plastic potential, Problems in elastic-plastic deformation – bending, torsion, shells with spherical and axial symmetry , Plane strain problems – slip line field theory, Bound theorems, Analysis of metal forming operations like drawing, extrusion, rolling and forging, Load calculations for the operations.

Total Hours: 42

ME3024 CONTROL SYSTEMS ENGINEERING

Prerequisite: Nil

L	T	P	C
3	1	0	3

Linear time invariant systems and their mathematical models, representations by the transfer function and state space, Transient analysis of systems by classical method and state space, stability analysis, steady state error, root locus technique, frequency response, Nyquist criterion, Design of control systems, classical methods and through state space, controllability and observability, Use of MATLAB.

Total Hours: 42

ME3025 NONLINEAR DYNAMICS AND CHAOS

Prerequisite: ZZ1001 Engineering Mechanics

L	T	P	C
3	0	0	3

Dynamical systems – nonlinear dynamics, Dynamics of continuous time systems – limit cycle – bifurcation and chaos – Poincaré section, Concepts of stability, Dynamics of discrete time systems – one dimensional maps – bifurcation and chaos, Henon map, Stability, Fractals- measures of fractals, Numerical methods – shooting method, harmonic balance method – Lyapunov exponents, Applications.

Total Hours: 42

ME3026 ENGINEERING FRACTURE MECHANICS

Prerequisite 1: ME2002 Elements of Solid Mechanics

Prerequisite 2: ME2012 Applied Mechanics of Solids/

ME2015 Theory of Elasticity and Plasticity

L	T	P	C
3	0	0	3

Significance of fracture mechanics, Griffith energy balance approach, Stress intensity approach, Problems in I, II & III modes, Linear elastic fracture mechanics (LEFM), Fracture toughness testing, Crack tip plasticity, Elastic plastic fracture mechanics (EPFM), J-integral, Crack opening displacement (COD) approach, Standard J_{Ic} test and COD test, Fatigue crack growth, Paris law, Prediction of fatigue crack growth, Practical problems.

Total Hours: 42

ME3027 FLUID POWER CONTROLS

Prerequisite: ME2001 Fluid Mechanics

L	T	P	C
3	0	0	3

Introduction to oil hydraulics and pneumatics, Basic types and constructions of Hydraulic pumps and motors, Hydraulic control elements, Electro hydraulic servomechanisms, Hydraulic power supplies, Design and analysis of typical hydraulic circuits, Components of pneumatic systems, Development of single and multiple actuator circuits, Electro-pneumatic control and air hydraulic control.

Total Hours: 42

ME3028 ADVANCED THERMODYNAMICS

Prerequisite: ME2014 Thermodynamics

L	T	P	C
3	1	0	3

General principles of classical thermodynamics, Euler and Gibbs-Duhem equations, Multi-component simple ideal gases, Reversible processes, Extremum principles in the Legendre transformed representation, Thermodynamic potentials and Massieu functions, Maxwell relations and Jacobian methods, Procedure to reduction of derivatives, Stability criteria of thermodynamic systems, First-order phase transition, Gibbs phase rule, Critical phenomena, Nernst postulate, Introduction to irreversible thermodynamics, Special topics on advanced thermodynamics.

Total Hours: 42

ME3029 COMPUTATIONAL METHODS IN ENGINEERING

Prerequisite: NIL

L	T	P	C
3	0	0	3

Basic consideration in numerical methods, Numerical error and accuracy, Numerical parameters, Numerical differentiation, Numerical solution of linear algebraic equations, Under relaxation and over relaxation, Root of equations, Numerical curve fitting and interpolation, Numerical integration, Numerical solution of ordinary differential equations.

Total Hours: 42

ME3121 POWDER METALLURGY

Prerequisite: Nil

L	T	P	C
3	0	0	3

Powder Metallurgy Process, Powder properties and their characteristics, Compaction and shaping, Powder Injection Moulding, Extrusion and rolling. Hot compaction techniques, Explosive compaction, Slip casting. Sintering, material transport mechanisms, Model studies, Powder shrinkage experiments, Sintering diagrams and sintering anomalies. Multi-component sintering, infiltration and reaction sintering, Sintering atmospheres and equipments. Powder metallurgy products, Research trends in Powder Metallurgy.

Total hours: 42

ME3122 INTRODUCTION TO MARKETING

Prerequisite: MA 2001 Mathematics III: Probabilities and Statistics

L	T	P	C
3	0	0	3

Marketing concepts, Marketing mix, Functions of marketing, Strategic planning in marketing, Contents of marketing plan, Market segmentation, Levels of market segmentation, Marketing research – analysis, Product lifecycle marketing strategy, Buying decision process, Marketing mix, Stages in buying process, Brand management, Managing business to business customer relations, Pricing, Organizational buying, Initiating and responding to price changes.

Total Hours: 42

ME3123 DESIGN AND ANALYSIS OF MANAGEMENT INFORMATION SYSTEMS

Prerequisite: Nil

L	T	P	C
3	0	0	3

Introduction to MIS - Building blocks- system design forces and development lifecycle, General system design methodology - system analysis and requirement specification, Database management- coding, forms design, storage and processing of data base files, System implementation - Verification and Validation, CMM, Software testing, training and audit, Security features.

Total Hours: 42

ME3124 WORK DESIGN AND MEASUREMENT

Prerequisite : Nil

L	T	P	C
3	0	0	3

Work design and methods study – work design – process analysis – operation analysis, Principles of motion economy, Work measurement, Time measurement – PTM, MTM, Work sampling, Ergonomics – nature of man-machine systems, Human information processing, Visual displays – Auditory and tactual displays- Bases of human motor activity – influence of display factors and control factors

Total Hours: 42

ME3125 COST ANALYSIS AND CONTROL

Prerequisite: Nil

L	T	P	C
3	0	0	3

Generally accepted Accounting Principles and Accounting Standards, Cash Flow Statement, Financial Statements Analysis, Costing and Control of Materials, Costing and Control of Labour ,Costing and Control of Factory (Manufacturing) Overheads, Cash Flow Statement, Activity Based Costing System, Volume-Cost-Profit Analysis, Capital Budgeting.

Total Hours: 42

ME3126 SUPPLY CHAIN MANAGEMENT

Prerequisite: Nil

L	T	P	C
3	0	0	3

Introduction and a strategic view of supply chains, Evolution of supply chain management (SCM) Supply chain performance in India, Supply chain strategy and performance measures, Supply chain performance measures, Introduction to Inventory management, Analyzing impact of supply chain redesign on the Inventory, Devising a strategy for transportation, Network design and operation decisions, Models for facility location and capacity allocation, Bullwhip effect, Supply chain restructuring, Enabling supply chain management through Information technology.

Total Hours: 42

ME3127 MANAGEMENT OF ORGANISATIONAL BEHAVIOUR

Prerequisite: Nil

L	T	P	C
3	0	0	3

Introduction to Organisational behaviour - assumptions, behaviour values, attitudes, personality, emotions, perception and abilities, Group process- communication, leadership and conflict resolution, Organisational process - work design, design of organisational structure, culture, Organisational change, stress and decision making.

Total Hours: 42

ME3128 PRODUCTION PLANNING AND CONTROL

Pre-requisite: Nil

L	T	P	C
3	0	0	3

Manufacturing planning and control framework, Continuous improvement, Process reengineering, Just-in-time principles, Forecasting, Sales and operations planning, Master production scheduling (MPS), Material requirements planning (MRP) – Lot sizing, buffering concept – nervousness, Just-in-time (JIT) – pull production systems, Mixed model production schedule, Shop-floor control and capacity analysis – capacity planning and control techniques – frame work of shop-floor control – production activity control techniques.

Total Hours: 42

ME3129 MANAGEMENT OF HUMAN RESOURCES

Prerequisite: Nil

L	T	P	C
3	0	0	3

Introduction to Management of human resources - evolution, issues strategy and instruments, Personnel management - functions, Job analysis and design, Job evaluation, Industrial relations - Labour laws, Conflict resolution, issues, Organisational Development - Organisational design, work organisation, Organisational change and management.

Total Hours: 42

ME3130 QUALITY PLANNING AND ANALYSIS

Prerequisite: Nil

L	T	P	C
3	0	0	3

Basic concepts, Total quality management, Leadership, Customer Satisfaction, Cost of poor quality, QC Tools Quality function deployment, Design of experiments, Total productive maintenance, Statistical process control, Control charts for variables and attributes, Six sigma, Acceptance sampling – sampling plan design, Reliability – life-history curve.

Total Hours: 42

ME4021 INDUSTRIAL TRIBOLOGY

Prerequisite 1: ME2001 Fluid Mechanics/ ME2004 Fluid Mechanics and Machinery

Prerequisite 2: ME2012 Applied Mechanics of Solids/

ME2015 Theory of Elasticity and Plasticity

L	T	P	C
3	0	0	3

Basic equations, Reynolds equations, Idealized hydrodynamic bearings, Finite bearings, Hydrodynamic instability, Externally pressurized and gas lubricated bearings, Surface topography, Mechanics of contact, Theories of friction, Wear of materials, Measurement of friction and wear.

Total Hours: 42

ME4022 VEHICLE DYNAMICS

Prerequisite: ME2003 Engineering Mechanics – Dynamics

L	T	P	C
3	0	0	3

Introduction to vehicle dynamics, Acceleration performance, braking performance, Aerodynamics and rolling resistance, Steady-state cornering, Acceleration–Braking and turning forces, Front wheel geometry–effects of front wheel geometry on vehicle performance, Dynamic axle Loads, Transient rollover, Acceleration, Rear wheel lockup, Drag forces, Total road loads, Tyre construction –Types- Types of tyers–Basic Tyre modelling considerations , Sensors, Actuators, Cruise control, Antilock Braking System (ABS), Traction control, Directional control, Vehicle stability controls, Active suspension, Computer aided analysis/Simulation–Simulation with MATLAB-Simulink and ADAMS

Total Hours: 42

ME4023 INTRODUCTION TO ROBOTICS

Prerequisite: Nil

L	T	P	C
3	1	0	3

Introduction to Robotics, Types, Sensors and Actuators in Robotics, Grippers, Robot kinematic analysis, Homogeneous transformation, Denavit-Hartenberg (DH) representation, Forward and Inverse kinematics, Robot Dynamic analysis, Jacobians, Lagrangian and Newton-Euler Methods, Trajectory generation, Robot programming, Robot Control.

Total Hours: 42

ME4024 DESIGN FOR MANUFACTURABILITY

Prerequisite: Nil

L	T	P	C
3	0	0	3

Implementing DFM, Concurrent Engineering, Design for quality, Design for Life Cycle, Design for Cost, Team Building and Training. Quality Tools in DFM. Computer Aided Technology, Creative Thinking in DFM, Tools. General Product Design – Impact of Design concept and early project decisions, Evaluating manufacturability of conceptual designs, Producibility, Geometric Tolerancing. Design for Assembly. Design for Machining. Design for forming. Design for Forging, Casting. Design for Heat Treatment. Design for Fastening & Joining. Design for Materials.

Total Hours: 42

ME4025 MECHATRONICS

Pre-requisite: Nil

L	T	P	C
3	0	0	3

Introduction to Mechatronics System, Types of Designs, Mechatronic Design process, Introduction to Actuators, Sensors and Transducers, Special Transducers, Introduction to Signals, System and Controls, PID Controller, Microprocessors and Microcontrollers, Programmable Logic Controller, Introduction to MEMS, Artificial Intelligence in Mechatronics, Case studies.

Total Hours: 42

ME4026 UNCONVENTIONAL ENERGY SYSTEMS

L	T	P	C
3	0	0	3

Prerequisite: Nil

Introduction to energy problem, Solar energy systems, Biomass energy utilization, Wind energy conversion systems, Small hydro power systems, Ocean thermal energy conversion, Wave and tidal energy utilization, Economic analysis of unconventional energy systems, Introduction to integrated energy systems.

Total hours: 42

ME4027 COMPUTATIONAL FLUID DYNAMICS

L	T	P	C
3	0	0	3

Prerequisite: Nil

Physical significance for mathematical classifications of partial differential equations as elliptic, parabolic and hyperbolic, Simplification methods of governing equations, Discretization methods for converting derivatives to their finite difference forms, Discretization error, computational methods for model equations, Methods to deal Dirichlet, Neumann and Robins type boundary conditions for regular and irregular shapes, Solution methods of the linear algebraic equations, consistency, stability and convergence of computational methods, Discrete perturbation stability analysis, Von Neumann stability analysis, Validation of computational solution, Four basic rules to obtain consistency and stability, Computation of the flow field using stream function-vorticity formulation, Analysis of two dimensional incompressible viscous flow inside a Lid Driven Cavity, Algorithms to obtain flow field by solving system of coupled equations.

Total Hours: 42

ME4028 AERODYNAMICS

Prerequisite: ME2001 Fluid Mechanics

L	T	P	C
3	0	0	3

Equations for incompressible inviscid flows, Fluid circulation and rotation, Blasius theorem for force and moment on bodies, Elementary flow patterns and their superposition. Flow past a cylinder, Kutta condition Vortex theory of lift. Conformal transformation, The Joukowski transformation - Aerodynamic center, Pitching moment, low speed flows over aerofoils - the vortex sheet, Thin aerofoil theory, Camber line at zero angle of attack, Characteristics of thin aero foils, Motion in three dimensions, Flow past slender bodies. Finite wings - downwash and induced drag - Prandtl-Lanchester theory - Biot- Savart law, Horseshoe effects, Ground effects, Lineraised compressible flows in two dimensions, Similarity rules, Aerofoil in compressible flows.

Total Hours: 42

ME4029 HEATING, VENTILATION AND AIR CONDITIONING

Prerequisite: Nil

L	T	P	C
3	0	0	3

Review on refrigeration, Principles of refrigeration - vapour compression system -- absorption system -- air refrigeration system -- components of refrigeration systems, Psychrometric processes – applications, Air conditioning systems, Human comfort, Cooling load calculation, Design of air conditioning systems, Duct design, Air distribution, Heating systems, Insulation, Air conditioning equipments and controls for temperature, pressure, moisture and noise, Installation and charging of refrigeration unit – testing -- trouble shooting.

Total Hours: 42

ME4030 FUNDAMENTALS OF COMBUSTION

Prerequisite: ME2014 Thermodynamics

L	T	P	C
3	0	0	3

Introduction to combustion, Enthalpies of reactants and products, Chemical kinetics, Adiabatic flame temperature, Reaction rates and orders, Different reactions, Flames and their structures, Properties of laminar flame, Turbulent flames, Droplet combustion, D^2 Law for droplet vaporization, Pollution – Emissions.

Total Hours: 42

ME4031 REFRIGERATION AND AIR CONDITIONING SYSTEMS

Prerequisite: Nil

L	T	P	C
3	0	0	3

Principles of refrigeration, Performance parameters, Refrigeration systems, System components, Other refrigeration systems, Introduction to liquefaction systems, Vapour compression refrigeration system, System components, Vapour absorption system, refrigerants, Psychrometry, requirement of air conditioning, ventilation standards, Applied psychrometry, summer air conditioning processes, winter air conditioning processes, Other air conditioning systems, Cooling load, design of air conditioning, Analysis for heating and cooling systems, Air conditioning equipments and control systems, Cooling load calculations, Analysis for heating and cooling systems, Air conditioning equipments and control systems.

Total Hours: 42

ME4032 AUTOMOBILE ENGINEERING

Prerequisite : Nil

L	T	P	C
3	1	0	3

Constructional details of engines, Cooling system Lubrication system , Fuel systems - components, Carburetors , Electronic fuel injection system, Ignition system, Transmission systems – Clutch - Gear box - Propeller shaft - Universal coupling - Differential - Axle, Brakes, Steering mechanism - power assisted steering, Vehicle body terminology, Chassis and suspension -Road springs -Shock absorbers - torsion bars, Air suspension systems, Wheels, Starting mechanism, Electrical equipments – regulators, Air pollution and control

Total Hours: 42

ME4033 INTRODUCTION TO COMPUTER GRAPHICS

Prerequisite: ZZ1004 Computer Programming

L	T	P	C
3	0	0	3

Introduction to computer graphics - Overview, Mathematics for computer graphics - Algorithms for generating line, circle and ellipse. Two-dimensional and three-dimensional transformations – Affine and perspective geometry - Orthographic, axonometric and oblique projections: perspective transformations. Plane curves, non-parametric and parametric curves: Space curves - cubic spline, Bezier curves, B-spline curves, NURBS. Surface description and generation - Surface of revolution, Sweep Surface, Linear Coons surface, Bezier surface, B-Spline surface, B-Spline surface filling, Introduction to solid modelling, Hidden lines and Hidden Surfaces.

Total Hours: 42

ME4034 EXPERIMENTAL METHODS IN FLUID FLOW AND HEAT TRANSFER

Prerequisite: Nil

L	T	P	C
3	0	0	3

Introduction to experimental methods – basic concepts, Pressure measurements, Flow measurement – passive-displacement methods – flow-obstruction methods – flow measurement by drag effects, Flow visualization methods, Temperature measurements – temperature scales – ideal-gas thermometer – transient response of thermal systems – thermocouple compensation – temperature measurements in high-speed flow, Transport-property measurement, Thermal-radiation measurements – emissivity measurement – reflectivity and transmissivity measurement – solar radiation measurement.

Total Hours: 42

ME4122 MECHANICAL BEHAVIOUR AND TESTING OF MATERIALS

Prerequisite: ME2101 Materials Science and Metallurgy

L	T	P	C
3	0	0	3

Plastic deformation by slip and twinning, Slip systems in FCC, BCC and HCP lattices, CRSS, Dislocations in FCC and HCP lattice. Strengthening mechanisms, Strengthening from fine particles, Fiber strengthening, Cold working and strain hardening, Brittle fracture, Griffith theory, Dislocation theories of brittle fracture, Ductile fracture, Fatigue of metals, Effects of metallurgical variables and fatigue, Creep and stress rupture, Fracture at elevated temperature, Creep resistant alloys. Tension test, Stress-strain curves, Ductility measurement, Effect of strain rate, Stress relaxation testing. Hardness tests, relationship between hardness and flow curve, micro hardness testing. Types of torsion failures and torsion testing.

Total Hours: 42

ME4123 TECHNOLOGY MANAGEMENT

Prerequisite: Nil

L	T	P	C
3	0	0	3

Technology – definition and characteristics, Process of technological change, Technology life cycles, Diffusion of technology, Critical factors in managing technology, Technology and competition, Technology Strategy – Transfer of technology – Technology intelligence – Collaborative mode, Appropriation of technology, Technology evaluation and financing, Technology audits, Intellectual property rights – patents – trade secrets – trade marks – copyrights.

Total Hours: 42

ME4125 COMPETITIVE MANUFACTURING MANAGEMENT

Prerequisite: Nil

L	T	P	C
3	0	0	3

Evolution of manufacturing, E-manufacturing, Continuous improvement, Process reengineering, Basic problem solving and improvement tools, Just-In-Time (JIT) Principles, TQM, Statistical process control, Six sigma quality, Small lot production, Setup time reduction, Pull production, Kanban, Focused factories and group technology, Production flow analysis, Cellular manufacturing, Work cell design.

Total Hours: 42

ME4126 ENGINEERING OPTIMIZATION

Prerequisite: Nil

L	T	P	C
3	0	0	3

Engineering applications of optimization, Classification, Linear programming, Duality, sensitivity analysis, Integer programming, Travelling salesman problem, Vehicle routing problem, Network models, Spanning tree problem, Shortest path problem, Maximum flow problem, Minimum cost flow problem, Network simplex method, Non-linear programming, Unconstrained optimization, Constrained optimization with equality and inequality constraints, Quadratic programming.

Total Hours: 42

ME4127 ACCOUNTING AND FINANCE FOR ENGINEERS

Prerequisite: Nil

L	T	P	C
3	0	0	3

Scope and functions of Finance and related discipline, Time value of money, Stock and Bond valuation, Sources of corporate finance, Financial Accounting, Journal, Ledger, Trial Balance, Profit and loss account, Balance sheet, Financial statement analysis, statement of changes in financial position, Financial Planning, Working capital, Capital Budgeting.

Total Hours: 42

ME4128 SIMULATION MODELLING AND ANALYSIS

Prerequisite: Nil

L	T	P	C
2	1	0	3

Introduction to system concept, Modelling and simulation, Monte Carlo simulation, Concepts in discrete event system simulation, Random number generation, Random variate generation, Input modelling for simulation, Verification and validation of simulation models, Output analysis for a single model, Introduction to simulation software– simple model building.

Total Hours: 42

ME4129 MODELLING OF MANUFACTURING SYSTEMS

Prerequisite: Nil

L	T	P	C
3	0	0	3

Modelling of manufacturing systems, Plant configurations, Performance measures, Computer controlled machines, Automated inspection systems, Material handling systems – AGVs, Facility layout, Group technology, Flexible manufacturing systems, Markov chain models, Random variables, Stochastic processes, Queuing models, queuing networks, application to manufacturing systems, simulation models.

Total Hours: 42

ME4130 HUMAN FACTORS IN ENGINEERING AND DESIGN

Prerequisite: Nil

L	T	P	C
3	0	0	3

Human factors and Systems, Nature of man-machine systems and characteristics, Visual capabilities– Quantitative visual displays, Representational displays, Human motor activity, Muscle physiology, Manual material handling limits, Motor skills, Human control of systems, Anthropometry and work-space design, Interpersonal aspects of workplace design.

Total Hours: 42 hours

**DETAILED SYLLABI OF
B.TECH DEGREE PROGRAMME IN
PRODUCTION ENGINEERING**

(Applicable from 2010 Admission onwards)

DEPARTMENT OF MECHANICAL ENGINEERING



NATIONAL INSTITUTE OF TECHNOLOGY CALICUT

SEMESTER 3

MA2001 MATHEMATICS III (PROBABILITY & STATISTICS)

Prerequisite: MA 1001

L	T	P	C
3	1	0	3

Total Hours: 56 Hrs

Module 1: Probability distributions (15 Hours)

Random variables, Binomial distribution, Hyper-geometric distribution, Mean and variance of a probability distribution, Chebyshev's theorem, Poisson distribution, Geometric distribution, Normal Distribution, Uniform distribution, Gamma distribution, Beta distribution, Weibull distribution. Joint distribution of two random variables.

Module 2: Sampling distributions and Inference concerning means (14 Hours)

Population and samples, The sampling distribution of the mean (σ known and σ unknown), Sampling distribution of the variance, Maximum Likelihood Estimation, Point estimation and interval estimation, point estimation and interval estimation of mean and variance, Tests of hypothesis, Hypothesis concerning one mean, Inference concerning two means.

Module 3: Inference concerning variances proportions (13Hours)

Estimation of variances, Hypothesis concerning one variance, Hypothesis concerning two variances, Estimation of proportions, Hypothesis concerning one proportion, Hypothesis concerning several proportions, Analysis of $r \times c$ tables, Chi-square test for goodness of fit.

Module 4: Regression Analysis (14 Hours)

Bi-variate Normal distribution- joint, marginal and conditional distributions. Curve fitting, Method of least squares, Estimation of simple regression models and hypothesis concerning regression coefficients, Correlation coefficient- estimation of correlation coefficient, hypothesis concerning correlation coefficient. Estimation of curvilinear regression models,

Analysis of variance:- General principles, Completely randomized designs, Randomized block diagram, Latin square designs, Analysis of covariance.

Text Book

Johnson, R. A., Miller and Freund's Probability and Statistics for Engineers, 6th edition., PHI, 2004.

References

1. Levin R. I. & Rubin D. S., Statistics for Management, 7th edition, PHI, New Delhi, 2000.
2. S.M. Ross, Introduction to Probability and statistics for Engineers, 3rd edition, Academic Press(Elsevier), Delhi, 2005.

EE2009 ELECTRICAL MEASUREMENTS AND MACHINES

L	T	P	C
3	0	0	3

Prerequisite: Nil

Total Hours: 42

Module 1 (9 hours)

Electromechanical Energy Conversion principles - Types of machines - Basics of rotating machines - Construction - Rotating magnetic field - Principles of operation - Emf and torque equation - Losses and efficiency.

Module 2 (12 hours)

DC Machines: principle of operation – generators and motors – classification –characteristics - starter - speed control - load test - Swinburne’s test - applications.

Transformers: Transformer Construction – principle of operation-equivalent circuit – regulation – efficiency – OC and SC tests –introduction to three phase transformer.

Module 3 (15 hours)

Alternators: Types, principle of operation - Synchronous motors: Principle of operation- starting- applications- Introduction to power Generation, Transmission and distribution system.

Induction Motors: Principle of operation – types – tests – Torque slip and performance characteristics – starting – speed control schemes – applications.

Single phase and special machines: FHP induction motors – universal motors - stepper motors – servo motors - tacho generators.

Module 4 (6 hours)

Measurement of high and low resistance using Voltmeter/ Ammeter method- Measurement of power in single phase ac circuits using three voltmeter method, three ammeter method and one wattmeter method - Measurement of power in three phase circuits using two wattmeter method- Measurement of Energy using single-phase energy meter.

References

1. Hughes, K, *Electrical Technology*, E.L.B.S., 1996.
2. Nagrath, I.J, Kothari D.P, *Electrical Machines*, Tata McGraw-Hill Publishing Company Limited-New Delhi,1997.
3. Cotton, H., *Advanced Electrical Technology*, CBS Publishers and Distributors, New Delhi,1984.
4. Vincent Del Toro, *Electrical Machines & Power systems*, Prentice Hall, 1998.
5. Chapman, S.J, *Electric Machines & Power systems*, McGraw Holl,1999.
6. Say, M.G, *Alternating Current Machines*, Pittman, 1983.
7. Vertnott, C.C., *Fractional & sub-fractional Horse-power Electric Motors*, McGraw Hill, New York, 1978.
8. Sawhney, A.K, *Electrical & Electronic Measurements & Instrumentation*, Dhanpat Rai & Sons, 1996.
9. Gupta, B.R & Vandana Singhal, *Fundamentals of Electric machines*, D. K Publishets, New Delhi, 2000.
10. Soni, Gulpta & Bhatnagar, *A course in Electric Power*, Dhanpat Rai & Sons.

ME2002 ELEMENTS OF SOLID MECHANICS

Prerequisite: ZZ1001 Engineering Mechanics

Total Hours: 42

L	T	P	C
3	0	0	3

Module 1 (12 hours)

Introduction, general concepts – definition of stress – stress tensor, Stress analysis of axially loaded members, shear stresses – direct shear problems, Strength based design of members (deterministic method), Axial strains and deformations in bars, Hooke's Law – idealized stress-strain relationships – Poisson's ratio, thermal strain, Saint Venant's principle, Elastic strain energy, Statically indeterminate systems, Strain Tensor, Constitutive relationships, generalized Hooke's law for isotropic materials, relationships between elastic constants, Thin walled pressure vessels.

Module 2 (10 hours)

Axial force, shear force and bending moment diagrams – sign conventions, Axial force, shear force and bending moments by direct approach, integration, Bending stresses in beams, Elastic flexure formula- bending stresses, Elastic strain energy in bending, Inelastic bending, Bending about both principal axes – Elastic bending with axial loads, Shear stresses in beams - shear flow - shearing stress formulae.

Module 3 (10 hours)

Torsion - torsion of circular elastic bars, statically indeterminate problems, torsion of inelastic circular bars, strain energy in torsion, Torsion of thin walled tubes, Deflection of beams - direct integration method, singularity functions, superposition techniques, moment area method, elementary treatment of statically indeterminate beams.

Module 4 (10 hours)

Transformation of stresses and strains (two-dimensional case only) - equations of transformation - principal stresses, Mohr's circles of stress and strain, Strain rosette, Compound stresses - superposition and its limitations - eccentrically loaded members, Columns - theory of columns - buckling theory - Euler's formula - effect of end conditions - eccentric loads and secant formula.

References

1. Popov, E.P., *Engineering Mechanics of Solids*, 2nd ed., Prentice Hall of India, New Delhi, 2000.
2. Beer, F.P., Johnston, E.R. and DeWolf, J.T., *Mechanics of Materials*, 3rd ed., Tata McGraw-Hill.
3. Timoshenko, S.P. and Young, D.H., *Elements of Strength of Materials*, McGraw-Hill.
4. Irving H. Shames, *Introduction to Solid Mechanics*, 2nd ed., Prentice Hall of India.
5. Crandall, S.H., Dahl, N.C. and Lardner, T.J., *Introduction to Mechanics of Solids*, McGraw-Hill.

ME2003 ENGINEERING MECHANICS – DYNAMICS

Prerequisite: ZZ1001 Engineering Mechanics

Total Hours: 42

L	T	P	C
3	0	0	3

Module 1 (13 hours)

Review of particle kinematics, Velocity and acceleration in rectangular coordinates – cylindrical coordinates – path variables, Review of particle dynamics – Newton’s Law for rectangular coordinates – cylindrical coordinates and path variables, Newton’s Law for system of particles – review of work-energy relations for a single particle – work-energy equations for system of particles – work-energy expression based on center of mass, Linear momentum considerations for a system of particles – impulsive forces – impact, Moment-of-momentum equation for a single particle – moment-of-momentum for a system of particles.

Module 2 (8 hours)

Kinematics of rigid bodies, Translation and rotation of rigid bodies – Chasles’ theorem – derivative of a vector fixed in a moving reference – applications of the fixed-vector concept – general relationship between time derivatives of a vector for different references – relationship between velocities of a particle for different references – acceleration of a particle for different references.

Module 3 (9 hours)

Moments and products of inertia – formal definition of inertia quantities – translation of coordinate axes – transformation properties of inertia terms – inertia ellipsoid and principal moments of inertia, Kinetics of plane-motion of rigid bodies, Moment-of-momentum equations – pure rotation of a body of revolution – body with two orthogonal planes of symmetry – slablike bodies – rolling of slablike bodies, General plane motion of a slablike body – pure rotation of an arbitrary rigid body – balancing.

Module 4 (12 hours)

Energy and impulse momentum methods for rigid bodies, Kinetic energy of rigid body – work-energy relations – angular momentum of a rigid body about any point in the body – impulse-momentum equations – impulsive forces and torques, Eccentric impact, Dynamics of general rigid-body motion – Euler’s equations of motion and applications – necessary and sufficient conditions for equilibrium of rigid body – three-dimensional motion about a fixed point – Euler angles – equations of motion using Euler angles – torque-free motion.

References

1. Shames, I.H., *Engineering Mechanics – Statics and Dynamics*, 4th ed., Prentice Hall of India, 1996.
2. Beer, F.P., and Johnston, E.R., *Vector Mechanics for Engineers*, McGraw-Hill, 2000.
3. Meriam, J.L., and Kraige, L.G., *Engineering Mechanics – Dynamics*, John Wiley & Sons, 2002.

ME2004 FLUID MECHANICS AND MACHINERY

Prerequisite: Nil

L	T	P	C
3	0	0	3

Total Hours: 42 hrs

Module 1 (10 hours)

Introduction – continuum hypothesis. properties of fluids – viscosity, Surface tension, Capillarity, Fluid statics – pressure at a point – variation of pressure in a static fluid – absolute and gauge pressures – pressure head - measurement of pressure, Manometers, Pressure gauges, Hydrostatic forces on plane areas – centre of pressure, Forces on curved surfaces, Floating and immersed bodies in fluids – buoyant force.

Module 2 (11 hours)

Flow of fluids – classification of flows – steady flow – uniform flow – incompressible flow – ideal flow – laminar and turbulent flows, Basic physical laws applied to a fluid flow – equation of continuity for one dimensional steady flow – equation of continuity in differential form, Energy equation, Momentum equation, Bernoulli's equation – application to flow through pipes, head loss in pipes – Darcy-Weisbach equation – pipes in series and parallel.

Module 3 (11 hours)

Fluid Machines – pumps and turbines, Flow through turbo-machines – velocity diagrams, Pumping machinery – rotodynamic and positive displacement pumps, Centrifugal pumps – head developed and power – specific speed of pumps, Characteristics of centrifugal pumps, Reciprocating pumps – indicator diagram – slip.

Module 4 (10 hours)

Turbines – impulse and reaction turbines, Pelton turbine – constructional details – calculation of power, Reaction turbines – principle of reaction turbines – radial, Axial and mixed flow turbines – draft tubes – constructional details of Francis and Kaplan turbines – calculation of power, Selection of turbines, Cavitation.

References

1. Joseph, B, Franzini., and E, John Finnemore., *Fluid Mechanics with Engineering Applications.*, Mc Graw Hill International Edition, 1997.
2. Victor L Streeter., *Fluid Mechanics.*, Mc Graw Hill, 1983.
3. Vijay Gupta., and Santhosh Gupta., *Fluid Mechanics and its Applications.*, New Age International Publishers, 2005.
4. Jagdish Lal., *Fluid mechanics and Hydraulics.*, Metropolitan, 1975.
5. Jagdish Lal., *Hydraulic Machines.*, Metropolitan, 1975.

ME2101 MATERIALS SCIENCE AND METALLURGY

Prerequisite: Nil

Total Hours: 42

L	T	P	C
3	0	0	3

Module 1 (9 hours)

Engineering materials: classification, requirements, properties and selection of engineering materials. Review of fundamentals - Crystal structure, Crystal imperfections, Edge and screw dislocations, interaction between dislocations, Frank-Reed source. Experimental techniques for metallographic studies, optical microscopy, electron microscopy (SEM and TEM), X-ray diffraction, grain size, grain size measurement, ASTM grain size number.

Module 2 (10 hours)

Solidification of metals - cooling curves, nucleation-homogeneous and heterogeneous nucleation, supercooling, critical radius - grain growth, dendritic pattern, equiaxed and columnar grains, grain boundary - grain boundary effects - solidification and structure of castings-coring, homogenization. Alloys - solid solutions - interstitial, substitutional ordered and disordered solid solutions, Hume-Rothery rules, intermetallic compounds, phase diagrams: - construction from cooling curves, lever rule - equilibrium diagrams of binary alloys, isomorphous (Cu-Ni), Eutectic (Bi-Cd, Pb-Sn) detailed study of Fe-C systems. Diffusion; mechanisms of diffusion - Fick's laws of diffusion - applications.

Module 3 (11 hours)

Deformation of metals: cold working, hot working, annealing of a cold worked article-recovery, recrystallisation and grain growth, elastic and plastic deformations: mechanisms of plastic deformation, deformation by slip - slip systems - slip planes and slip directions, critical resolved shear stress - deformation by twinning. Strengthening mechanisms: work hardening, solid solution hardening, dispersion hardening, precipitation hardening, grain boundary strengthening. Heat treatment of steels: stress relieving, annealing, normalising, hardening, TTT diagram, tempering, hardenability, Jominy test. Surface hardening: flame hardening, induction hardening, Case hardening: carburising, nitriding, cyaniding, etc. Metallic Coatings, hard facing, metal cladding, anodising, diffusion coatings .

Module 4 (13 hours)

Ferrous alloys: steels - alloy steels, tool steels, stainless steels, effect of alloying elements on properties of steels, cast irons-classification, structure, properties, applications. Non-ferrous alloys: Al and Al alloys, Cu and Cu alloys, Mg and Mg alloys, Zn and Zn alloys - major types, composition, properties and applications. Non-metallic materials: thermoplastics, thermosetting plastics, elastomers, composites, ceramics, glasses. Selection and use of engineering materials. Recent developments in materials science: smart materials, shape memory alloys, functionally graded materials, piezo-electric materials.

References

1. Smith, W.F., *Science of Engineering Materials*, 4th ed., Prentice-Hall, 1996.
2. Callister, W. D., *Materials Science and Engineering*, 5th ed., John Wiley, 2000.
3. Avner, S. H., *Introduction to Physical Metallurgy*, 2nd ed., Tata McGraw Hill, 1982.
4. Van, Vlack., L. H., *Elements of Materials Science*, 6th ed., Addison Wesley Publishing Company, 1989.
5. Shackelford, J. F., *Materials Science for Engineers*, 2nd ed., Prentice-Hall, 1996.
6. Higgins, R. A., *Engineering Metallurgy Part I*, 6th ed., Applied Physical Metallurgy, ELBS, 1991.
7. Raghavan, V., *Material Science and Engineering*, Prentice-Hall of India, 2005.
8. Reed, Hill., *Physical Metallurgy Principles*, Affiliated East-West Press New Delhi, 1992.
9. Jastrzebiski, *Nature and Properties of Engineering Materials*, 2nd ed., John Wiley and Sons, 1976.
10. Charles, J.A., Crane, F.A.A., and Furness J.A.G., *Selection and Use of Engineering Materials*, 3rd ed., Butterworth Heinemann, 1997.

ME2091 MACHINE DRAWING

Prerequisite: ZZ1002 Engineering Graphics

L	T	P	C
0	0	3	2

Total Hours: 42

Module 1 (9 hours)

Introduction to machine drawing, Principles of orthographic projections applied to machine drawing, First angle and third angle projections, Methods of dimensioning, Conversion of pictorial projections into orthographic projections, Sectional views, Rules and conventions of sectioning, Full sectional, half sectional, partial sectional and revolved sectional views of simple machine parts, Screwed fastenings – screw thread forms – vee and square threads – nomenclature of threads – conventional representation of threads, Hexagonal and square headed bolts and nuts, Locking arrangements of nuts, Various types of machine screws and set screws, Foundation bolts.

Module 2 (9 hours)

Pipe joints – coupler joint – nipple joint – union joint – socket and spigot joint – integral and screwed flanged joints, Shaft joints – cotter and pin joints – socket and spigot joint – gib and cotter joint – sleeve and cotter joint and knuckle joint, Couplings – muff couplings, flanged couplings, flexible coupling, Oldham's coupling and universal coupling, Parallel and tapered sunk keys – hollow and flat saddle keys – feather key and pin key, Bearings – solid journal bearings – bushed bearings – Plummer block – foot step bearing and pedestal bearing.

Module 3 (15 hours)

Assembly drawings – types – accepted norms, I.C. engine parts – piston – connecting rod, Steam Engine parts – eccentric – stuffing box, Parts of a lathe – tail stock – tool post, Miscellaneous assemblies – vices – screw jack, Valves.

Module 4 (9 hours)

Surface texture – nomenclature of surface texture – designation of surface texture – selection of surface characteristics, Limits, fits and tolerances – nomenclature – classification of fits – systems of fits and tolerances – designation – selection of fits and tolerances, Working/Production drawings – working drawings of simple machine elements, Computer aided drafting, Simple exercises using CAD Packages.

References

1. Bhatt, N.D., and Panchal, V.M., *Machine Drawing*, 43rd ed., Charotar Publishing House, 2008.
2. Narayana, K.L., Kannaiah, P., and Reddy, K.V., *Machine Drawing*, Wiley Eastern, 2005.
3. John, K.C., and Varghese, P.I., *Machine Drawing*, VIP Publishers, 2009.
4. Gill, P.S., *A Text Book of Machine Drawing*, Kalson Publishers, 2001.
5. Sidheswar, N., Kannaiah, P., and Sastry, V.V.S., *Machine Drawing*, Tata McGraw-Hill, 2007.
6. Ajeet Singh, *Machine Drawing: Includes AutoCAD*, 1st ed., Tata McGraw-Hill, 2010.

ME2191 PRODUCTION TECHNOLOGY LABORATORY I

Prerequisite: Nil

L	T	P	C
0	0	3	1

Total Hours: 42

Classification of Machine tools and processes, Machining on centre lathes, study of parts and function, cutting tools, types and materials, Grinding, selection of speeds, feeds and depth of cut, Cutting fluids, methods of work holding, Lathe operations like turning, taper turning and eccentric turning, thread cutting, knurling, drilling boring and profile turning, tolerance and surface finish.

References

1. Chapman., *Workshop Technology* Vol II, ELBS, 1980.
2. Boothroyd., *Fundamentals of Metal Machining & Machine Tools*, McGraw Hill, 1975.
3. Axleod., and Anderson., *Machine Tool Operations*, Vol II, Tata McGraw Hill.
4. Chowdhary, H., *Workshop Technology Vol II – Machine Tools*, Media Promoters and Publishers, 1997
5. HMT., *Production Technology*, 3rd reprint, Tata McGraw Hill, 1987

SEMESTER 4

MA2002 MATHEMATICS IV

Prerequisite: MA 1001, MA 1002

L	T	P	C
3	1	0	3

Total Hours: 56 Hrs

Module 1 Series Solutions and Special Functions (15 Hours)

Power series solutions of differential equations, Theory of power series method, Legendre Equation, Legendre Polynomials, Frobenius Method, Bessel's Equation, Bessel functions, Bessel functions of the second kind, Sturm-Liouville's Problems, Orthogonal eigenfunction expansions.

Module 2 Partial differential Equations (16 Hours)

Basic Concepts, Cauchy's problem for first order equations, Linear Equations of the first order, Nonlinear Partial Differential Equations of the first order, Charpit's Method, Special Types of first order equations, Classification of second order partial differential equations, Modelling: Vibrating String, Wave equation, Separation of variables, Use of Fourier Series, D'Alembert's Solution of the wave equation, Heat equation: Solution by Fourier series, Heat equation: solution by Fourier Integrals and transforms, Laplace equation, Solution of a Partial Differential Equations by Laplace transforms.

Module 3 Complex Numbers and Functions (13 Hours)

Complex functions, Derivative, Analytic function, Cauchy- Reimann equations, Laplace's equation, Geometry of Analytic functions: Conformal mapping, Linear fractional Transformations, Schwarz - Christoffel transformation, Transformation by other functions.

Module 4 Complex Integration (12 Hours)

Line integral in the Complex plane, Cauchy's Integral Theorem, Cauchy's Integral formula, Derivatives of analytic functions. Power series, Functions given by power series, Taylor series and Maclaurin's series. Laurent's series, Singularities and Zeros, Residue integration method, Evaluation of real Integrals.

Text Book

Kreyszig E, Advanced Engineering Mathematics, 8th Edition, John Wiley & Sons, New York, 1999.

Reference Books

1. I.N. Sneddon, Elements of Partial Differential Equations, Dover Publications, 2006.
2. Wylie C. R. & Barret L. C., Advanced Engineering Mathematics, 6th Edition, Mc Graw Hill, New York, 1995.
3. Donald W. Trim, Applied Partial Differential Equations, PWS – KENT publishing company, 1994.

ME2013 MECHANICS OF MACHINERY

Prerequisite: ZZ1001 Engineering Mechanics

Total Hours: 42

L	T	P	C
3	0	0	3

Module 1 (12 hours)

Introduction to mechanisms, Applications of mechanisms, Kinematics of mechanisms – kinematic diagrams, Degree of freedom, Position and displacement analysis – graphical methods, Velocity analysis – relative motion – graphical method – instant center, Mechanical advantage, Acceleration analysis – graphical method.

Module 2 (10 hours)

Analytical methods in mechanism analysis, Computer oriented methods in kinematic analysis, Cam Design, Cam and follower types, Displacement diagrams, Cam profile synthesis – graphical and analytical methods, Design of plate cam – reciprocating flat faced follower – roller follower, Advanced cam profile techniques.

Module 3 (10 hours)

Gears – Law of gearing, Involute spur gears – involutometry, Spur gear details – interference – backlash, Gear standardization, Internal gear, Cycloidal gear, Non-standard gears, Bevel, helical and worm gearing, Gear Trains – simple and compound gear trains – planetary gear trains – solution of planetary gear train problems – applications.

Module 4 (10 hours)

Kinematic synthesis, Tasks of kinematic synthesis – type and dimensional synthesis – graphical synthesis for motion – path generation without and with prescribed timing, Function generation – overlay method, Analytical synthesis techniques, Complex number modelling – loop closure equation technique – Freudenstein's equation, Case studies in synthesis of mechanisms.

References

1. Uicker, J.J.Jr., Pennock, G.R., and Shigley, J.E., *Theory of Machines and Mechanisms*, 3rd ed., Oxford University Press, 2009.
2. Sandor, G.N., and Erdman, A.G., *Advanced Mechanism Design: Analysis and Synthesis, Vol. I & II*, Prentice-Hall of India, 1988.
3. Mabie, H.H., and Reinholtz, C.F., *Mechanisms and Dynamics of Machinery*, 4th ed., John Wiley & Sons, 1987.
4. Ghosh, A, and Mallik, A.K., *Theory of Mechanisms and Machines*, 3rd ed., Affiliated East-West Press, 1998.
5. Waldron, K.J., and Kinzel, G.L., *Kinematics, Dynamics and Design of Machinery*, John Wiley & Sons, 2004.
6. Norton, R.L., *Design of Machinery*, Tata McGraw-Hill, 2004.
7. Martin, G.T., *Kinematics and Dynamics of Machines*, McGraw-Hill, 1969.
8. Rattan, S.S., *Theory of Machines*, 3rd ed., Tata McGraw-Hill, 2009.
9. Nikravesh, P.E., *Planar Multibody Dynamics*, CRC Press, 2008.

ME2015 THEORY OF ELASTICITY AND PLASTICITY

Prerequisite: ME2002 Elements of Solid Mechanics

Total Hours: 42

L	T	P	C
3	0	0	3

Module I (11 hours)

Analysis of stress - basic assumptions, stress at a point, Stress tensor, stress transformation, Mohr's circle, principal stresses principal planes, octahedral stresses, hydrostatic and pure shear states, Analysis of strain - strain at a point, strain tensor - analogy with stress tensor.

Module 2 (10 hours)

Equation of elasticity – equations of equilibrium, Strain-displacement equations - compatibility equations - constitutive equations - Navier equations, use of polar coordinates. 2-D problems - plane stress problems - plane strain problems, Axisymmetric problems - Lamé's problem - rotating disks - shrink fits.

Module 3 (10 hours)

Three dimensional problems, torsion of non circular sections, St.Venant's theory, Prandtl's stress function approach - elliptical and triangular cross sections, Prandtl's membrane analogy, Special problems in bending - Unsymmetric bending, shear centre, Bending of curved beams.

Module 4 (11 hours)

Introduction to plasticity - ideally plastic solid - stress space and strain space - nature of yield locus - yield surfaces of Tresca and VonMises - stress strain relations- Prandtl-Reuss equations, Analysis of elastic-plastic problems (spherical shell and cylindrical shell under internal pressure, rotating disks etc.).

References

1. S.P. Timoshenko, and J.N. Goodier, *Theory of Elasticity*, McGraw Hill International Edn., Third Edn., 1970.
2. L.S. Srinath, *Advanced Mechanics of Solids*, Tata McGraw Hill, New Delhi, Second Edition, 2003.
3. Den Hartog, *Advanced Strength of Materials*, McGraw Hill, New York.
4. A.J. Durelli, E.A. Philips and C.H. Psao, *Introduction to the Theoretical and Experimental Analysis of Stress and Strain*, McGraw Hill, New York.
5. Fred B. Seely and Smith, *Advanced Mechanics of Materials*, John Wiley and sons, New York.
6. W. Johnson, and P.B. Mellor, *Engineering Plasticity*, Van Nostrand Reinhold, 1973.

ME2016 THERMODYNAMICS AND HEAT TRANSFER

Prerequisite: Nil

Total Hours: 42

L	T	P	C
3	0	0	3

Module 1 (8 hours)

Basic concepts of thermodynamics – thermodynamic system – properties of a system – state and equilibrium – processes and cycles – forms of energy – temperature, The Zeroth law of thermodynamics, Concept of heat and work – moving boundary work, The First law of thermodynamics – energy balance for closed system – energy balance for steady-flow systems.

Module 2 (12 hours)

The second law of thermodynamics – thermal energy reservoirs – heat engines – Kelvin-Planck statement – refrigerators and heat pumps – Clausius statement, Reversible and irreversible processes, The Carnot cycle, Entropy – the increase of entropy principle – the T ds relations – the entropy change of ideal gases, Thermodynamic property relations – The Maxwell relations – The Clapeyron equation – general relations for du, dh, ds, C_v , and C_p , The Joule-Thomson coefficient.

Module 3 (12 hours)

Modes of heat transfer, Differential equations of heat conduction, Initial and boundary conditions, One-dimensional steady state heat conduction, Critical radius of insulation, Heat transfer from finned surfaces, Transient heat conduction – lumped system analysis, Differential and integral equations of heat convection, Integral solution for forced convection over a flat plate, Fully-developed flow in tubes, Empirical relations for heat convection.

Module 4 (10 hours)

Heat exchanger – overall heat transfer coefficient – LMTD and effectiveness-NTU methods, Thermal radiation – black body radiation – radiation properties – laws of thermal radiation, View factor algebra, Radiative energy exchange between black, diffuse, and gray surfaces, Electrical analogy.

References

1. Cengel, Y.A., *Introduction to Thermodynamics and Heat Transfer*, Mc Graw Hill, 1997.
2. Holman, J.P., *Heat Transfer*, 9th ed., Tata Mc Graw Hill, 2005.
3. Janna, W.S., *Engineering Heat Transfer*, 2nd ed., CRC Press, 2000.

ME2111 ESSENTIALS OF MANAGEMENT

Prerequisite: Nil

L	T	P	C
3	0	0	3

Total Hours: 42 hours

Module 1 (9 Hours)

The management process, Schools of management thought, Kinds of managers – basic managerial roles and skills – the nature of managerial work, Contemporary management issues and challenges, Basic elements of planning – types of plans.

Module 2 (9 Hours)

Organizing process, Concepts of authority – responsibility – power – accountability – delegation of authority, Types of organization structures, Directing, Leading – motivational strategies – communication, Basic elements of control.

Module 3 (12 Hours)

Managing human resources in organizations, Functions of financial management – classification of capital – sources of finance – financial statements, Nature of marketing – marketing mix – sales promotion.

Module 4 (12 Hours)

Managerial decision making process – decision criteria under certainty – risk – uncertainty – analytical models of decision making, Network techniques – critical path method – Programme Evaluation and Review Technique – time/cost trade-off in critical path networks.

References:

1. Koontz, H., and Wehrich, H., *Essentials of Management: An International Perspective*, 8th ed., McGraw Hill, 2009.
2. Griffin, R.W., *Management: Principles and Applications*, Cengage Learning, 2008.
3. Kotler, P., Keller K.L., Koshy, A., and Jha, M., *Marketing Management*, 13th ed., 2009.
4. Khan, M.Y., and Jain, P.K., *Financial Management*, Tata-McGraw Hill, 2008.

ME2112 METAL CASTING AND JOINING

Prerequisite: Nil

Total Hours: 42

L	T	P	C
3	0	0	3

Module 1 (10 hours)

Introduction - solidification of metals – mechanism of solidification - solidification with predominant interface resistance - solidification with constant surface temperature - solidification with predominant resistance in mould and solidified metal - flow of molten metal in moulds - furnaces and melting practices - patterns - pattern allowance - design considerations - shrinkage and machining allowance – foundries.

Module 2 (11 hours)

Casting processes – comparison - sand casting - shell moulding - silicate bonded sand process (CO₂ process) - expanded polystyrene process - plaster mould casting - ceramic mould casting - investment casting - permanent mould casting - slush casting - pressure casting - die casting - centrifugal casting - squeeze casting – semisolid casting (rheocasting, thixoforming) - casting techniques for single crystal components - rapid solidification - residual stress - inspection of castings - casting design – gating system design - risering - casting alloys - economics of casting – design rules for castings Casting Defects, defects in Steels, Schaeffler diagram, Carbon Equivalent, Carbide precipitation in Stainless steels, – case studies with specific examples of sand cast and permanent mould cast parts.

Module 3 (11 hours)

Classification - filler materials - consumable electrodes - liquid state - chemical - arc - resistance – electrical characteristics of the arc - analysis of metal transfer - free light and short circuiting metal transfer- equations for heat flow in welding - Friction Stir Welding - equations for temperature distribution in the Heat Affected Zone- gas metal reactions - sensitivity to hydrogen porosity - weld pool solidification- contraction and residual stress crack sensitivity - dilution and uniformity of the weld deposit.

Module 4 (10 hours)

The metallurgy of welding – metallurgy of weld metal and HAZ for carbon steels - ferritic and high alloy steels - austenitic and high alloy steels - non ferrous metals (Aluminium and its alloys, copper and its alloys, magnesium and its alloys) - weld quality - weldability - testing welded joints - welding design and process selection - brazing, soldering, adhesive bonding, and mechanical joining processes, joining plastics - surface energy and contact angle - capillary action in brazing and soldering - residual stress and stress concentration factors in adhesive bonding.

References

1. Ghosh, A., and Mallik, A.K., *Manufacturing Science*, Affiliated East West Press, 2009.
2. Heine, R., and Rosenthal, P., *Principles of Metal Casting*, 33rd reprint, Tata McGraw Hill, 2008.
3. Richard, A., Little., *Welding and Welding Technology*, Tata McGraw Hill, 2001.
4. Heine, R., and Rosenthal, P., *Principles of Metal Casting*, Tata McGraw Hill, 1985.

ME2092 FLUID MECHANICS AND FLUID MACHINERY LABORATORY

Prerequisite: ME2001 Mechanics of Fluids

L	T	P	C
0	0	3	2

Total Hours: 42

Study of plumbing tools and pipe fittings, Study of measuring instruments, Measurement of metacentric height and radius of gyration of a floating body, Calibration of flow measuring devices - venturimeter- orifice meter - notches and weirs - nozzle meters, Determination of loss of head due to friction in pipes, Verification of Bernoulli's theorem, Determination of lift and drag coefficients of cylinder and airfoil, Demonstration of laminar and turbulent flow in pipes - critical velocity, Forces on curved and plane surfaces, Experiments on turbines - performance and operating characteristics, Experiments on pumps - centrifugal pumps - reciprocating pumps - gear pumps, Experiment on torque converter.

CE2095 STRENGTH OF MATERIALS LABORATORY

Prerequisite: CE2001 Mechanics of Solids or equivalent.

L	T	P	C
0	0	3	2

Total Hours: 42

List of Exercises

1. Tension test on MS rod
2. Shear Test on MS rod
3. Torsion test on MS Specimen
4. Hardness tests on metals
5. Impact tests on metals
6. Bending test on steel beams
7. Spring test – open and close coil springs
8. Compression test on cubes and cylinders – determination of modulus of elasticity
9. Study of extensometers and strain gauges

SEMESTER 5

ME3001 DYNAMICS OF MACHINERY

Prerequisite: ME2013 Mechanics of Machinery

L	T	P	C
3	0	0	3

Total hours: 42

Module 1 (10 Hours)

Static force analysis of machines, Static force analysis with friction, Force analysis of gears, spur— helical — bevel, Method of virtual work, Dynamic force analysis, Principle of super position, Complex algebra method.

Module 2 (12Hours)

Balancing— Static and dynamic unbalance, Balancing of rotating masses – Balancing machines, Balancing of single cylinder engines – Balancing of multi cylinder engines – Balancing of V and radial engines, Balancing of linkages, Gyroscopes and its applications, Cam dynamics, Governors, Flywheels.

Module 3 (10Hours)

Recap of the Single DOF vibration systems– free and forced vibration – equivalent viscous damping, Transient vibration, Rotating unbalance, Support excited vibration, Critical speed of shafts, Vibration measuring instruments – Vibration of two DOF systems- formulation-normal mode analysis-solution of matrix Eigen value problem.

Module 4 (10 Hours)

Two DOF— Forced harmonic vibration, Vibration absorber, Multi DOF systems— matrix formulation, Lagrange’s equation, Introduction to vibration of continuous systems— vibration of string, Approximate methods– Rayleigh’s energy method – Dunkerley’s equation, Holzer’s method, Geared system.

References

1. Uicker, J.J. Jr., Pennock, G.R., and Shigley, J.E., *Theory of Machines and Mechanisms*, 3d ed., Oxford University Press, 2009.
2. Mabie, H.H., and Reinholtz, C.F., *Mechanisms and Dynamics of Machinery*, 4d ed., John Wiley & sons, 1987.
3. Ghosh, A, and Mallik, A.K., *Theory of Mechanisms and Machines*, 3d ed., Affiliated East-West Press, 1998.
4. Holowenko, A.R., *Dynamics of Machinery*, John Wiley & Sons, 1965.
5. Waldron, K. J., and Kinzel, G. L., *Kinematics, Dynamics and Design of Machinery*, John Wiley & Sons, Inc., 2004.
6. Norton, R.L., *Design of Machinery*, Tata McGraw-Hill, 2004.
7. Rattan, S.S., *Theory of Machines*, 3d ed., Tata McGraw-Hill, 2009.
8. Nikraves, P.E., *Planar Multibody Dynamics*, CRC Press, 2008.
9. Thomson, W.T., Dahleh, M.D., and Padmanabhan, C, 5d ed., *Theory of Vibrations with Applications*, Pearson Education, 2008.
10. Meirovitch, L., *Elements of Vibration Analysis*, 2d ed., McGraw-Hill, 2007.
11. Den Hartog, J.P., *Mechanical Vibrations*, 4d ed., McGraw-Hill, 1985.

ME3103 MACHINE TOOLS

Prerequisite: Nil

Total Hours: 42

L	T	P	C
3	0	0	3

Module 1 (10 hours)

Machine tool systems, kinematics of machine tools: - job-tool relative motions, types of drives, kinematics of gear boxes, realisation of various machine tools like lathe, milling machines, grinding machines, drilling machines, shaping machines, planning machines, boring machines. Mechanical controls.

Module 2 (10 hours)

Design of machine tool structures - spindles and guide - ways. dynamics of machine tools. Hydraulic and pneumatic circuits: components - valves, motors, accumulators, etc. - characteristics. Features of typical machine tools, control circuits and their characteristics.

Module 3 (11 hours)

Machining operations: thread cutting, turning, facing, taper turning, form cutting with form tools, gear forming, gear shaping, gear hobbing, kinematics of gear shapers and gear hobbors, boring, boring tools, boring bars. Drilling, fluted drills, deep hole drilling. Grinding machines, types, construction features, wheel mounting, etc. Special purpose machine tools: Automated machines, jig boring machine, superfinishing, honing machines etc.

Module 4 (11 hours)

Design of modern CNC machines, positioning accuracy and repeatability of CNC Machine tools. Machining centers, 3,4,5 axis machining, design of CNC machine tools. Mechatronic elements, sensors and transducers, tool changers. Testing of machine tools, positioning accuracy and repeatability. Machine tool error analysis, sources of error, error compensation strategies, real time error compensation techniques, CNC programming, industrial design, aesthetics and ergonomics. Acceptance testing of machine tools. Machine tools for micro machining. Modern trends in machine tools.

References

1. Acherkan ., *Principle of Machine tools*, Vol. 1,2,3 and 4, Mir publishers, 1972.
2. Chapman., *Workshop Technology*, Vol. 1, Vol. 2, Vol.3, ELBS,1980.
3. Khaimovitch., *Hydraulic control of Machine tools*, Pergamon Press, 1965.
4. Bhattacharyya, A., *Principles of Machine Tools*, New Central Book Agency, 2008.
5. Bhattacharyya, A., *Metal Cutting: Theory & Practice*, 22nd reprint, New Central Book Agency, 2008.
6. HMT., *Production Technology*, 3rd reprint, Tata McGraw Hill, 1987.
7. Mehta, N.K., *Machine Tool Design & Numerical Control*, 2nd ed., Tata McGraw Hill, 2005.
8. Ernst, *Oil Hydraulics power – Industrial applications*, McGraw Hill Book Company.
9. Shaw, M.C., *Metal Cutting Principles*, CBS Publishers and Distributors, 1999.
10. HMT Limited., *Mechatronics*, 17th Reprint Tata McGraw Hill Publishing Company Limited, 2008.
11. Boothroyd., *Fundamentals of Metal Machining & Machine Tools*, McGraw Hill, 1975.
12. Donaldson., Lecain., and Gould., *Tool design*, Tata McGraw Hill, 2001.

ME3104 METROLOGY AND COMPUTER AIDED INSPECTION

Prerequisite: Nil

Total Hours: 42

L	T	P	C
3	0	0	3

Module 1(10 hours)

Measurement fundamentals: Measurement system elements, Temperature, Pressure and Strain sensors. Experimental Test Plan- Random Tests, Replication & repetition. Calibration - Sensitivity, Range, Accuracy, Standards, Traceability. Regression analysis, Data outlier detection. (Ref: 1)

Module 2 (10 hours)

Uncertainty analysis- Type A and Type B, Determining combined standard uncertainty- Uncorrelated and correlated input quantities, case-studies and problems. Expanded uncertainty, reporting, establishing conformity. (Ref: 2)

Module 3 (11 hours)

Metrology: Interferometry, Slip gauges, Comparators, Abbe's principle, Pneumatic transducer, Electronic transducers, Angle measurement- Sine bar, angle gauges. Optical instruments- Profile projectors, Autocollimators. Surface finish- Parameters, Stylus instruments.

Module 4 (11 hours)

Gauge design and tolerancing, Inspection of geometric tolerances and true position tolerances. Screw thread measurements - Three wire method calculations, Gear measurements- Tooth vernier, Base tangent, measurement over pins, profile checking. Coordinate Measuring Machines- Construction, Operation & Programming, Software, Applications. (Ref:4) Machine Vision: Sensing, Preprocessing, Segmentation, Description, Recognition and Interpretation. (Ref:5)

References

1. Figliola, R.S., & Beasley, D.E., *Theory and Design for Mechanical Measurements*, 3rd ed., John Wiley & Sons Inc, 2005.
2. Kirkup., and Frenkel, R.B., *An Introduction to Uncertainty in Measurement Using the GUM*, Cambridge University Press, 2006.
3. Collett, C.V., & Hope, A.D., *Engineering Measurements*, Second edition, ELBS/Longman, 1983.
4. Galyer, J., F.W., Shotbolt, C.R., *Metrology for Engineers*, Fifth edition, Thomson Learning, 1990.
5. Doebelin, E.O., *Measurement Systems*, 5th ed., McGraw-Hill International, 2004.
6. Black, S.C., Chiles, V., Lissaman, A.J., Martin, S.J., *Principles of Engineering Manufacture*, 3rd ed., Butterworth-Heineman, 1996.

ME3105 PRODUCTION MANAGEMENT

Prerequisite: Nil

Total Hours: 42

L	T	P	C
4	0	0	4

Module 1 (10 Hours)

Characteristics of production systems, Modern production management systems, Operation strategy and competitiveness – competitive dimensions of operations, Product design and process selection – quality function deployment – value analysis – break even analysis, Strategic capacity planning, Procurement of capital equipment – alternative evaluation method.

Module 2 (12 Hours)

Forecasting, Time series analysis – components of time series – moving average – simple exponential smoothing – simple regression, Error measurement – tracking signal, Point estimates and interval estimates, Production planning and control – framework, Material requirement planning (MRP) – technical issues – system dynamics – production activity control, Production activity control techniques – finite loading – Gantt chart – priority sequencing.

Module 3 (12 Hours)

Inventory control – functions of inventory – inventory problem classification – Relevant cost, Selective inventory control, Independent demand systems – deterministic models – sensitivity analysis – quantity discount – batch production – introduction to probabilistic models, Basic concepts of supply chain management, Logistics management.

Module 4 (12 Hours)

Facilities planning, Objectives of facility planning, Facilities planning strategies, Assembly chart, Operation process chart, Scrap and equipment estimation, Facility design – management and planning tools – flow, space and activity relationship – flow patterns, Layout planning – systematic layout planning, Types of layout – process layout – product layout – group technology layout – retail service layout.

Module 5 (10 Hours)

Quality management, Quality costs, Analytical tools for quality control, Introduction to TQM, Introduction to six sigma, Statistical process control, Control charts for variables – X-bar and R chart, Control charts for attributes – P and C chart, Introduction acceptance sampling.

References

1. Chase, R.B., Shanker, R., Jacobs, F.R. and Aquilano, N.J., *Production & Supply Management*, 12th ed., Tata McGraw-Hill Edition, 2010.
2. Tersine, R.J., *Principles of Inventory and Materials Management*, 4th ed., Prentice-Hall International, 1994.
3. Vollmann, Berry, Whybark and Jacobs, *Manufacturing Planning and Control for Supply Chain Management*, 5th ed., Tata McGraw-Hill Edition, 2005.
4. Tomkins, White, Bozer, Frazelle, Tanchoco and Trevino, *Facility Planning*, 2nd ed., John Wiley & Sons, 1996.
5. Grant, E.L, and Leavenworth, R.S., *Statistical Quality Control*, 7th ed., McGraw-Hill, 1996.

ME3003 ENVIRONMENTAL STUDIES FOR MECHANICAL ENGINEERS

Prerequisite: Nil

L	T	P	C
3	0	0	3

Total Hours: 42

Module 1 (9 hours)

Scope and importance of Environmental Studies, Ecosystems – Structure and function, Forest, Grassland and Desert ecosystems, diversity in ecosystems, Value of biodiversity, Threats to biodiversity – Wildlife Protection Act – Forest Conservation Act, Conservation of biodiversity, Environmental ethics, Climate change, global warming, acid rain, ozone layer depletion, nuclear accidents and holocaust.

Module 2 (11 hours)

Natural resources and associated problems: Forest resources, Aquatic ecosystems, Water resources, Mineral resources, Land resources, Causes, effects and control measures of Water pollution, Soil pollution and Marine pollution, Water (Prevention and control of Pollution) Act, Water conservation, rain water harvesting, watershed management, Disaster management: floods, earthquake, cyclone and landslides, Solid Waste Management: Causes, effects and control measures of urban and industrial wastes, Wasteland reclamation – Consumerism and waste products.

Module 3 (10 hours)

Environmental Pollution – Definition – Causes, effects and control measures of: - Air Pollution, Noise pollution, Thermal pollution and nuclear hazards, Environmental Protection Act – Air (Prevention and Control of Pollution) Act – Issues involved in enforcement of environmental legislation.

Module 4 (7 hours)

Renewable and non-renewable resources, Growing energy needs, renewable and non-renewable energy sources, use of alternate energy sources, From Unsustainable to Sustainable development – Urban problems related to energy, Role of an individual in conservation of natural resources, equitable use of resources for sustainable lifestyles – Role of Information Technology in Environment and human health.

Field work (Equal to 5 lecture hours)

Visit to a local area to document environmental assets-river/forest/grassland/hill/mountain – Visit to a local polluted site – Urban/Rural/Industrial/Agricultural – Study of common plants, insects, birds – study of simple ecosystems-pond, river, hill slopes, etc.

References

1. Agarwal, K.C., *Environmental Biology*, Nidi Publ. Ltd., Bikaner, 2001.
2. Bharucha Erach, *The Biodiversity of India*, Mapin Publishing Pvt. Ltd, Ahmedabad, India.
3. Brunner, R.C., *Hazardous Waste Incineration*, McGraw-Hill Inc.480p. , 1989.
4. Clark, R.S., *Manne Pollution*, Clanderson Press Oxford.
5. Cunningham, W.P., Cooper, T.H., Gorhani, E., and Hepworth, M.T., *Environmental Encyclopedia*, Jaico Publ. House, Mumbai, 1196p., 2001.
6. De A.K., *Environmental Chemistry*, Wiley Eastern Ltd.
7. Gleick, H.P., *Water in crisis, Pacific Institute for Studies in Dev. Environment and Security*. Stockholm Env. Institute. Oxford Univ. Press, 473p., 1993.
8. Heywood, V.H and Watson, R.T., *Global Biodiversity Assessment*, Cambridge Univ. Press, 1140p. 1995.
9. Jadhav, H and Bhosale, V.M.. *Environmental Protection and Law*, Himalaya -Pub. House, Delhi 284 p. 1995.
10. Mckinney, M.L., and Schoer, R.M., 199p., *Environmental Science systems and Solutions*, Web enhanced edition. 63.9p.
11. Mhaskar, A.K, *Matter Hazardous*, Techno-Science Publications.
12. Miller, T.G. Jr., *Environmental Science*, Wadsworth Publishing Co.
13. Odum, E.P., *Fundamentals of Ecology*, W.B., Saunders Co., USA, 574p., 1971.
14. Rao, M.N, and Datta, A.K., *Waste Water treatment*. Oxford & IBH Publ. Co., 345p. 1987.
15. Sharma, B.K., *Environmental Chemistry*, Goel Publ. House, Meerut, 2001.
16. Townsend, C., Harper, J, and Michael Begon, *Essentials of Ecology*, Blackwell Science.
17. Trivedi, R.K., *Handbook of Environmental Laws, Rules, Guidelines, Compliances and Standards*, Vol. I and II, Enviro Media (R).
18. Trivedi , R.K., and Goel, P.K., *Introduction to air pollution*, Techno-Science Publications.
19. Wagner, K.D., *Environmental Management*, W.B. Saunders Co., Philadelphia, USA, 499p., 1998.

ME3192 METROLOGY AND INSTRUMENTATION LABORATORY

Prerequisite: Nil

L	T	P	C
0	0	3	1

Total Hours: 42

1. Calibration and determination of uncertainties of the following;
(a) Strain gauge load cells (b) Bourdon tube pressure gauge (c) LVDT (d) Thermocouple (e) Tachometers using stroboscopes, etc.
2. Measurement of thread parameters using Universal Measuring Microscope, three wire method, thread pitch micrometer
3. Evaluation of straightness using autocollimator, spirit level
4. Measurement of tool angles of single point tool using TMM
5. Measurement of gear parameters using Profile projector
6. Study and measurement of surface finish using surface roughness tester
7. Study and measurements with CMM
8. Experiments on limits and fits
9. Study and use of ultrasonic flaw detector
10. Exercises on measurement system analysis
11. Study and making measurements with thread pitch micrometer, disc micrometer, thread pitch gauge, height gauge, slip gauges, optical flat, three pin micrometer, pyrometer, RTD, Sling psychrometer, zoom microscope, etc.

ME3194 PRODUCTION TECHNOLOGY LABORATORY II

Prerequisite: Nil

L	T	P	C
0	0	3	1

Total Hours: 42

Introduction: Limits and Fits, Horizontal and Vertical milling machine – Spindle drives and feed motion - Milling cutters – indexing head – Simple, compound and differential indexing, shaping machine - cutting motion, slotting machine, Grinding machine – Surface, cylindrical and centreless grinding – Tool and cutter grinder, unconventional machining, NC/CNC machine.

Exercises:

Shaping and slotting Exercises - Flat and bevel surfaces, grooves, Slots, guide ways, key ways etc. Exercises in horizontal and Vertical milling machine - Surface, slot, key way and gear milling. Turning Exercises - Limits and Fits. Grinding Exercises. Non – traditional Machining. NC / CNC Machining.

References

1. HMT, *Production Technology*, 3rd reprint, Tata McGraw Hill, 1987.
2. ASTME, *Tool Engineer's Handbook*.
3. Chapman, *Workshop Technology*, Vol II AND III, ELBS, 1980.
4. Rao, P. N., *Manufacturing Technology*, Tata McGraw Hill, 2009.
5. Groover., & Zimmer., *CAD/CAM*, Prentice Hall, 1984.
6. Mehta.N.K., *Machine Tool Design & Numerical Control*, 2nd ed., Tata McGraw Hill, 2005.

SEMESTER 6

ME3113 QUANTITATIVE TECHNIQUES FOR MANAGEMENT

Prerequisite: Nil

Total Hours: 42

L	T	P	C
3	1	0	3

Module 1 (12 hours)

Models in operations research - principles of modelling, formulation of linear programming models, Graphical solution of linear programs in two variables, Linear program in standard form, Solving system of linear equations, Principles of the simplex method, Simplex method in Tableau form, Finding a feasible basis, Computational problems – degenerate solutions – unbounded solutions.

Module 2 (9 hours)

Duality concept – general primal-dual relations, Formulating transportation problems, Transportation simplex method, Assignment problems and solution.

Modules 3 (12 hours)

Theory of games – pure strategies – games with the saddle point – mixed strategies – principles of dominance, Solutions of games using graphical method and linear programming method, Dynamic programming – multistage decision process – principle of optimality – examples.

Module 4 (9 hours)

Queuing theory – Basic structure of queuing models – the role of exponential distribution – performance measures of a queuing system, Single server queuing models – unlimited queuing – limited queuing.

References

1. Taha, H.A., *Operations Research: An Introduction*, 8th ed., Pearson Education, Inc., 2008.
2. Hillier, F. S., and Lieberman, G. J., *Introduction to Operations Research*, 8th Ed., Tata McGraw Hill, 2005.
3. Ravindran A., Philips, D., and Solberg, J. J., *Operations Research: Principles and Practice*, 2nd ed., John Wiley & Sons Inc., 1989.
4. Hadley, G., *Linear Programming*, Addison Willey Narisa, Narosa Publishing House, 1987.

ME3114 CAD/CAM/CIM

Prerequisite: Nil

L	T	P	C
3	0	0	3

Total Hours: 42

Module 1 (9 hours)

Introduction to computer graphics, 2D and 3D transformations, Plane and space curves, surface description and generation, CAD/CAM hardware and software, CAD/CAM data exchange and integration.

Module 2 (11 hours)

CNC machine tools, fundamentals of CNC machine tools, constructional features, drives and controls, stepper motors, servo motors, hydraulic systems, feed back devices, counting devices, interpolators linear, circular interpolation and other emerging techniques, adaptive control systems for turning and milling.

Module 3 (11 hours)

CNC manual part programming and computer assisted programming, APT language, geometry, motion and auxiliary statements, macro statements, post processors, CNC programming with interactive graphics, use of various software packages, development of CNC programmes for special problems.

Module 4 (11 hours)

Computer integrated manufacturing systems, material handling and identification technologies, computer aided inspection, group technology, flexible manufacturing systems, industrial robotics and machine vision, rapid prototyping, design for manufacturability, process planning and concurrent engineering, lean production and agile manufacturing.

References

1. David, F.Rogers., & Adams, J.H., *Mathematical Elements of Computer Graphics*, 15th Reprint, McGraw Hill International, 2008.
2. David, F., Rogers., *Procedural Elements for Computer Graphics*, McGraw Hill International, 1998.
3. Ibrahim., Zeid., *CAD/CAM Theory and Practice*, Tata McGraw Hill publishing company, 1991.
4. Yoram., Koren., *Computer Control of Manufacturing Systems*, Mc Graw Hill Book Company, 1983.
5. Mikell, P. Groover., *Automation, Production Systems, and Computer Integrated Manufacturing*, Pearson Education, 2008.
6. Mehta, N.K., *Machine Tool Design & Numerical Control*, 2nd ed., Tata McGraw Hill, 2005.
7. Bolton. W., *Mechatronics, Electronic Control Systems in Mechanical Engineering*, Addison Wesley Longman Limited, 2003.
8. HMT Limited, *Mechatronics*, 17th Reprint, Tata McGraw Hill Publishing Company Limited, 2008.
9. Fu., K.S. Gonzalez., R.C., and Lee., C.S.G , *Robotics, Control, Sensing, Vision and Intelligence* , McGraw Hill International, 1987

ME3013 THERMAL ENGINEERING

Prerequisite: Thermodynamics and Heat Transfer

L	T	P	C
3	0	0	3

Total Hours: 42

Module 1 (10 Hours)

Internal combustion engines –classification, spark ignition and compression ignition engines, 2-stroke and 4-stroke engine, valve timing diagrams, theoretical and actual cycles, deviation of an actual cycle from ideal cycle - loss due to dissociation and specific heat variation, different systems of IC engines, combustion process in CI and SI engines, excess air calculations, performance of IC engines, Friction measurement, heat balance sheet for IC engines, governing of IC engines.

Module 2 (10 Hours)

Nozzles - isentropic flow of fluids through variable area passage, expression for velocity and discharge, throat pressures and areas for maximum discharge, effect of friction, supersaturated flow, Wilson line, Steam turbines - impulse and reaction turbines, compounding, velocity diagrams for single stage and several blade rings, work done and blade efficiency, conditions for maximum efficiency.

Module 3 (10 Hours)

Gas turbine cycles - Joule Brayton cycle, open and closed cycles, effect of various parameters on performance, regeneration, intercooling and reheating. Reciprocating compressors - single stage and multi stage compressors, condition for maximum efficiency, Rotary compressors – types, work done and efficiency in centrifugal compressor.

Module 4 (9 Hours)

Refrigeration - working, performance and application of air refrigerator, vapour compression refrigeration, pressure–enthalpy diagram and temperature-entropy diagram, co-efficient of performance, vapour absorption refrigeration. Air conditioning, psychrometry, psychrometric processes, cooling and dehumidification, heating and humidification .

References

1. Maleev, M.L., *Internal Combustion Engines*, McGraw Hill.
2. Kearton, W.J., *Steam Turbines: Theory & Practice*, ELBS.
3. Yunus, A. Cengel and Michael, A. Boles, *Thermodynamics – an engineering approach*, Tata McGraw Hill Publishing Company.
4. Lewitt, E.H., *Thermodynamics Applied to Heat Engines*, Sir Isaac Pitman & Sons.
5. Cohen, H., and Rogers, G.F.C., *Gas Turbine Theory*, 4th ed., Pearson Prentice Hall, 2009
6. Rajput, R.K., *Thermal Engineering*, 6th ed., Laxmi Publications.
7. Mathur, M.L. and Sharma, R.P., *Internal Combustion Engines*, Dhanpatrai Publications.
8. Wilbert, F., Stoecker and Jerald, W., Jones, *Refrigeration and Air Conditioning*, Mc-Graw Hill International Editions.

ME3014 DESIGN OF MACHINE ELEMENTS

Prerequisite: ME2002 Elements of Solid Mechanics

L	T	P	C
4	0	0	4

Total Hours: 56

Module 1 (13 hours)

Introduction to Design – steps in design process – design factors – principles of standardization, Selection of materials, Statistical considerations in Design, Stress concentration, Theories of failure, Impact load, Fatigue loading, Consideration of creep and thermal stresses in design, Threaded fasteners – thread standards – stresses in screw threads – analysis of power screws – bolted joints – preloading of bolts – gasketed joints – eccentric loading.

Module 2 (15 hours)

Welded joints – types of welded joints – stresses in butt and fillet welds – torsion and bending in welded joints – welds subjected to fluctuating loads – design of welded machine parts and structural joints, Springs – stresses in helical springs – deflection of helical springs – extension, compression and torsion springs – design of helical springs for static and fatigue loading – critical frequency of helical springs – stress analysis and design of leaf springs.

Module 3 (16 hours)

Power shafting – stresses in shafts – design for static loads – reversed bending and steady torsion – design for strength and deflection – design for fatigue loading – critical speed of shafts, Stresses in keys, Design of keyed connections.

Design of gears – spur, helical, bevel and worm gears – tooth loads – gear materials – design stresses – basic tooth stresses – stress concentration – service factor – velocity factor – bending strength of gear teeth – Buckingham's equation for dynamic load – surface strength and durability – heat dissipation – design for strength and wear.

Module 4 (12 hours)

Lubrication and bearing design – types of lubrication and lubricants – viscosity – journal bearing with perfect lubrication – hydrodynamic theory of lubrication – design considerations – heat balance – journal bearing design, Rolling Contact Bearings – bearing types – bearing life – static and dynamic capacity – selection of bearings with axial and radial loads – lubrication – seals – shaft, housing and mounting details.

References

1. Shigley, J.E., *Mechanical Engineering Design*, 1st Metric ed., McGraw-Hill, 1986.
2. Shigley, J.E. and Mischke C.R., *Mechanical Engineering Design*, 6th ed., Tata McGraw-Hill, 2003.
3. Siegel, M.J., Maleev, V.L. and Hartman, J.B., *Mechanical Design of Machines*, 4th ed., International Textbook Company, 1965.
4. Phelan, R.M., *Fundamentals of Mechanical Design*, Tata McGraw-Hill, 1967.
5. Doughtie, V.L. and Vallance, A.V., *Design of Machine elements*, McGraw-Hill, 1964
6. Juvinall, R.C. and Marshek, K.M., *Fundamentals of Machine Component design*, 3rd ed., John Wiley & Sons, 2000.
7. Norton, R.L., *Machine Design*, 2nd ed., Pearson Education, 2000.

Data Handbooks (allowed for reference during examinations also)

1. Narayana Iyengar, B.R. and Lingaigh, K., *Machine Design Data Handbook*, Vol. I & II
2. P.S.G. Tech., *Machine Design Data Hand Book*.

ME3195 CAD/CAM/CIM LABORATORY

Prerequisite: Nil

L	T	P	C
0	0	3	1

Total Hours: 42

Exercises on Solid Modelling: using commercial packages like Pro-E, CATIA.

Exercises on Finite Element Analysis: Introduction to FEM- 1D, 2D and 3D elements- Exercises on Heat Conduction, fluid flow and Elasticity may be given using commercial FEM packages like ANSYS, ABAQUS.

Assembly and Mechanism Design: Assembling of various parts and Tolerance analysis

Synthesis and Design of Mechanisms-Animations Exercises on various mechanisms like four bar linkages and its variations, cam and follower, Two and Four Stroke engines. Design for manufacturability-use of commercial software packages.

Computer Aided Manufacturing: Process Control using PLC-PID control strategy Part Programming fundamentals- Manual Part Programming and Computer Aided Part Programming. Exercises on CNC Lathe and Machining Center/Milling Machines

Programming of Industrial Robots: Computer Aided Inspection and Quality Control, Demonstration of the capability of Coordinate Measuring Machine using a sample component e.g.: Engine Block – Concepts of Reverse Engineering and Rapid Prototyping Technology.

References

1. David, F.Rogers., & J.H. Adams., *Mathematical Elements of Computer Graphics*, 15th Reprint, McGraw Hill International, 2008.
2. Ibrahim., Zeid., *CAD/CAM Theory and Practice*, Tata McGraw Hill publishing company, 1991.
3. Yoram., Koren., *Computer Control of Manufacturing Systems*, Mc Graw Hill Book Company, 1983.
4. Mikell, P.Groover., *Automation, Production Systems, and Computer Integrated Manufacturing*, Pearson Education, 2008.
5. HMT Limited., *Mechatronics*, 17th Reprint Tata McGraw Hill Publishing Company Limited, 2008

ME3092 THERMAL ENGINEERING LABORATORY

Prerequisite: Nil

Total Hours: 42

L	T	P	C
0	0	3	2

Study of spark ignition (SI) and compression ignition (CI) engine systems - fuel system - lubrication system - cooling system - starting system - ignition system - governing system - power transmission system - types of carburetors - fuel injectors - multi point fuel injection (MPFI) system - common rail direct injection (CRDI) system - gasoline direct injection (GDI) system, Study of different types of boilers and its components, Study of fuel properties measuring systems - bomb calorimeter - gas calorimeter - red-wood viscometer - flash and fire apparatus, Study of dynamometers, Constant speed performance characteristics of SI engine, Morse test at constant throttle and at constant load, Constant speed performance characteristics of SI engine, Constant speed performance characteristics of MPFI engine, Performance characteristics of constant speed CI engine, Constant speed performance characteristics of single cylinder CI engine, Determination of frictional horse power (FHP) by retardation test, Performance characteristics with cooling water temperature (cooling curve experiment) by suitable test, Valve timing diagrams of single and multi cylinder engines, Measurement of thermal conductivity of metal rod, Study of heat transfer in forced convection and to determine convective heat transfer coefficient, Measurement of emissivity, Performance test on vapour compressor refrigeration system, Comparison of heat transfer coefficient of fins of different geometrical shapes, Determination of the effectiveness of shell and tube heat exchanger apparatus.

Semester 7

ME 4102 THEORY OF METAL CUTTING

Prerequisite: Nil

Total Hours: 56

L	T	P	C
4	0	0	4

Module 1 (14 hours)

Tool nomenclatures- ASA, ORS, NRS, etc., Insert- geometries and nomenclature. Mechanics of chip formation, orthogonal and oblique cutting, shear angle, velocity relationship. Theories of cutting- Merchant's analysis, Lee and Shaffer's theory, etc. Tool geometries- various types of drill points, developments in milling cutters, etc. Selection of cutting parameters in turning, milling, drilling, etc. Force and power estimation in various machining processes. Modelling of cutting processes.

Module 2 (14 hours)

Tool materials, carbide grade design, coating techniques and applications. Advances in cutting tool materials. Theories of tool wear, measurement of tool wear, tool failure analysis. Tool life and economics of machining. Abrasive machining processes, mechanics of grinding, power requirements, mechanics of wheel wear.

Module 3 (14 hours)

Tool Dynamometers: Turning, Milling, Drilling and Grinding Dynamometers, features and measuring strategy. Thermal aspects of machining: Cutting fluids and its selection. Optimal machining conditions and productivity, Machinability: criteria and factors affecting machinability. Surface integrity, methods of improving surface integrity.

Module 4 (14 hours)

Modern machining processes- principles, process characteristics and application of ECM, EDM, USM, AJM, EBM, LBM, PAM, etc. Capability analysis. Micro/nano machining, recent developments.

References

1. Amitabh, Ghosh., and Asok, Kumar, Mallik., *Manufacturing Science*, Affiliated East West Press Pvt. Ltd., 2008.
2. Juneja, B.L., and Sekhon, G.S., *Fundamentals of Metal Cutting and Machine Tools*, New Age, International (P) Ltd., 2000.
3. Amitabha, Battacharyya., *Metal Cutting, Theory and Practice*, 22nd reprint, New Central Book Agency, 2008.
4. Serope, Kalpakjian., and Steven, R. Schmid., *Manufacturing Engineering and Technology*, 5th ed., Pearson Education, 2006.
5. Shaw, M.C., *Metal cutting Principles*, Oxford clarendon Press, 1984.
6. Vekatesh, V.C., and Chandrasekharan, H., *Experimental Techniques in Metal cutting*, Prentice hall of India
7. E.M. Trent, *Metal Cutting*, 4th ed., Butterworth Heinemann, 2000.
8. Boothroyd, *Fundamentals of Metal Machining & Machine Tools*, McGraw Hill, 1975.
9. Pandey, P.C., & Shan., *Modern Machining Processes*, 33rd reprint, Tata Mc Graw Hill., 2008.

ME4103 TOOL ENGINEERING AND DESIGN

Prerequisite: Nil

Total Hours: 42

L	T	P	C
3	0	0	3

Module 1 (10 hours)

Design of chips forming tools, single point tools, tool geometry, tool materials - milling cutters, drills & reamers, grinding wheels, tipped tools and inserts. Influence of cutting parameters on cutting force and power, cutting power estimation in Turning, Milling & Drilling.

Module 2 (10 hours)

Press Working Tools, power presses, die cutting operations, centre of pressure, punch & die size and press tonnage calculations, scrap - strip layout . Compound and progressive dies, die design, drawing dies, blank development, press tonnage estimation, blank holding pressure, multiple draws, design of drawing dies.

Module 3 (11 hours)

Design of a fixture, elements of fixture, standard work holding devices, principles of location & clamping, plain & concentric location, clamping elements, quick acting clamps, design of plate fixtures, turning fixtures and indexing fixtures.

Module 4 (11 hours)

Design of Jigs, Jigs for drilling & reaming, types of jigs, guide bushings, indexing jigs, design of plate jigs, angle plate jigs, indexing jigs and box jigs.

References

1. Acherkan ., *Principle of Machine tools*, Vol. 1, 2, 3 and 4, Mir publishers, 1972.
2. Amitabha, Battacharyya., *Metal Cutting, Theory and Practice*, 22nd reprint, New Central Book Agency, 2008.
3. ASTME, *Fundamentals of Tools Design*, Prentice Hall of India, 1962.
4. F.W. Wilson., *Hand Book of Fixture Design*, Mc Graw Hill, 1962.
5. Donaldson., Lecain., and Gould., *Tool design*, Tata McGraw Hill, 2001.
6. Rodin. P., *Design & Production of Metal Cutting Tools*, MIR Publishers.
7. HMT, *Production Technology*, 3rd reprint, Tata McGraw Hill, 1987.
8. P. H. Joshi., *Jigs and Fixtures*, Tata McGraw Hill, 2003.

ME4192 MANAGEMENT SCIENCE LABORATORY

Prerequisite: ME3105 Production Management

L	T	P	C
0	0	3	1

Total Hours: 42

1. Performance analysis of a serial supply chain – role play game.
2. Problem formulation and solution & sensitivity analysis using LINGO.
3. Simulation exercise using ARENA.
4. Construction of X-bar, R chart and process capability determination.
5. Design a process layout for the given problem.
6. Preparation of assembly chart, product structure and material planning using MRP.
7. Stop watch time study of a drill press operation.
8. Learning curve.
9. Visual acuity test – dark adaptation analysis.

References

Supply Chain game:

1. Chinna Pamulety T., and Madhusudanan Pillai, V., *Performance analysis of a serial supply chain under advance demand information*, Proceedings of the International Conference on Latest Trends in Simulation Modelling and Analysis (COSMA 2009), pp 270 - 275, December 17 – 19, National Institute of Technology Calicut, Kerala, India, 2009.

Mathematical formulation:

1. Ravindran, Philips and Solberg, *Operations research: Principles and Practice*, 2nd ed., John Wiley & Sons, 1987.
2. LINDO Systems, Inc., *Optimisation Modelling with LINGO* by Lynus schrage, 6th ed., 2006, (http://www.lindo.com/index.php?option=com_content&view=article&id=38&Itemid=24, Accessed on December 2010).
3. <http://www.lindo.com>, (Accessed on December 2010).

Simulation:

1. Kelton, W.D., Sadowski, R.P., and Sturrock, D.T., *Simulation with ARENA*, 4th ed., McGraw Hill Higher Education, 2008.
2. <http://www.arenasimulation.com> (Accessed on December 2010).

Control chart:

1. Grant, E.L. and Leavenworth, R.S., *Statistical quality Control*, 7th ed., McGraw-Hill, 1996.
2. Juran, J.M. and Gryna, F.M., *Quality Planning and Analysis*, 3rd ed., Tata McGraw-Hill Edition, 1995.

Process layout:

1. Francis, R.L., McGinnis, Jr., L.F. and White, J.A., *Facility Layout and Location: An Analytical Approach*, 2nd ed., Prentice-Hall of India, 1999.
2. Deb, K., *Optimisation for Engineering Design: Algorithms and Examples*, Prentice-Hall of India Pvt. Ltd, -use for simulated annealing procedure, 1995.

Product structure and MRP:

1. Vollmann, Berry, Whybark and Jacobs, *Manufacturing Planning and Control for Supply Chain Management*, 5th ed., Tata McGraw-Hill Edition – see Chapter on Material Requirement Planning, 2005

Time study:

1. Barnes, R.M., *Motion and Time Study: Design and Measurement of Work*, 7th ed., 1980, John Wiley & Sons, 1980.
2. International Labour Office Geneva, *Introduction to Work Study*, 3rd ed., Universal Book Corporation, 1979

Learning curve:

1. Chase, R.B., Shanker, R., Jacobs, F.R. and Aquilano, N.J., *Production & Supply Management*, 12th ed., Tata McGraw-Hill Edition – Chapter 5A Learning Curve, pp 169 – 186, 2010.

Visual acuity test:

1. Sanders, M.S., and McCormick, E.J., *Human Factors in Engineering and design*, McGraw-Hill International editions, 7th ed., 1993.

ME4193 METAL CUTTING LABORATORY

Prerequisite: Nil

L	T	P	C
0	0	3	1

Total Hours: 42

Study and programming of CNC machines, Measurement of cutting force in various machine tools; Study of the variation of cutting force with parameters like cutting velocity, feed, depth & tool geometry, Study of influence of cutting fluids on machining, Study of tool and cutter grinder, Surface integrity studies on parts machined in traditional machine tools, Experiments on cylindrical grinding machines, Metal removal rate and tool wear rate studies on die sinking EDM, Study of crank press and preparation of scrap strip layout, Preparation of tool layout for turret lathe

References

1. Amitabh, Ghosh., and Asok, Kumar, Mallik., *Manufacturing Science*, Affiliated East West Press Pvt. Ltd., 2008.
2. Juneja, B.L., and Sekhon, G.S., *Fundamentals of Metal Cutting and Machine Tools*, New Age, International (P) Ltd., 2000.
3. Amitabha, Battacharyya., *Metal Cutting, Theory and Practice*, 22nd reprint, New Central Book Agency, 2008.
4. Serope, Kalpakjian., and Steven, R. Schmid., *Manufacturing Engineering and Technology*, 5th ed., Pearson Education, 2006.
5. Shaw, M.C., *Metal cutting Principles*, Oxford clarendon Press, 1984
6. Vekatesh, V.C., and H. Chandrasekharan., *Experimental Techniques in Metal cutting*, Prentice hall of India E.M. Trent, "Metal Cutting", Butterworth Heinemann.
7. Geoffrey, Boothroyd and W. A. Knight, *Fundamentals of Metal Machining & Machine Tools*, McGraw Hill, 1975.
8. P.C.Pandey., & Shan., *Modern Machining Processes*, 33rd reprint, Tata Mc Graw Hill., 2008.

ME4098 PROJECT

Prerequisite: Nil

L	T	P	C
0	0	3	3

Total Hours: 42

Students are required to take up a project (generally in groups) in any topic related to Mechanical Engineering under the guidance of a faculty member. The project work commenced in VII Semester (normally 5 hours/week) shall be continued in VIII Semester too. At the end of the VII semester, an interim report describing the details of the project work has to be submitted to the Department, usually in a prescribed format. Presentation of this part of the work is to be done before an evaluation committee.

Semester 8

ME4111 INDUSTRIAL ENGINEERING

Prerequisite: Nil

L	T	P	C
3	0	0	3

Total Hours: 42 hours

Module 1 (8 hours)

Productivity – productivity measurement approaches at the enterprise level – techniques for productivity improvement, Work study – working conditions – introduction to ergonomics.

Module 2 (10 Hours)

Method study – techniques – various types of charts and diagrams – flow and handling of materials – tools for recording the movement of workers, Principles of motion economy – micromotion study – SIMO chart.

Module 3 (12 Hours)

Work measurement – basic procedure – techniques, Work sampling, Time study – allowances – standard time, Introduction predetermined time standards, Job analysis – job evaluation – merit rating , Wages and incentives.

Module 4 (12 Hours)

Cost concepts – income measurement – profit planning – control – decision making , Cost function, Break even analysis, Job/Order costing, Batch costing, Depreciation methods, Introduction Activity based costing.

References

1. I. L.O., *Introduction to Work Study: Indian Adaptation*, 3rd. ed., Oxford & IBH Publishing Co. Pvt. Ltd. New Delhi, 2003.
2. Barnes, R. M., *Motion and Time Study: Design and Measurement of Work*, 7th ed., John Wiley & Sons, 1980.
3. Khan and Jain, *Management Accounting*, 3rd ed., Tata McGraw-Hill Publishing Company Ltd. 2009.

MS4004 INDUSTRIAL ECONOMICS

Prerequisite: Nil

L	T	P	C
3	0	0	3

Total Hours: 42 Hrs

Module 1 (11 hours)

General Foundations of Economics; Nature of the firm; Forms of organizations-Objectives of firms-Demand analysis and estimation-Individual, Market and Firm demand, Determinants of demand, Elasticity measures and business decision making, Demand Forecasting-Theory of the firm-Production functions in the short and long run-Cost concepts- Short run and long run costs- economies and diseconomies of scale

Module 2 (9 hours)

Product Markets-Market Structure-Competitive market-Imperfect competition (Monopoly, Monopolistic competition and Oligopoly) and barriers to entry-Pricing in different markets-Differential Pricing-Supply, Demand and Government Policies-Game Theory-Prisoner's Dilemma

Module 3 (11 hours)

Macro Economic Aggregates-Gross Domestic Product; Economic Indicators; Models of measuring national income; Inflation ; Fiscal and Monetary Policies ; Monetary system; Money Market, Capital market; Indian stock market; Development Banks; Changing role of Reserve Bank of India

Module 4 (11 hours)

International trade - Foreign exchange market- Balance of Payments (BOP) and Trade-Effects of disequilibrium in BOP in business- Trade regulation- Tariff versus quotas- International Trade and development and role of international institutions (World Bank, IMF and WTO) in economic development.

References

1. Bo Soderston, International Economics,
2. Gupta, S.B Monetary Economics, (1994). S. Chand & Co., New Delhi.
3. Gregory.N.Mankiw, Principles of Micro Economics, Cengage Publications, 2007
4. Gregory.N.Mankiw, Principles of Macro Economics, Cengage Publications, 2007
5. *Indian Economy – Its Development Experience*, Misra, S.K. and V.K. Puri (2001) Himalaya Publishing House, Mumbai, 2009.
6. *Microeconomics*, R.S. Pindyck, D.L. Rubinfeld and P.L. Mehta, Pearson Education, 2005. *Advanced Economic Theory*, Micro Economics H.L. Ahuja, Chand Publications, 2004.
7. Economics, Samuelson, P.A.; & W.D. Nordhaus, Tata McGraw Hill, 18 Ed., 2005.
8. Public Finance, B.P. Tyagi, Jai Prakash Nath & Co., 1997.

PN : Supplementary materials would be suggested / supplied for select topics on Indian economy

ME4097 SEMINAR

L	T	P	C
0	0	3	1

Prerequisite: Nil

Total Hours: 42

Search technical literature in the form of peer reviewed journals and conference proceedings and identify a current research topic relevant to Mechanical Engineering – Comprehend the topic and prepare a technical report on the topic of presentation in the specified format – Prepare presentation aids and deliver a technical presentation to the class – Appropriate weights will be given for communications skills (both verbal and written) as well as for capacity to impress the audience and ability to handle question and answer session.

ME4099 PROJECT

Prerequisite: ME4098 Project

Total Hours: 70

L	T	P	C
0	0	5	5

The project work commenced in VII Semester shall be continued in VIII Semester, normally 5 hours/week. At the end of the VIII semester, the final report/thesis describing the details of the entire project work has to be submitted to the Department, usually in a prescribed format. Presentation of the entire work is to be done before an evaluation committee and a successful oral defense of the thesis before the committee is required.

ELECTIVES

ME3021 INTRODUCTION TO FINITE ELEMENT METHODS

Prerequisite: Nil

Total Hours: 42

L	T	P	C
3	0	0	3

Module 1 (10 hours)

Introduction – various numerical methods – concepts of variational calculus – variational methods of approximation, Ritz method, Weighted residual methods – Galerkin method – subdomain method – least square method – collocation method, Problems.

Module 2 (10 hours)

Finite element analysis of one-dimensional problems – procedure – one-dimensional elements and interpolation functions – analysis of one-dimensional second and fourth order equations – natural co-ordinates – interpolation functions – computer implementation.

Module 3 (12 hours)

Finite element analysis of two-dimensional problems – two-dimensional elements and interpolation functions – second order equations involving a scalar valued function – comments on mesh generation and composition of boundary conditions – analysis of plane elasticity and incompressible fluid flow problems – time dependent problems (transient heat transfer) – iso-parametric elements and numerical integration.

Module 4 (10 hours)

Dynamic Analysis – Hamilton’s Principle – Eigen value problems – non linear problems – three-dimensional elements and interpolation functions – formulation of three-dimensional problems – two and three-dimensional Navier Stoke’s equations – three-dimensional heat transfer equations.

References

1. Reddy, J.N., *An Introduction to the Finite Element Method*, 3rd ed., Tata McGraw-Hill, 2005.
2. Reddy, J.N., *Applied Functional Analysis and Variational Methods in Engineering*, International Edition, McGraw-Hill, 1987.
3. Huebner, K. H., *The Finite Element Method for Engineers*, John Wiley & Sons.
4. Zienkiewicz, O.C., *The Finite Element Method*, Tata McGraw-Hill Edition.
5. Zienkiewicz, O.C., and Morgan, K., *Finite Elements and Approximation*, John Wiley & Sons, 1983.
6. Cook, R.D., Malkus, D.S., Plesha, M.E., and Witt, R.J., *Concepts and Applications of Finite Element Analysis*, 4th ed., John Wiley & Sons, 2004.

ME3022 EXPERIMENTAL STRESS ANALYSIS

Prerequisite: ME2002 Elements of Solid Mechanics or Equivalent

Total Hours: 42

L	T	P	C
3	0	0	3

Module 1 (9 hours)

Analysis of stress at a point and strain at a point, Stress-strain relations, Principal stresses and principal strains, Prediction of failures, Basic equations in elasticity theory, Formulation of problems, Field equations, Plane stress and plane strain problems, Solution of problems using Airy's stress function.

Module 2 (12 hours)

Strain measurements, Strain and its relation to experimental determinations, Types of strain gauges – mechanical strain gauges – optical strain gauges - inductance strain gauges, Electrical resistance strain gauges - strain sensitivity in metallic alloys - gauge construction-strain gauge adhesives and mounting methods - gauge sensitivities and gauge factor – performance characteristics of foil strain gauges - temperature compensation, Strain gauge circuits - potentiometer - Wheatstone bridge circuits. Strain rosettes- rectangular and delta rosette.

Module 3 (12 hours)

Photo elasticity - basics of optics – double refraction - stress optic law - stress and birefringence, Two dimensional photoelasticity - plane polariscope - circular polariscope - isoclinics - isochromatics - effects of stressed model in a plane polariscope and circular polariscope – dark field and light field arrangements, Compensation techniques, Photoelastic materials, Calibration methods, Separation methods, Scaling model to prototype stresses.

Module 4 (9 hours)

Theory of brittle coating method - coating stresses, Failure theories - brittle coating patterns - crack detection, Ceramic based brittle coatings, Resin based brittle coatings, Test procedures for brittle coating analyses - analysis of brittle coating data.

References

1. James. W. Dally, and William E. Riley, *Experimental Stress Analysis*, McGraw Hill, Third Edn., 1991.
2. R.G. Budynas, *Advanced Strength and Applied Stress Analysis*, McGraw Hill, Second Edn., 1999.
3. L.S. Sreenath, M.R. Raghavan, K. Lingaiah, G. Garghesha, B. Pant, and K. Ramachandra, *Experimental Stress Analysis*, Tata Mc Graw Hill.
4. Timoshenko and Goodier, *Theory of elasticity*, McGraw Hill, New York, Third Edn., 1970.

ME3023 THEORY OF PLASTICITY

Prerequisite: ME2012 Applied Mechanics of Solids

Total Hours: 42

L	T	P	C
3	0	0	3

Module 1 (10 hours)

Review of the theory of stress and Strain – transformation laws – principal stress and strain – Mohr’s circle, Stress strain relations, Material properties, Introduction to the theory of plasticity – behaviour of metals under uni-axial tension and compression — true stress-true strain relations — effect of work hardening, Bollarding and Barrelling, Empirical stress-strain relations for work hardening materials.

Module 2 (10 hours)

Yield criterion – stress space representation of yield criterion – representation of Tresca and von-Mises criterion – yield surface for work hardening materials, Stress strain relations in the plastic range — Prandtl -Reuss, Levy-Mises and St. Venant’s stress-strain relations, Plastic potential, Principle of maximum work dissipation.

Module 3 (12 hours)

Elastic-Plastic analysis – pure bending of a beam – torsion of circular bar – thick spherical shell under internal pressure – thick cylindrical shell under internal pressure – rotating cylinders – rotating disks, Plane strain problems – simple slip line fields, Bound theorems and their applications

Module 4 (10 hours)

Application of the theory of plasticity to metal forming operations – plasticity analysis of extrusion and drawing of wires and strips – analysis of tube drawing with mandrels – analysis of rolling – analysis of forging, Load calculations for the operations.

References

1. Chakrabarty, J., *Theory of Plasticity*, Van-Nostrand Reinhold Co., London, 1975.
2. Johnson, W., and Meller, P.B., *Engineering Plasticity*, Mc-Graw Hill Book Co., New York, 1987.
3. Hoffman, O. and Sachs, G., *Introduction to the theory of Plasticity for Engineers*, Mcgraw Hill Book Co., New York, 1953.

ME3024 CONTROL SYSTEMS ENGINEERING

Prerequisite: Nil

Total Hours: 42

L	T	P	C
3	1	0	3

Module 1 (12 hrs)

Introduction to control system engineering, History, Representation of feedback control system by block diagrams, Physical systems and their mathematical models, Representation of linear time invariant systems, Order of the system, Classical method, Transfer function approach, Block diagram reduction, State space representation, Mathematical models of mechanical, electrical, hydraulic and pneumatic elements and systems, Conversion of state Space to transfer function and transfer function to state space, Transformation of mathematical model using MATLAB.

Module 2 (12 hrs)

Transient response analysis, Solution of first order, Second order and Higher order systems, Solution by Laplace transform, Solution of states space equation, Performance parameters of first order and second order systems, Stability of systems, Routh-Hurwitz criterion, Steady state error, Error constants, Improving time response and steady state error, Root locus techniques, Application of MATLAB in transient response.

Module 3 (8 hrs)

Frequency response of systems, Plotting the frequency response, Rectangular plots, Polar plots, Bode plots and Nichols chart, Stability analysis, Nyquist plots and Nyquist criterion, Gain margin, Phase margin, Application of MATLAB in frequency response.

Module 4 (10 hrs)

Design of control systems, The design philosophy, Design of Lead, Lag, Lead- Lag, Proportional, Integral, derivative and PID controllers using Root locus and Bode plot, Tuning of controllers and PID controller gain tuning techniques, Design of controllers via state space, Controllability and observability, Applications of MATLAB in design of controllers.

References

1. Ogata, K., *Modern Control Engineering*, 4th ed., Prentice-Hall of India, 2002.
2. I.J. Nagrath, I.J., and Gopal, M., *Control Systems Engineering*, 5th ed., New Age International Publishers, 2007.
3. Ogata, K., *System Dynamics*, 4th ed., Pearson Education Inc., 2004.
4. Kuo, B.C., *Automatic Control Systems*, 7th ed., Prentice-Hall of India, 1995.
5. Chen ,C.T., *Linear System Theory and Design*, 3rd ed., Oxford University Press, 1999.
6. Franklin, G.F., Powell, J.D., and Naeini, A.E., *Feedback Control of Dynamic Systems*, 4th ed., Prentice Hall, 2002.
7. Dorf R.C., and Bishop, R.H., *Modern Control Systems*, 11th ed., Pearson Education, 2008.
8. Azzo, J.J.D., and Houpis, C.H., *Linear Control System Analysis and Design*, 4th ed., McGraw Gill Publishers, 1995.

ME3025 NONLINEAR DYNAMICS AND CHAOS

Prerequisite: ZZ1001 Engineering Mechanics

Total Hours: 42

L	T	P	C
3	0	0	3

Module 1 (10 hours)

Introduction to dynamical systems, Discrete and continuous time systems, Autonomous and non-autonomous systems, Discrete time systems – one-dimensional map – fixed points of maps and their stability, Bifurcation of maps, Continuous time systems – phase space and flows – attracting sets, Concepts of stability.

Module 2 (10 hours)

Equilibrium solutions, Fixed points and stability of continuous time systems, Classification and stability of equilibrium solutions, Periodic solutions – Periodic solutions of continuous time dynamical systems, Autonomous and non-autonomous systems, Limit cycle, Poincaré section, Bifurcation – local and global bifurcation of continuous systems – static and dynamic bifurcations – Hopf bifurcations, Quasiperiodic solutions, Circle map.

Module 3 (10 hours)

Dynamics of discrete time systems, Logistic equation – bifurcation diagram of one-dimensional maps – chaotic solutions of maps, Henon map, Continuous systems – Duffing's equation – Rossler equations- period doubling and Intermittency mechanisms, Tools to identify and analyze motions – time history – state-space and pseudo state space- Fourier spectra – Poincare' sections and maps, Lyapunov exponents.

Module 4 (12 hours)

Fractals and dynamical systems, Examples of fractals – Koch curve – Cantor set etc., Fractal dimension – measures of fractal dimension, Computational methods – shooting method, harmonic balance method, Determination of Lyapunov exponents and fractal dimensions, Applications of nonlinear dynamics.

References

1. Strogatz, S.H., *Nonlinear Dynamics and Chaos*, Westview Press, 1994.
2. Nayfeh, A.H., and Balachandran, B., *Applied Nonlinear Dynamics*, John Wiley & Sons, 1995.
3. Thomson, J.M.T., and Stewart, H.B., *Nonlinear Dynamics and Chaos*, John Wiley & Sons, 1986.
4. Moon, F.C., *Chaotic and Fractal Dynamics*, John Wiley & Sons, 1987.
5. Baker, G.L., and Gollub, J.P., *Chaotic Dynamics*, 2nd ed., Cambridge University Press, 1996.
6. Peitgens, Jurgens, and Saupe, *Chaos and Fractals*, Springer Verlag, 1992.
7. Scheinerman, E.R., *Invitation to Dynamical Systems*, Prentice hall, New Jersey, 1996.
8. Drazin, P.G., *Nonlinear Systems*, Cambridge University Press, 1992.
9. Devaney, R.L., *An Introduction to Chaotic Dynamical Systems*, 2nd ed., Addison-Wesley, 1989.
10. Jordan, D.W., Smith, P., *Nonlinear ordinary differential equations*, 4th ed., Oxford University Press, 2007.

ME3026 ENGINEERING FRACTURE MECHANICS

Prerequisite 1: ME2002 Elements of Solid Mechanics

**Prerequisite 2: ME2012 Applied Mechanics of Solids/
ME2015 Theory of Elasticity and Plasticity**

L	T	P	C
3	0	0	3

Total Hours: 42

Module 1 (10 hours)

Introduction – significance of fracture mechanics, Stress concentration factor, Griffith energy balance approach, Irwin’s modification to the Griffith theory, Stress intensity approach, Crack tip plasticity, Fracture toughness, Subcritical crack growth, Influence of material behaviour, Problems in I, II & III modes, Mixed mode problems, Linear elastic fracture mechanics (LEFM) – elastic stress field approach – mode I elastic stress field equations – expressions for stresses and strains in the crack tip region, Finite specimen width, Superposition of stress intensity factors (SIF), SIF solutions for well known problems.

Module 2 (10 hours)

Energy balance approach – Griffith energy balance approach – relations for practical use, Determination of SIF from compliance, Slow stable crack growth and R-curve concept, Description of crack resistance, LEFM Testing – Plane strain and plane stress fracture toughness testing, Determination of R-curves, Effects of yield strength and specimen thickness on fracture toughness, Practical use of fracture toughness and R-curve data.

Module 3 (10 hours)

Crack Tip Plasticity – Irwin plastic zone size – Dugdale approach – shape of plastic zone – state of stress in the crack tip region, Elastic plastic fracture mechanics (EPFM) – development of EPFM, J-integral, Crack opening displacement (COD) approach, COD design curve, Relation between J and COD, Standard J_{Ic} test and COD test.

Module 4 (12 hours)

Fatigue crack growth – description of fatigue crack growth using stress intensity factor, Effects of stress ratio and crack tip plasticity, Crack closure, Paris Law, Prediction of fatigue crack growth under constant amplitude and variable amplitude loading, Fatigue crack growth from notches – short crack problem, Practical problems – through cracks emanating from holes – corner cracks at holes – cracks approaching holes – fracture toughness of weldments – service failure analysis – applications in pressure vessels, pipelines and stiffened sheet structures.

References

1. Ewalds, H.L. and Wanhill, R.J.H., *Fracture Mechanics*, 1st ed., Edward Arnold Edition, 1993.
2. Broek, D., *Elementary Engineering Fracture Mechanics*, 4th ed., Sijthoff & Noordhoff International Publishers, 1991.
3. Kåre Hellan, *Introduction to Fracture Mechanics*, McGraw-Hill Book Company, 1983.
4. Prashant Kumar, *Elements of Fracture Mechanics*, Wheeler Publishing, 1999.

ME3027 FLUID POWER CONTROLS

Prerequisite: ME2001 Fluid Mechanics

L	T	P	C
3	0	0	3

Total Hours: 42

Module 1 (10 Hours)

Introduction to oil hydraulics and pneumatics, their advantages and limitations, ISO symbols and standards in Oil Hydraulics and pneumatics, Recent developments, applications, Basic types and constructions of Hydraulic pumps and motors, Ideal pump and motor analysis, Practical pump and motor analysis, Performance curves and parameters.

Module 2 (11 Hours)

Hydraulic Actuators, Hydraulic control elements – direction, pressure and flow control valves. Valve configurations, General valve analysis, valve lap, flow forces and lateral forces on spool valves, Series and parallel pressure compensation flow control valves, Flapper valve Analysis and Design, Analysis of valve controlled and pump controlled motor, Electro-hydraulic servo valves-specifications, selection and use of servo valves.

Module 3 (11 Hours)

Electro hydraulic servomechanisms – Electro hydraulic position control servos and velocity control servos, Nonlinearities in control systems (backlash, hysteresis, dead band and friction nonlinearities). Basic configurations of hydraulic power supplies – Bypass Regulated and Stroke Regulated Hydraulic Power Supplies, Heat generation and dissipation in hydraulic systems: Design and analysis of typical hydraulic circuits, Use of Displacement – Time and Travels-Step diagrams: Synchronization circuits and accumulator sizing. Meter - in, Meter - out and Bleed-off circuits: Fail Safe and Counter balancing circuits.

Module 4 (10 Hours)

Components of pneumatic systems: Direction, flow and pressure control valves in pneumatic systems, Development of single and multiple actuator circuits, Valves for logic functions: Time delay valve, Exhaust and supply air throttling, Examples of typical circuits using Displacement – Time and Travel-Step diagrams, Will-dependent control, Travel-dependent control and Timedependent control, combined control, Program Control, Electro-pneumatic control and air hydraulic control, Applications in Assembly, Feeding, Metalworking, materials handling and plastics working.

References

1. Joji, P., Pneumatic controls, Wiley India Pvt. Ltd., 2008.
2. Anthony Esposito., Fluid Power with applications, Pearson Education.
3. Ernst, W., Oil Hydraulic Power and its Industrial Applications, New York, McGraw Hill.
4. Lewis, E. E., and H. Stern, Design of Hydraulic Control Systems, New York, McGraw Hill.
5. Morse, A. C., Electro hydraulic Servomechanism, New York, McGraw Hill.
6. Pippenger, J.J., and R.M. Koff, Fluid Power Control systems, New York, McGraw Hill.
7. Fitch, Jr., E.C., Fluid Power Control Systems, New York, McGraw Hill.
8. Khaimovitch., Hydraulic and Pneumatic Control of Machine Tools.
9. John Watton., Fluid Power Systems: modeling, simulation and microcomputer control, Prentice Hall Int.
10. Herbert E. Merritt., Hydraulic control systems, John Wiley and Sons Inc.
11. Thoma, Jean U., Hydrostatic Power Transmission, Trade and Technical Press, Surrey, England.
12. Ian Mencal., Hydraulic operation and control of Machine tools, Ronald Press.
13. Sterwart., Hydraulic and Pneumatic power for production, Industrial Press.
14. Hasebrink J.P., and Kobler R., Fundamentals of Pnuematics/electropeumatics, FESTO Didactic publication.
15. Werner Deppert and Kurt Stoll., Pneumatic Control-An introduction to the principles, Vogel – Verlag.
16. Blaine W. Andersen., The analysis and Design of Pneumatic Systems, John Wiley and Sons, Inc.
17. Blackburn, J.F., G. Reethof, and J.L. Shearer, Fluid Power Control, New York, Technology Press of M. I. T.

ME3028 ADVANCED THERMODYNAMICS

Prerequisite: ME2014 Thermodynamics

L	T	P	C
3	1	0	3

Total Hours: 42

Module 1 (10 hours)

General principles of classical thermodynamics – postulational approach – basic postulates – conditions of equilibrium – fundamental equations – equations of state, Euler equation, Gibbs-Duhem equation, Multi-component simple ideal gases.

Module 2 (10 hours)

Reversible processes – maximum work theorem – alternate formulation – energy minimum principle, Legendre transformations, Extremum principles in the Legendre transformed representation, Thermodynamic potentials and Massieu functions.

Module 3 (10 hours)

Maxwell relations and Jacobian methods, Procedure to reduction of derivatives, applications, Stability criteria of thermodynamic systems, First-order phase transition, single component and multi-component systems, Gibbs phase rule – phase diagram for binary systems.

Module 4 (12 hours)

Critical phenomena, Liquid and solid Helium, Nernst postulate, Introduction to irreversible thermodynamics – linearised relation – Onsager’s reciprocity theorems, Special topics on advanced thermodynamics.

References

1. Callen, H.B., *Thermodynamics and an Introduction to Thermostatistics*, Second Edition, John Wiley & Sons, 1985.
2. Rao, Y.V.C., *Postulational and Statistical Thermodynamics*, Allied Publishers, 1994.
3. Zemansky, M.W., Abbot, M.M. and Van Ness, H.C., *Basic Engineering Thermodynamics*, McGraw-Hill, 1987
4. Saad, M.A., *Thermodynamics for Engineers*, Prentice Hall of India, 1987.
5. Lee, J.F., Sears, F.W., *Thermodynamics: An Introductory Text for Engineering Students*, Addison Wesley, 1964.
6. Wark Jr., K., *Advanced Thermodynamics for Engineers*, McGraw-Hill, 1995.
7. O’ Cornell, J. P. and Maile, J. M., *Thermodynamics – Fundamentals for Applications*, Cambridge University Press, 2004.
8. Sonntag, R.E., Borgnakke, C and Van Wylen, G. J., *Fundamentals of Thermodynamics*, Sixth Edition, John Wiley & Sons, 2004.

ME3029 COMPUTATIONAL METHODS IN ENGINEERING

Prerequisite: Nil

Total Hours: 42

L	T	P	C
3	0	0	3

Module 1 (8 hours)

Basic consideration in numerical methods, Numerical error and accuracy – round-off error – truncation error – accuracy of numerical results – Numerical stability, Iterative convergence – conditions of convergence – rate of convergence – termination of iteration, Numerical parameters – step size – convergence criterion, Numerical differentiation, – Taylor series approach – polynomial fitting approach.

Module 2 (12 hours)

Numerical solution of linear algebraic equations, Direct methods – Gaussian elimination – tridiagonal matrix algorithm – LU decomposition, Indirect methods – Jacobi iteration – Gauss-Seidel iteration, Under relaxation and over relaxation, Root of equations, Search method for real roots, Bisection method, Regula falsi and secant methods, Newton-Raphson method and modified Newton's method .

Module 3 (10 hours)

Numerical curve fitting and interpolation, Exact fit and interpolation – exact fit with an n-th order polynomial – uniformly spaced independent variable, Lagrange interpolation, Newton's divided-difference interpolating polynomial – general formulas – uniformly spaced data – extrapolation, Numerical interpolation with splines, Method of least squares for a best fit –basic considerations – linear regression – best fit with a polynomial.

Module 4 (12 hours)

Numerical integration – rectangular and trapezoidal rules – Simpson's rules, Higher-accuracy methods – Richardson extrapolation – Romberg integration – higher-order Newton-Cotes formulas , Integration with segments of unequal width – unequally space data – adaptive quadrature – Gauss quadrature, Numerical solution of ordinary differential equations, Initial value problems – Euler's method – Heun's method – Modified Euler's method – Runge-Kutta methods – predictor-corrector methods, Boundary value problems – shooting methods – finite difference methods.

References

1. Jaluria, Y., *Computer Methods for Engineering*, Allyn and Bacon, Inc., 1988.
2. Chapra, S.C., and Canale, R.P., *Numerical Methods for Engineers*, 4th ed, Tata McGraw-Hill, 2002.
3. Griffith, D.V., and Smith, I.M., *Numerical Methods for Engineers:A Programming Approach*, CRC Press, 1991.

ME3121 POWDER METALLURGY

Prerequisite: Nil

L	T	P	C
3	0	0	3

Total Hours: 42

Module 1 (10 hours)

Versatility and benefits of Powder Metallurgy, PM Process, Powder production techniques - mechanical, atomisation, chemical - reduction and carbonyl and electro-chemical processes: Ceramic powder production, Powder properties and their characteristics, Sieve analysis, Microscopy, Sedimentation analysis: Specific surface and other technological properties: Powder conditioning.

Module 2 (11 hours)

Compaction and shaping - Cold and Iso-static compaction, Die compaction, Pressing equipments and tooling: Powder Injection Moulding, Extrusion and rolling. Hot compaction techniques, Hot Iso-static Pressing (HIP), equipments, tooling and applications: Explosive compaction: Slip casting.

Module 3 (10 hours)

Sintering - stages, single component, material transport mechanisms: Model studies: Powder shrinkage experiments: Sintering diagrams and sintering anomalies. Multi-component sintering - solid phase and liquid phase, infiltration and reaction sintering: Sintering atmospheres and equipments.

Module 4 (11 hours)

Powder metallurgy products, Porous parts, Sintered carbides, Cermets, Electric and magnetic parts and ceramic components, Sintered friction materials. P/M parts of the year, Research trends in Powder Metallurgy.

References

1. Thummler, F., and Oberacker, R., *An introduction to Powder Metallurgy*, The Institute of Materials, The University Press, Cambridge Great Britain.
2. ASM Handbook, *Powder Metal Technologies and Applications* (ASM Handbook, Vol 7).
3. Leander, F., and West, W.G., *Fundamentals of Powder Metallurgy*, Metal Powder Industries Federation, 2002.
4. Upadhyaya, G.S., *Powder Metallurgy Technology*, 1st ed., Cambridge International Science Publishing Co, 2002.
5. Sinha, A.K., *Powder Metallurgy*, Dhanpat Rai Publications, 2003.
6. Angelo, P.C., and Subramanian, R., *Powder Metallurgy*, Prentice Hall of India, 2008.

ME3122 INTRODUCTION TO MARKETING

Prerequisite: MA2001 Mathematics III: Probability and Statistics

Total Hours: 42

L	T	P	C
3	0	0	3

Module 1(10 Hours)

Introduction to marketing, Evolution of marketing concept, Scope of marketing, Marketing management task, Functions of marketing, Marketing mix, Developing marketing strategies, Marketing and customer value, Corporate and division. Strategic planning in marketing, Business unit strategic planning, Contents of marketing plan.

Module 2 (10 Hours)

Identifying market segments and targets, Levels of market segmentation, Base for segmenting consumer markets, Base for segmenting business markets, Marketing Research--Marketing Research Process-Research objectives, Research Plan development, Collecting information, Analysis.

Module 3 (10 Hours)

Analyzing consumer markets, Influencing consumer behavior, The buying decision process, Theories of consumer decision making, Analyzing Competitive strategies business markets, Organizational buying, Participating in the buying process, Stages in buying process, Managing business to business customer relations, Institutional government markets.

Module 4 (12 Hours)

Product strategy, Product characterization and classification, Product and brand relationship, Packaging, Challenges in new product development, Consumer adoption process, Product lifecycle marketing strategy, Brand management, Developing pricing strategies and progress, Understanding prices, Setting the prices, Adapting the prices, Initiating and responding to price changes.

References

1. Kotler, P., Keller, K..L., Koshy, A., and Jha, M., *Marketing Management*, 13th edition, Prentice Hall India Ltd, New Delhi, 2009.
2. Ramaswamy V.S and Namkumari S., *Marketing Management*, Macmillan India Ltd, New Delhi, 1997.
3. Keegan, *Global Marketing Management*, Pearson Education India, New Delhi, 2002.
4. Saxena, *Marketing Management*, 2nd edition, Tata McGraw Hill , 2002.

ME3123 DESIGN AND ANALYSIS OF MANAGEMENT INFORMATION SYSTEMS

Prerequisite: Nil

Total Hours: 42

L	T	P	C
3	0	0	3

Module 1 (11 hours)

Concepts of data and information – Producing information from data – economies of information – analysis of system – management and formal information system concepts, Building blocks in information systems – system design forces – information development life cycle – information systems for strategic planning.

Module 2 (10 hours)

General steps in Information system design – systems investigation and requirements engineering – System analysis and general system design – charting tools for system analysis and design.

Module 3 (11 hours)

Introduction to database management – classification of data items – Coding considerations – types of code structures – Forms design. General File storage consideration – composition and classification of data files – selection consideration for file media and file organization methods, concepts of data structures – data association – sorting and searching techniques.

Module 4 (10 hours)

System implementation – Verification and Validation of Software system – Software metric and models, introduction to capability maturity model – software testing approaches – training and post implementation audit – Recent developments in information systems, Security features in global information systems.

References

1. Burch and Grudnitski, *Information Systems – Theory and Practice*, 5th ed., John Wiley & Sons, New York, 1989.
2. Hawryskiewicz, I.T., *Introduction to Systems Analysis and Design*, Prentice Hall of India, 1989.
3. Ian Sommerville, *Software Engineering*, 6th ed., Pearson Education Asia, 2001.
4. Lucas, Henry C., *Analysis, Design, and Implementation of Information Systems*, 4th ed., McGraw Hill, New York, 1992.
5. O' Brien, J.A., *Management Information Systems*, 4th ed., Tata McGraw Hill, 1999.

ME3124 WORK DESIGN AND MEASUREMENT

Pre-requisite: Nil

Total Hours: 42 hours

L	T	P	C
3	0	0	3

Module 1 (12 Hours)

Definition and scope of work design and measurement – work Design and methods study – scope of work design – procedure for methods study – process analysis – process charts – operation analysis – cyclographs – principles of motion economy, Work Measurement – objectives – time study equipment – establishment and maintenance of time standards, Allowances and performance rating, Concept of rating in time study.

Module 2 (10 Hours)

Precision time measurement, Synthesis of standard data, Pre-determined fundamental motion time standards – MTM, Work factor System, Standard data, Work sampling – statistical techniques in work sampling – confidence limits, Work Study in office – work simplification – measurement of performance, Forms design – diagnostic and procedure charts.

Module 3 (10 Hours)

Ergonomics –nature of man-machine systems – characteristics – purpose, Operational functions and components – types of systems, Information input and processing, Sources and pathways of stimuli, Human information processing, Visual displays – quantitative and qualitative displays – visual codes, symbols and signs – general guidelines in design of visual displays.

Module 4 (10 Hours)

Auditory and tactual displays – masking – types of auditory displays – cutaneous senses , Tactual displays, Speech communication – speech intelligibility – components of speech communication, Nature of human activity and their effects, Bases of human motor activity – human control of systems – input-output channels – compatibility, Influence of display factors and control factors on system control.

References

1. Barnes, R. M, *Motion and Time Study: Design and Measurement of Work*, John Wiley & Sons, NY, 7th ed., 1980.
2. Mark S. Sanders and Earnest J. McCormick, *Human Factors in Engineering and Design*, 6th ed., McGraw-Hill, 1987.
3. Marvin E., Mundel, D. Danner, and David L. Anner, *Motion and Time Study*, 6th ed., Prentice Hall of India, 1985.
4. Murrell K.F.H. and Schnauber, H, *Ergonomics*. Econ, Munich, 1986.
5. Gavriel Salvendy, *Handbook of Human Factors & Ergonomics*, Inter-science, 1997.

ME3125 COST ANALYSIS AND CONTROL

Prerequisite: Nil

Total Hours: 42

L	T	P	C
3	0	0	3

Module 1(10 Hours)

Nature of Management Accounting, Generally accepted Accounting Principles and Accounting Standards, Accounting Cycle and Statements of Financial Information Understanding Corporate Financial Statements and Reports.

Module 2 (10 Hours)

Cash Flow Statement, Financial Statements Analysis, Cost Concepts and Management Needs, Costing and Control of Materials, Costing and Control of Labour ,Costing and Control of Factory (Manufacturing) Overheads ,Costing and Control of Administrative, Selling and Distribution Overheads.

Module 3 (10 Hours)

Activity Based Costing System, Job-Order and Batch Costing, Process, Joint and By-Product Costing, Variable Costing and Absorption (Full) Costing

Module 4 (12 Hours)

Volume-Cost-Profit Analysis, Budgeting and Profit Planning, Standard Costs and quality Costs, Cost Variance Analysis, Revenue and Profit Variance Analysis, Responsibility Accounting, Short-Run Decision Analysis, Capital Budgeting

References

1. Khan, M Y. and Jain, P K, *Management Accounting: Text, Problems and Cases, 4/e*, Tata McGraw-Hill, 2009.
2. Horngren, C.T., Datar, S.T., Foster, D., Rajan, M.V. and Ittner, C., *Cost Accounting: Managerial Emphasis*, 13th ed., Pearson, 2009.
3. Khan, M Y. and Jain, P K, *Cost Accounting and Financial Management*, Tata McGraw-Hill, 2008.

ME3126 SUPPLY CHAIN MANAGEMENT

Prerequisite: Nil

Total Hours: 42

L	T	P	C
3	0	0	3

Module 1 (10 hours)

Introduction and a strategic view of supply chains, Evolution of Supply Chain Management (SCM), Importance of the supply chain, Decision phases in a supply chain, Process views of supply chain, Enablers of supply chain performance, Supply chain performance in India – challenges in maintaining supply chain in India, Supply chain strategy and performance measures– competitive and supply chain strategies – customer service and cost trade –offs, Achieving strategic fit, Supply chain performance measures – enhancing supply chain performance.

Module 2 (11 hours)

Supply chain drivers – framework for structuring drivers, Introduction to inventory management – types of inventory – inventory related costs, Managing inventories in a supply chain – single stage inventory control, Inventory control policies – periodic review and continuous review – deterministic and probabilistic models – managing cycle stock, safety stock and seasonal stock, Impact of service level on safety stock, Analyzing impact of supply chain redesign on the inventory – impact of centralization and decentralization on inventory – choice of mode of transport.

Module 3 (11 hours)

Drivers of transportation decisions – modes of transportation– choices and comparison of their performance measures, Devising a strategy for transportation – distribution network design options for a transportation network – cross docking practices, Vehicle scheduling in transportation – savings algorithm, Network design and operation decisions – role of network design in the supply chain – factors influencing network design decisions – framework for network design decisions.

Module 4 (10 hours)

Models for facility location and capacity allocation – network optimization models – capacitated plant location models – gravity location models – network operations model, Strategic role of units in the network, Innovations in supply chains– supply chain integration – internal and external, Bullwhip effect – quantifying the bullwhip effect, Remedial strategies for coping with the bullwhip effect, Supply chain restructuring– postponement – supply chain mapping – move from make to stock (MTS) to customer to order (CTO) model, Enabling supply chain management through information technology .

References

1. Shah, J., *Supply Chain Management –Text and Cases*, Pearson Education, 2009.
2. Chopra, S., and Meindel, P., *Supply Chain Management: Strategy, Planning, and Operation*, Pearson Prentice Hall of India, 2007.
3. Levi, D.S., Kaminsky, P., Levi, E.S., and Shankar, R., *Designing and Managing the Supply Chain: Concepts, Strategies, and Case Studies*, Tata McGraw Hill, 2008.
4. Chase, R.B., Shankar, R., Jacobs, F.R., and Aquilano, N.J., *Operation and Supply Chain Management*, Tata McGraw Hill, 2010.
5. Shapiro, J.F., *Modeling the Supply Chain*, Thomson Learning, 2007.
6. Vollmann, T.E., Berry, W.L., Whybark, D.C., and Jacobs, F.R., *Manufacturing Planning and Control for Supply Chain Management*, Tata McGraw–Hill, 2006.

ME3127 MANAGEMENT OF ORGANISATIONAL BEHAVIOUR

Prerequisite: Nil

Total Hours: 42

L	T	P	C
3	0	0	3

Module 1 (11 Hours)

Introduction to Organizational Behaviour (OB): - Development and challenges, assumptions of contemporary OB. Foundations of individual behaviour values – attitudes – personality – emotions – perception – abilities – motivation in organisations – work related attitudes.

Module 2 (11 Hours)

Group Process: Foundations of group behavior, understanding team, communication, leadership, power, conflict and negotiation.

Module 3 (10 Hours)

Organisational Process: Work design and technology, organisation structure and design – organisational culture.

Module 4 (10 Hours)

Special topics: Organisational change, stress management, decision making in organisations.

References

1. Robbins, *Organisational Behavior*, 9th ed., Pearson Education, 2002.
2. Greenberg and Baron, *Behavior in Organisations*, 7th ed., Pearson Education, 2002.
3. Machane and Vonglinow, *Organisational Behavior*, 2nd ed., TMH, 2003.
4. Hersey, Balaschard and Johnson, *Management of Organisational Behavior*, 8th ed., Pearson Education, 2002.

ME3128 PRODUCTION PLANNING AND CONTROL

Prerequisite: Nil

Total Hours: 42

L	T	P	C
3	0	0	3

Module 1 (12 Hours)

Evolution of manufacturing planning and control (MPC) system – MPC system framework, Continuous improvement, Process reengineering, Just-in-time principles – various kind and sources of waste in manufacturing operations, Forecasting – forecasting for established and new product – time series analysis – error measurement.

Module 2 (10 Hours)

Sales and operations planning – sales and operations planning process – strategic variables – relevant cost – quantitative methods, Master production scheduling (MPS) – MPS technique – final assembly schedule – freezing and time fencing.

Module 3 (10 Hours)

Material requirements planning (MRP) – advanced concepts in MRP – lot sizing – buffering concept – nervousness, Just-in-time (JIT) – advanced concepts in JIT – pull production systems, Mixed model production schedule.

Module 4 (10 Hours)

Shop-floor control and capacity analysis – hierarchy of capacity planning decisions – capacity planning and control techniques – input/output control – frame work of shop-floor control – production activity control techniques – advanced concepts in scheduling.

References

1. Vollmann, Berry, Whybark and Jacobs, *Manufacturing Planning and Control for Supply Chain Management*, 5th ed., Tata McGraw-Hill Edition, 2005.
2. Nicholas, J.M., *Competitive Manufacturing Management: Continuous Improvement, Lean production and Customer – Focussed Quality*, Tata McGraw Hill Edition, 2001.
3. Narasimhan, S.L., McLeavy, D.W., and Billington, P.J., *Production planning and Inventory Control*, 2nd ed., Prentice-Hall of India, 2000.
4. Tersine, R.J., *Production and Operations Management: Concepts, Structure, and Analysis*, 2nd ed., North-Holland, 1985.
5. Monks, J.G., *Operations Management: Theory and Problems*, 3rd ed., McGraw-Hill International Edition, 1987.
6. Panneerselvam, R., *Production and Operations Management*, Prentice-Hall of India, 2001.

ME3129 MANAGEMENT OF HUMAN RESOURCES

Prerequisite: Nil

Total Hours: 42

L	T	P	C
3	0	0	3

Module 1 (11 Hours)

Human Resource Management - Historical Evolution, Topology of companies, concept of an involved employee, HR issues, Corporate and HR strategy - Linking Business and HR planning - HR instruments- Diversity issues.

Module 2 (11 Hours)

Personnel Management: Personnel Functions – Personnel Management Environment in India – Manpower Planning - Recruitment – selection and Induction of Employees – Staff Training and Development – Career Planning – Job Analysis and Design – Compensation Planning – Salary Administration – Job Evaluation – Merit Rating – Incentive Schemes.

Module 3 (10 Hours)

Industrial Relations: Managing Industrial Relations – Labour Laws – Trade Union – Employee Discipline – Grievance handling mechanisms – Suspension, Dismissal and Retrenchment – Industrial Conflict Resolution – Collective Bargaining – Productivity Bargaining – Workers, Participation in Management – Gold Collar Employee Management – Recent issues in Industrial Relations – Turnover.

Module 4 (10 Hours)

Organizational Development: Organizational Design – Dimensions – Restructuring Strategies – Work Organization – Organizational Development – Change Agents – Process of organizational change – Managing Resistance to Change – Modules in OD – Role of Counseling.

References

1. Dwivedi, R.S., *Manpower Management – An Integrated Approach to Personnel Management and Labour Relations*, PHI, 1984.
2. Yoder, D., and Stoadohar P.D., *Personnel Management and Industrial Relations*, PHI 1986.
3. Monappa, A., and Saiyadain M. S., *Personnel Management*, TMH, 1988.
4. Kapoor, N.D., *Introduction to Commercial and Industrial Law*, Sultan Chand & Sons, New Delhi, 1986.

ME3130 QUALITY PLANNING AND ANALYSIS

Prerequisite: Nil

Total Hours: 42

L	T	P	C
3	0	0	3

Module 1 (10 hours)

Introduction – history, definition, Responsibility for quality, Total quality management – approach, Leadership, Customer satisfaction, Employee involvement, Continuous process improvement, Supplier partnership, Cost of poor quality.

Module 2 (12 hours)

Seven QC tools, Quality function deployment, ISO 9000, Bench marking, Poka yoke, Failure mode and effect analysis, Design of experiments, Taguchi's quality engineering, Total productive maintenance.

Module 3 (10 hours)

Statistical quality control – fundamentals – assignable causes, Rational subgrouping, Control charts for variables – average range chart, average standard deviation chart, control charts for attributes – chart for fraction non-conforming, chart for count of non-conformities, Process capability, Six sigma.

Module 4 (10 hours)

Acceptance sampling – operating characteristic curve, Types of sampling plans, Acceptance quality level, Average outgoing quality, Sampling plan design, Reliability – life-history curve, System reliability, Testing.

References

1. Besterfield, D.H., *Quality Control*, 7th ed., Pearson Education, 2006.
2. Juran, J. M. and Gryna, F. M., *Quality Planning and Analysis*, 3rd ed., Tata McGraw Hill, 1995.
3. Grant, E.L. and Leavenworth, R.S., *Statistical Quality Control*, 7th ed., Tata McGraw-Hill, 2000.

ME4021 INDUSTRIAL TRIBOLOGY

Prerequisite 1: ME2001 Fluid Mechanics/ ME2004 Fluid Mechanics and Machinery

**Prerequisite 2: ME2012 Applied Mechanics of Solids/
ME2015 Theory of Elasticity and Plasticity**

L	T	P	C
3	0	0	3

Total Hours: 42

Module 1 (11 hours)

Introduction – Basic equations, Derivation of Reynolds equation, Energy equation, Idealized hydrodynamic bearings, Mechanism of pressure development, Plane slider bearings, Idealized journal bearings, Infinitely long and short bearings.

Module 2 (11 hours)

Finite bearings – performance characteristics – numerical solution, Hydrodynamic instability, Design of journal bearings, Analysis of externally pressurized and gas lubricated bearings.

Module 3 (10 hours)

Costs of wear, Surface topography, Mechanics of contact, Theories of friction, Friction of metals and non-metals, Temperature of sliding surfaces, Stick-slip, Rolling friction.

Module 4 (10 hours)

Wear of metals, Adhesive wear, Abrasive wear, Corrosion and corrosion wear, Erosion, Surface fatigue and impact wear, Wear of elastomers, Wear of ceramics and composite materials, Measurement of friction and wear.

References

1. Majumdar, B.C., *Introduction to Tribology*, 4th ed., A.H. Wheeler, Bangalore, 1978.
2. Pinkus and Sternlicht, *Theory of hydrodynamic lubrication*, John Wiley & Sons, New York, 1961.
3. Moore, D. F., *Principle and Application of Tribology*, Pergamon Press, New York, 1975.
4. Rabinowicz, E., *Friction and Wear of Metals*, John Wiley & Sons, New York, 1995
5. Johnson, K.L., *Contact Mechanics*, Cambridge University Press, 1985.
6. Thomas, T.R., *Rough Surfaces*, Longman Inc., 1982.

ME4022 VEHICLE DYNAMICS

Prerequisite: ME2003 Engineering Mechanics – Dynamics

L	T	P	C
3	0	0	3

Total hours: 42

Module 1 (11 Hours)

Introduction to vehicle dynamics, Acceleration performance, Braking performance, Aerodynamics and rolling resistance, Steady-state cornering, Suspensions – steering systems, Rollover-acceleration – braking and turning forces.

Module 2 (11 Hours)

Front wheel geometry—effects of front wheel geometry on vehicle performance, Dynamic axle Loads, Transient rollover, Acceleration—Traction limited acceleration—Power limited acceleration—Road friction, Rear wheel lockup, Drag forces, Total road loads, Vibration, Roll center analysis.

Module 3 (10 Hours)

Tyre construction –Types- Types of tyers—Basic Tyre modelling considerations—Tyre forces on hard surfaces—Tyre-soil interaction, Characterizing typical terrains for mobility analysis.

Module 4 (10 Hours)

Sensors, Actuators, Cruise control, Antilock braking system (ABS), Traction control, Directional control, Vehicle stability controls, Active suspension, Computer aided analysis/Simulation—Simulation with MATLAB-Simulink and ADAMS.

References

1. Thomas D. Gillespie, *Fundamentals of Vehicle Dynamics*, Society of Automotive Engineers, 1992.
2. Wong, J.Y., *Theory of Ground Vehicles*, John Wiley and Sons, 3rd ed., 2001.
3. Hans Pacejka, *Tyre and Vehicle Dynamics*, SAE Publications, 2nd ed., 2005.
4. Blundell, M. and Harty, D., *The Multi body Systems Approach to Vehicle Dynamics*, Elsevier Publications, 2004.

ME4023 INTRODUCTION TO ROBOTICS

Prerequisite: Nil

Total Hours: 42

L	T	P	C
3	1	0	3

Module 1 (11 hrs)

Brief History, Types and applications of robots. Present status and future trends in robotics, Overview of robot subsystems. Challenges in robotics, Characteristics of robots, Robot configurations and concept of work space, Types of actuators and sensors in robotics, Types of grippers.

Module 2 (10 hrs)

Introduction to Manipulator Kinematics, Position and orientation of rigid bodies, Planar and spatial mechanism description, Homogenous transformations, Denavit - Hartenberg (DH) notation, Forward and inverse kinematic analysis, Examples.

Module 3 (11 hrs)

Linear and rotational velocity of rigid bodies, Velocity propagation from link to link, Jacobians, Singularities, Static forces in manipulators, Jacobians in force domain, Cartesian transformation of velocities and static forces. Forward and Inverse Dynamics, Lagrangian and Newton – Euler’s formulation methods, Examples.

Module 4 (10 hrs)

Trajectory Generation, General consideration in path description and generation, Joint space schemes, Collision free path planning, Robot programming. Robot Control, Independent joint control, PD and PID feedback, Issues in nonlinear control, Examples.

References

1. Craig, J.J., *Introduction to Robotics, Mechanics and control*, 2nd ed., Pearson Education, 1999.
2. Spong, M.W., and Vidyasagar, M., *Robot Dynamics and Control*, John Wiley and Sons, 1989.
3. Groover, M.P., Weiss, M., Nagel, R.N., and Odrey, N.G., *Industrial Robotics: Technology, Programming and Applications*, McGraw Hill Publishers, 1986.
4. Paul, R.P., *Robot Manipulators Mathematics Programming, Control: The computer control of robotic manipulators*, MIT Press, 1979.
5. Schilling, R.J., *Fundamentals of Robotics, Analysis and Control*, Prentice Hall of India, 1996.
6. Niku, S.B., *Introduction to Robotics: Analysis, Systems, Applications*, John Wiley and Sons, 2010.

ME4024 DESIGN FOR MANUFACTURABILITY

Prerequisite: Nil

L	T	P	C
3	0	0	3

Total Hours: 42

Module 1 (9 hours)

Introduction – Design philosophy, implementing DFM, Benefits of DFM Concurrent Engineering – Design for quality, Design for Life Cycle, Design for Cost, Enabling Technology, Concurrent Engineering and the Organization, Improving the Development process. Management Frameworks – Architecture, Management’s concerns with Manufacturability, Team Building and Training. Team Building and Training - Justification of DFM, Viewpoints for DFM.

Module 2 (9 hours)

Quality Tools in DFM – Problem Solving Tools, Quality Function Deployment, Benchmarking, Computer Improvement, Taguchi approach. Computer Aided Technology – CAD/CAM/CAE, Rapid Prototyping, Group Technology, CIM Creative Thinking in DFM, Tools. General Product Design – Impact of Design concept and early project decisions, Evaluating manufacturability of conceptual designs, Producibility, Geometric Tolerancing.

Module 3 (12 hours)

Design for Assembly – Principles, improving serviceability, recyclability. Design for Machining – Principles, Non-Traditional Machining. Design for forming – Principles, fine blanking, roll forming, precision forming, metal spinning, tube fabrication.

Module 4 (12 hours)

Design for Forging, Casting. Design for Coating – Painting, powder coating, metal spraying. Design for Heat Treatment. Design for Fastening & Joining – Design guidelines for fasteners, adhesive assembly, and welded assemblies. Design for Materials: Plastics, Composites, Ceramics, Powder Metallurgy.

References

1. Chitale, A.K., and Gupta, R.C., *Product Design and Manufacturing*, Prentice-Hall Of India Pvt. Ltd, 2004.
2. Dieter, G.E., and Schmidt, L.C., *Engineering Design: A Materials And Processing Approach*, 4th ed., McGraw Hill, 2009.
3. Bakerjian, Ramon, Ed., *Design for Manufacturability*, Tool & Manufacturing Engineers Handbook, Society of Manufacturing Engineers, 1992.

ME4025 MECHATRONICS

Prerequisite: Nil

Total Hours: 42

L	T	P	C
3	0	0	3

Module 1 (10 Hrs)

Introduction to mechatronics Systems, Key elements, Mechatronics design process, Types of design – Traditional and mechatronics designs, Information systems, Real time interfacing (Hardware-in-the loop simulation), Elements of data acquisition system.

Module 2 (11 Hrs)

Introduction to actuators, sensors and transducers, Mechanical, fluid power and electrical actuators, Actuator selection criteria, Performance characteristics of sensors, Sensors for position, motion, force and temperature, Flow sensors, Range sensors, Ultrasonic sensors, Fibre optic sensors, Selection of sensors. Special transducers - Piezoelectric transducer - Magnetostrictive transducer - Shape memory alloy (SMA) transducer.

Module 3 (11 Hrs)

Introduction to signals, system and controls, System representation, Linearisation, Time delays, Measures of system performance, Closed loop controllers – PID controller – Digital controllers, Controller tuning, Adaptive control, Supervisory control, Introduction to microprocessors, Microcontrollers and programmable logic controllers, Components, PLC programming.

Module 4 (10 Hrs)

Introduction to MEMS, Microsensors in mechatronics, Sensors for condition monitoring, Artificial intelligence in mechatronics, Introduction to fuzzy logic control and neural networks, Case studies of mechatronics systems.

References

1. Bolton, W., *Mechatronics*, Pearson Education Asia, 2004.
2. Shetty, D., and Kolk, R.A., *Mechatronics System Design*, Thomson Learning, 2001
3. Neculescu, D., *Mechatronics*, Parson Education Asia, 2002.
4. H.M.T. Ltd, *Mechatronics*, Tata McGraw Hill Publishers, 1998.
5. Singh, B.P., *Microprocessors and Microcontrollers*, Galgotia Publishers, 1997.
6. Petruzella, F.D., *Programmable Logic Controllers*, Tata McGraw Hill Publishers, 1989.
7. Kant, K., *Computer Based Industrial Control*, Prentice Hall India, 1999.

ME4026 UNCONVENTIONAL ENERGY SYSTEMS

Prerequisite: Nil

Total Hours: 42

L	T	P	C
3	0	0	3

Module 1 (12 hours)

Introduction – energy problem – finite conventional energy sources – energy and environment–need for renewables and energy efficiency, Solar energy – measurement of solar radiation –estimation of terrestrial solar radiation – methods of solar collection and thermal conversion –thermal analysis of flat plate collectors – testing procedures – solar pond – parabolic collectors – paraboloid dish – central receiver, Energy storage systems, Applications of solar thermal systems – residential water heating – industrial heating – power generation.

Module 2 (10 hours)

Biomass energy systems – biomass conversion routes – combustion – gasification – anaerobic digestion – pyrolysis – cogeneration, Performance analysis and testing, Thermal applications – power generation.

Module 3 (10 hours)

Wind energy conversion – wind distribution – types and operation of wind turbines and their characteristics – generators and control strategies, Small hydro power – classification of hydro turbines – performance analysis – selection and sizing, Ocean thermal energy conversion–power generation options, Wave and tidal energy – systems for power generation.

Module 4 (10 hours)

Economic analysis – calculation of energy cost from renewables – comparison with conventional energy systems, calculation of carbon dioxide reduction – incremental costs for renewable energy options, Introduction to integrated energy systems.

References

1. Sukhatme, S.P., and Nayak, J.K., *Solar Energy-Principles of Thermal Collection and Storage*, 3rd ed., Tata McGraw Hill, 2008.
2. Duffie, J.A., and Beckman, W.A., *Solar Engineering of Thermal Processes*, 3rd ed., Wiley, 2006.
3. Goswami, D.Y., Kreith, F., and Kreider, J.F., *Principles of Solar Engineering*, 2nd ed., Taylor and Francis, 2003.
4. Twidell, J. and Weir T., *Renewable Energy Resources*, 2nd ed., Taylor and Francis, 2006.
5. Boyle, G. (Ed.), *Renewable Energy*, 2nd ed., Oxford University Press, 2004.
6. Deublein, D., and Steinhauser A., *Biogas from Waste and Renewable Resources: An Introduction*, 2nd ed., Wiley, 2010.

ME4027 COMPUTATIONAL FLUID DYNAMICS

L	T	P	C
3	0	0	3

Prerequisite: Nil

Total Hours: 42

Module 1 (10 hours)

Introduction to analytical, numerical and computational methods, Mathematical description of physical phenomena, Physical significance for mathematical classifications of partial differential equations as elliptic, parabolic and hyperbolic, Physical meaning of general partial differential equations, Simplification methods – proper choice of coordinate – transformed coordinates – normalization, Physical domain and computational domain, Discretization methods for converting derivatives to their finite difference forms – Taylor series method – polynomial fitting method – integral method and physical formulation, Discretization error, first order, second order and higher order accuracy discretization methods.

Module 2 (10 hours)

Model equations – Laplace’s equation – heat equation – first order wave equation – Burger’s equation (INVISCID), Computational methods for one, two, three-dimensional steady state conduction problem in Cartesian and cylindrical co-ordinates, Methods to deal Dirichlet, Neumann and Robins type boundary conditions for regular and irregular shapes, Fine, coarse, uniform and non-uniform grids, Solution of the linear algebraic equations – Gaussian elimination method – Tri-diagonal Matrix Algorithm (TDMA), Iterative methods – Gauss-Seidel point by point method – Gauss Seidel line by line methods – under and over relaxations.

Module 3 (10 hours)

Computational Methods for one, two and three-dimensional heat equations - explicit, implicit, Crank-Nicholson, ADI schemes, ADE schemes, Fractional step methods, Hopscotch scheme, Douglass scheme, Conservative form of partial differential and finite difference equations, Methods to deal interface property and non linearity, Consistency, stability and convergence of computational methods, Discrete perturbation stability analysis, Von-Neumann stability analysis, Validation of computational solution.

Module 4 (12 hours)

Computational methods of first order wave equations and Burger’s Equation (INVISCID) – explicit schemes – implicit schemes – upstream difference schemes – Lax–Wendroff scheme – Mac Cormack – hybrid and power law schemes, Dissipation and dispersion errors, Four basic rules to obtain consistency and stability, Computation of the flow field using stream function-vorticity formulation, Analysis of two dimensional incompressible viscous flow inside a Lid Driven Cavity, Algorithms to obtain flow field by solving coupled system of equations – semi implicit methods for pressure linked equations and its revised schemes.

References

1. Anderson, D.A., Tennehill J.C., and Pletecher R.H., *Computational Fluid Mechanics and Heat Transfer*, Hemisphere, 1984.
2. Patankar, S.V. *Numerical Heat Transfer and Fluid Flow*, Hemisphere, 1980.
3. Muraleedhar, K., and Sundararajan, T. *Computational Fluid Flow & Heat Transfer*, Narosa, 1995.
4. Versteeg, H.K. & Malalasekera, W. *An introduction to computational fluid Dynamics: The Finite Volume Method*, Adison Wesley-Longman, 1995.
5. Roache, P.J. *Computational Fluid Dynamics*, 2edn, Hermosa, 1982.
6. Hornbeck, R.W. *Numerical Marching Techniques for Fluid Flows with Heat Transfer NASA*, SP-297, 1973.
7. Hoffmann Klaus. A., *Computational Fluid Dynamics for Engineers-Volume I*, Engineering Education System, Wichita, 1993.

ME4028 AERODYNAMICS

Prerequisite: ME2001 Fluid Mechanics

L	T	P	C
3	0	0	3

Total Hours: 42

Module 1 (11 hours)

Equations for incompressible inviscid flows, Fluid circulation and rotation – vorticity - Kelvin's theorem - velocity potential - stream function - equation of a stream line - complex potential, Blasius theorem for force and moment on bodies, Elementary flow patterns and their superposition.

Module 2 (11 hours)

Flow past a cylinder - Magnus effect - Kutta condition - Vortex theory of lift. Conformal transformation, The Joukowski transformation - lift on arbitrary cylinder, Aerodynamic center, Pitching moment.

Module 3 (10 hours)

Aerofoils - low speed flows over aerofoils - the vortex sheet, Thin aerofoil theory -symmetric aerofoil, Tear drop theory, Camber line at zero angle of attack, Characteristics of thin aero foils, Motion in three dimensions, Flow past slender bodies.

Module 4 (10 hours)

Finite wings - downwash and induced drag - Prandtl-Lanchester theory - Biot- Savart law, General series solution, Glauret method, Multhop's method, Horseshoe effects, Ground effects, Linearised compressible flows in two dimensions - flow past a wavy wall, Similarity rules, Aerofoil in compressible flows.

References

1. Anderson ,J.D., *Fundamentals of Aerodynamics*, 5th ed., McGraw Hill, New York, 1998
2. Kuethe,A.M., and Chow,C., *Foundations of Aerodynamics*, Fourth Edition, Wiley Eastern, New Delhi, 1986.
3. Katz,J.,and Plotkin,A., *Low Speed Aerodynamics*, McGraw Hill, New York, 1991.
4. Houghton,E.L., and Brock,A.E., *Aerodynamics for Engineering Students*, Edward Arnold, London, 1960.

ME4029 HEATING, VENTILATION AND AIR CONDITIONING

Prerequisite: Nil

L	T	P	C
3	0	0	3

Total Hours: 42

Module 1 (11 Hours)

Principles of refrigeration -- Carnot refrigeration cycle -- unit of refrigeration – capacity -- coefficient of performance.

Refrigeration systems -- vapour compression system – theoretical and practical cycles – system components – compressors – condensers – expansion devices – evaporators – refrigerants.

Air refrigeration cycle, Vapour absorption refrigeration system.

Module 2 (11 Hours)

Psychrometry – psychrometric processes – determination of condition of air entering conditioned space.

Air conditioning systems – summer, winter and year-round-year air conditioning systems -- central and unitary systems.

Requirement of air conditioning – human comfort – comfort chart and limitations – effective temperature – factors governing effective temperature – design considerations.

Module 3 (10 Hours)

Cooling load calculations – various heat sources contributing heat load – solar load -- equipment load -- infiltration air load -- duct heat gain -- fan load -- moisture gain through permeable walls and fresh air load, Design of air conditioning systems.

Duct design – equal friction method -- static regain method -- velocity reduction method, Air distribution systems, Analysis for heating and cooling systems, Insulation.

Module 4 (10 Hours)

Heating systems – warm air systems – hot water systems – steam heating systems – panel and central heating systems, Heat pump circuit, Heat sources for heat pump.

Air conditioning equipments and control systems – air filters – humidifiers – fan – blowers – control systems for temperature and humidity – noise control.

Installation and charging of refrigeration unit, Testing for leakage, Cause for faults and rectification.

References

1. Noman C. Harris, *Modern Air conditioning Practice*, 2nd ed. McGraw-Hill, 1974.
2. Stoecker, W.F., *Refrigeration & Air conditioning*, 2nd ed., McGraw Hill, New York, 1987.
3. Dossat, R.J., *Refrigeration & Air conditioning*, 4th ed., prentice hall, 1997.
4. Arora, C.P., *Refrigeration & Air conditioning*, 2nd ed., McGraw Hill,, 2000.
5. Stoecker, W.F., *Principles of Air conditioning*, 2nd ed., industrial press, 1977.
6. Laub, J.M., *Heating & air conditioning of buildings*, Holt, Rinehart and Winston, 1963.
7. Kell, J.R., and Martin, P.L., *Air conditioning & Heating of buildings*, 6th ed., Architectural Press, 2007.
8. Carrier's *Handbook for Design of Unit Air Conditioners*, 14th ed. Kenrick Place Media Ltd, 1996.

ME4030 FUNDAMENTALS OF COMBUSTION

Prerequisite: ME2014 Thermodynamics

L	T	P	C
3	0	0	3

Total Hours: 42

Module 1 (12 hours)

Introduction to combustion, Flames classification, First law of thermodynamics, Combustion stoichiometry, Reactants and products, Standard enthalpies and enthalpy of formation – Enthalpy of combustion and heating, Adiabatic flame temperatures, Second law of thermodynamics - Gibb's function.

Module 2 (11 hours)

Chemical kinetics, Global and elementary reactions, Reaction rates, Rate laws and reaction orders, Temperature and pressure dependence on rate coefficients, Unimolecular and bimolecular reactions – Chain and chain-branching reactions, H₂-O₂ chemical mechanisms, Explosion limits.

Module 3 (12 hours)

Premixed laminar flames – Laminar flame structure, Flame velocity and flame thickness, Simplified analysis of laminar flame, Effect of equivalence ratio on flame speed and flame thickness, Flame quenching and ignition - Flammability limits, Laminar diffusion flames – Structure of diffusion flame from Laminar Jets.

Module 4 (7 hours)

Introduction to turbulent flames, Droplet combustion and its applications – Simple Model for evaporating and burning droplet - D² Law - Pollutant emissions - Effects of Pollutants - Emission Index.

References

1. Stephen R.T., *An Introduction to Combustion: Concepts and Applications*, 2nd ed., McGraw-Hill, 2000.
2. Kuo, K.K., *Principles of Combustion*, 2nd ed., Wiley - Interscience, 2005.
3. Warnatz, J., Maas, U., and Dibble, R.W., *Combustion: Physical and Chemical Fundamentals, Modelling and Simulation, Experiments, Pollutant Formation*, 4th ed., Springer-Verlag, 2005.
4. Glassman, I., and Yetter, R.A., *Combustion*, 4th ed., Academic Press, 2008.
5. Williams, F.A., *Combustion Theory*, 2nd ed., Westview Press, 1994.
6. Borman, G, and Ragland, K., *Combustion Engineering*, McGraw Hill, 1998.

ME4031 REFRIGERATION AND AIR CONDITIONING SYSTEMS

Prerequisite: Nil

L	T	P	C
3	0	0	3

Total Hours 42

Module 1 (11 Hours)

Principles of refrigeration – Carnot refrigeration cycle – Various methods of producing cold, Performance parameters – capacity – Coefficient of performance (COP), Refrigeration systems – Vapour compression system – theoretical and practical cycles, System components – Compressors – Condensers – Expansion devices – Evaporators, Other refrigeration systems – Vapour absorption system – Air cycle refrigeration – Steam jet refrigeration – thermo electric cooling and magnetic refrigeration, Introduction to liquefaction systems Cascading – simple Linde Hampson system – Claude cycle liquefier.

Module 2 (11 Hours)

Vapour compression refrigeration system – theoretical and practical cycles – simple and multi-pressure systems – thermodynamic analysis, System components – Compressors – Reciprocating compressors – single and multistage compressors – work of compression – effect of clearance – effect of inter-cooling – optimum pressure ratio – efficiencies – rotary compressors – screw type and vane type compressors – hermetic, semi hermetic and open compressors, condensers – water cooled and air cooled condensers – evaporative condensers, expansion devices – capillary tube – constant pressure expansion valve – thermostatic expansion valve – float valve, evaporators – natural, Vapour absorption system – principle of operation of aqua – ammonia and lithium bromide – water systems – electrolux system – comparison between vapour compression and absorption systems, Refrigerants – thermodynamic, physical and chemical properties of refrigerants – Selection criteria of refrigerants, designating refrigerants.

Module 3 (10 Hours)

Psychrometry – psychrometric processes – determination of air entering conditioned space, Requirement of air conditioning – human comfort – comfort chart and limitations – effective temperature – factors governing effective temperature – design considerations – inside design condition, ventilation standards, Applied psychrometry, summer air conditioning processes, winter air conditioning processes, Other air conditioning systems – summer – winter and round the year air conditioning systems – central and unitary systems.

Module 4 (10 Hours)

Cooling load calculations – various heat sources – solar load – equipment load – infiltration air load – duct heat gain – fan load – moisture gain through permeable walls and fresh air load, design of air conditioning systems – Duct design – equal friction – static regain and velocity reduction methods – distribution systems – insulation, Analysis for heating and cooling systems, Air conditioning equipments and control systems – air filters – humidifiers – fan – blowers – control systems for temperature and humidity – noise and noise control.

References

1. Stoecker, W.F., Refrigeration & Air Conditioning, McGraw Hill, New York, 1958.
2. Stoecker, W.F., & Jones J.W., Refrigeration & Air Conditioning, McGraw Hill, New York, 1982.
3. Dossat, Refrigeration & Air Conditioning, 2nd ed., Wiley Eastern Limited, New Delhi, 1989.
4. Jordan & Priester, Refrigeration & Air Conditioning, 2nd ed., Prentice Hall India Pvt. Ltd, 1985.
5. Arora, C.P., Refrigeration & Air Conditioning, Tata McGraw Hill, New Delhi, 1995.
6. Stoecker W.F., Principles of Air Conditioning, Industrial Press, New York, 1968.
7. Laub, Heating & air conditioning of Buildings, Holt, Rinehart & Winston, New York, 1963.
8. Kell & Marting, Air conditioning & Heating of Buildings, Baltonworth, New York, 1995.
9. Carrier's Handbook for Design of Unit Air Conditioners, McGraw Hill Book Co, New York, 1965.
10. Threlkeld, J. L., Thermal Environmental Engineering, 2nd ed., Prentice Hall, 1970.
11. Norman C. Harris, N. C., Modern Air Conditioning Practice, 3rd ed., McGraw Hill, 1985.
12. Levenhagen, J. L., Spethmann, D. H., Heating Ventilating and Air Conditioning Controls and Systems, McGraw Hill, 1993.
13. Carrier Design hand book
14. ASHRAE hand book

ME4032 AUTOMOBILE ENGINEERING

Prerequisite : Nil

L	T	P	C
3	1	0	3

Total Hours: 42

Module 1 (9 Hours)

Constructional details of engines - engine parts - piston - different types - piston rings cylinder block - cylinder head - gudgeon pin - connecting rod - bearing bushes - different type of bearings, Cooling system- purpose of cooling - types of cooling systems - air cooling - water cooling - radiator - types of radiators - constructional details - thermostat - temperature indicators.

Module 2 (13 Hours)

Lubrication - purpose of lubricating systems - grading of oils - oil pumps - oil filters - oil pressure indicators, Fuel systems - fuel system components - fuel tank - fuel filters and screens - fuel gauges - fuel pumps, Carburetors - idle and low speed circuits - high speed part load circuit - full power circuit - choke, Electronic fuel injection system, Gasoline Direct injection system, Air assisted fuel injection system, Diesel injection system - Common rail Direct Injection system, Ignition system - Battery and coil ignition - Electronic Ignition system - Distributor less Ignition system

Module 3 (12 Hours)

Transmission - clutch - types of clutches - single and multi plate clutches - centrifugal clutch, Fluid coupling, Torque converter, Gear box - sliding mesh - constant mesh - synchro mesh, Propeller shaft, Universal coupling, Differential, Axle - semi floating - three - fourth floating - fully floating, Brakes - mechanical and hydraulic brakes - vacuum - servo and air brakes - components of braking systems and their functions - constructional details, Anti lock braking system. Steering mechanism - steering geometry - steering gears - worm and wheel gears - power assisted steering.

Module 4 (8 Hours)

Vehicle body terminology, Chassis and suspension - chassis lay out, Independent suspension - Road springs - Shock absorbers - torsion bars, Air suspension systems, Wheels - tyres and tubes, Starting mechanism - starter drives - over running clutch. Electrical equipments - battery - battery charging - charging circuit - regulators. Air pollution and control - Pollution rating - Catalytic converters, Exhaust Gas circulation, Turbocharger.

References

1. Joseph Heitner, *Automotive mechanics Principles and Practices*, 2nd ed., D. Van Nostrand Company, 1967.
2. Newton. K and Steeds.W., *The Motor Vehicle*, The English Language Book Society and Newnes Butterworth, London, 1972.
3. William H Crouse and Donald L Anglin, *Automotive Mechanics*, 10th ed., Pearson Higher Education, 1993.
4. William H Crouse and Donald L Anglin, *Automotive engine*, 8th ed., McGraw-Hill, 1994.
5. William H Crouse and Donald L Anglin, *Automotive fuel - lubricating and cooling systems*. 6th ed., McGraw-Hill, 1981.
6. William H Crouse and Donald L Anglin, *Automotive chassis and body*. 5th ed., McGraw-Hill, 1975.
7. William H Crouse, *Automotive electrical equipments*. 8th ed., McGraw-Hill, 1976.
8. Kirpal Singh, *Automobile Engineering Vol. I & II*, 8th ed., Standard Publishers Distributors, Delhi, 1999.

ME4033 INTRODUCTION TO COMPUTER GRAPHICS

Prerequisite: ZZ1004 Computer Programming

Total Hours: 42

L	T	P	C
3	0	0	3

Module 1 (11 hours)

Introduction to computer graphics - Overview of computer graphics, Mathematics for computer graphics - Representing and interfacing with pictures, Description of graphic devices, Raster Scan Graphics, Algorithms for generating line, circle and ellipse – Polygon filling - Fundamentals of anti-aliasing.

Module 2 (11 hours)

Two-dimensional transformations, Three-dimensional transformations – scaling, shearing, rotation, reflection, translation. Affine and perspective geometry - Orthographic, axonometric and oblique projections: perspective transformations.

Module 3 (10 hours)

Plane curves, non-parametric and parametric curves: Space curves – Representation of space curves, cubic spline, Bezier curves, B-spline curves, NURBS.

Module 4 (10 hours)

Surface description and generation- Surface of revolution, Sweep Surface, Linear Coons surface, Bezier surface, B-Spline surface, B-Spline surface filling, Introduction to solid modelling, Hidden lines and Hidden Surfaces.

References

1. Rogers, D.F., and Adams, J.A., *Mathematical Elements for Computer Graphics*, 2nd ed., Tata McGraw Hill, 2009.
2. Rogers, D.F., *Procedural Elements for computer Graphics*, 2nd ed., Tata McGraw Hill, 1997.
3. Hearn, D., and Baker, M.P., *Computer Graphics*, 2nd ed., Prentice Hall of India Private Limited, 2007.
4. Foley, J.D., Dam, A.V., Feiner, S.K., and Hughes, J.F., *Computer Graphics: Principles and Practice in C*, 2nd ed., Addison-Wesley Professional, 1995.
5. Mortenson, M.E., *Geometric Modeling*, 2nd ed., John Wiley & Sons, 1997.

ME4034 EXPERIMENTAL METHODS IN FLUID FLOW AND HEAT TRANSFER

Prerequisite: Nil

Total Hours: 42

L	T	P	C
3	0	0	3

Module 1 (11 hours)

Introduction to experimental methods – basic concepts – accuracy – precision– resolution– uncertainty, Pressure measurements – dynamic response considerations – dead-weight tester – bourdon-tube pressure gage – diaphragm and bellows gages – bridgman gage – pirani thermal-conductivity gage – knudsen gage – ionization gage – alphanatron.

Module 2 (11 hours)

Flow measurement – passive-displacement methods – flow-obstruction methods – sonic nozzle – flow measurement by drag effects – pressure probes – hot-wire and hot-film anemometers – magnetic flowmeters, Flow visualization methods – smoke methods – shadowgraph – schlieren photography – laser doppler anemometer – laser-induced fluorescence – particle image velocimetry.

Module 3 (10 hours)

Temperature measurements – temperature scales – ideal-gas thermometer – temperature measurement by mechanical effects – temperature measurement by electrical effects – temperature measurement by radiation – transient response of thermal systems – thermocouple compensation – temperature measurements in high-speed flow – interferometric method.

Module 4 (10 hours)

Transport-property measurements – thermal conductivity measurements – measurement of viscosity – gas diffusion – calorimetry – convective heat transfer measurement – humidity measurement – heat flux meters – pH measurement, Thermal-radiation measurements – emissivity measurement – reflectivity and transmissivity measurement – solar radiation measurement.

References

1. J.P. Holman, *Experimental Methods for Engineers*, McGraw-Hill Company.
2. Figliola, Richard S, & Beasley, Donald E, *Theory and Design for Mechanical Measurements*, Third edition, John Wiley & Sons Inc.
3. Doebelin, Ernest O., *Measurement Systems*, 4th edition, McGraw-Hill International.

ME4122 MECHANICAL BEHAVIOUR AND TESTING OF MATERIALS

Prerequisite: ME2101 Materials Science and Metallurgy

L	T	P	C
3	0	0	3

Total Hours: 42

Module 1 (8 hours)

Concepts of crystals, Plastic deformation by slip and twinning, Slip systems in FCC, BCC and HCP lattices, Critical resolved shear for slip, Theoretical shear strength of solids, Stacking faults and deformation bands.

Module 2 (14 hours)

Observation of dislocations, Geometric properties of dislocations, Edge and screw dislocations, Climb and cross slip, Dislocations in FCC and HCP lattice, Partial dislocations, Stress fields and energies of dislocations, Forces between dislocations. Applications of dislocation theory, Strengthening from grain boundaries, Grain size measurements, Yield point phenomenon, Strain aging, solid solution strengthening, Strengthening from fine particles, Fiber strengthening, Cold working and strain hardening, Annealing of cold worked metal.

Module 3 (12 hours)

Fracture in metals, Griffith theory of brittle fracture, Metallographic aspects of fracture, Fractography, Dislocation theories of brittle fracture, Ductile fracture, Notch effects, Fatigue of metals, The S-N curve, Low cycle fatigue, Fatigue crack propagation, Effects of metallurgical variables and fatigue, Corrosion fatigue, Effect of temperature on fatigue. Creep and stress rupture, Creep curve, mechanism of creep formation, Stress rupture test, Activation energy for steady state creep, Fracture at elevated temperature, Creep resistant alloys.

Module 4 (8 hours)

Tension test, Stress-strain curves, Instability in tension, Ductility measurement, Effect of strain rate, temperature and testing machine on flow properties, Stress relaxation testing. Hardness test, Brinell, Rockwell and Vickers hardness, flow of metal under the indenter, relationship between hardness and flow curve, micro hardness testing. Torsion test, Mechanical properties in torsion, Torsion stresses for large plastic strains, Types of torsion failures, and torsion testing.

References

1. George, D.M., *Mechanical Metallurgy*, McGraw – Hill Inc, 2001.
2. Hertzberg, R.W., *Deformation and Fracture Mechanics of Engineering Materials*, 4th ed., John Wiley & Sons, 1995.
3. McClintock, F.A., and Argon, A.S., *Mechanical Behavior of Materials*, 1st ed., Addison-Wesley Publications, 1966.
4. Reed Hill, R.E., *Physical Metallurgy Principles*, 2nd ed., Affiliated East-West Press, 2008.
5. Hayden, H.W., *Structure And Properties Of Materials: Mechanical Behaviour Vol. 3 (Structure & Properties Of Materials)*, John Wiley & Sons Inc, 1965.
6. Honeycombe, R.W.K., *Plastic Deformation of Metals*, 2nd ed., Edward Arnold, 1984.

ME4123 TECHNOLOGY MANAGEMENT

Prerequisite: Nil

L	T	P	C
3	0	0	3

Total Hours: 42

Module 1 (9 hours)

Technology – definition and characteristics, Management of technology, Process of technological change, Technology life cycles – the S-curve of technological process, Diffusion of technology.

Module 2 (9 Hours):

Critical factors in managing technology, Technology and competition – competitive consequences of technological change.

Module 3 (6 Hours):

Technology Strategy – strategic impact of technology – Transfer of technology -Technology intelligence – Collaborative mode, Appropriation of technology.

Module 4 (6 Hours):

Technology evaluation and financing, Technology audits, Intellectual property rights – patents – trade secrets – trade marks – copyrights.

References

1. Khalil, T., *Management of Technology*, Tata McGraw-Hill, 2009.
2. Narayanan, V.K., *Managing Technology and Innovation for Competitive Advantage*, Pearson Education Asia, 2001.
3. Burgelman, R.A., Christensen, C.M., and Wheelwright, S.C., *Strategic Management of Technology Innovation*, McGraw-Hill, 2004.
4. Shane, S., *Technology Strategy for Managers and Entrepreneurs*, Pearson Education, Inc., 2009.
5. Gaynor, G.H., *Handbook of Technology Management*, McGraw-Hill, 1996.

ME4125 COMPETITIVE MANUFACTURING MANAGEMENT

Pre-requisite: Nil

Total Hours: 42

L	T	P	C
3	0	0	3

Module 1 (10 hours)

Evolution of manufacturing, Modern developments, E-manufacturing – e-manufacturing and supply chain – business process design models and concepts, Continuous improvement, Process reengineering, Basic problem solving and improvement tools, Just-in-Time (JIT) – value added focus – sources of waste – JIT Principles.

Module 2 (10 hours)

TQM – framework for managing total quality – employee involvement – benchmarking – quality certification and awards, Statistical process control – variation in processes – control charts – process capability, Six sigma quality – methodology.

Module 3 (10 hours)

Lean production – small lot production – setup time reduction – pull production – pull and push systems – kanban.

Module 4 (12 hours)

Focused factories and group technology – ways of doing work – facility layout – part families and machine groups – production flow analysis, Cellular manufacturing – part family/machine cell formation methods – linked cells – workcell design – workcell capacity – staffing a workcell.

References

1. Nicholas, J., *Competitive Manufacturing Management – Continuous Improvement, Lean Production, and Customer-Focused Qualities*, McGraw-Hill Edition, 2001.
2. Greeff, G., and Ghoshal, R., *E-manufacturing and Supply Chain Management*, Elsevier, 2004
3. Sing, N., and Rajamani, D., *Cellular Manufacturing Systems: Design, Planning & Control*, 1st ed., Chapman & Hall, 1996.
4. Askin, R.G., and Standridge, C.R., *Modelling and Analysis of Manufacturing Systems*, John Wiley & Sons. Inc, 1993.
5. Mikell P. Groover (2001). *Automation, Production Systems, and Computer-Integrated Manufacturing*, 2nd ed., Prentice-Hall of India Private Limited.
6. Bedworth, D.D., Henderson, M.R., and Wolfe, P.M., *Computer-Integrated Design and Manufacturing*, McGraw-Hill International Edition, 1991.
7. Chang, T-C, Wysk, R.A., and Wang, H-P, *Computer-Aided Manufacturing*, 2nd ed., Prentice-Hall International, Inc, 1998.

ME4126 ENGINEERING OPTIMIZATION

Pre-requisite: Nil

L	T	P	C
3	0	0	3

Total Hours: 42

Module 1 (10 hours)

Introduction – engineering applications of optimization, Statement of an optimization problem, Classification of optimization problems, Linear Programming, Mathematical formulations, Graphical solution, Simplex method, Artificial variable technique – M-method – two-phase method, Duality theory, Sensitivity analysis.

Module 2 (10 hours)

Integer programming, Mathematical formulations, Zero-one problems – additive algorithm, Gomory’s cutting plane algorithm, Branch and bound algorithm, All integer primal algorithm, All integer dual algorithm, Mixed integer programming – cutting plane algorithm and Bender’s partitioning algorithm.

Module 3 (10 hours)

Travelling Salesman Problem, Mathematical formulations, Branch and bound algorithms, Heuristics – nearest neighbourhood algorithm – pairwise-interchange heuristic – three-opt heuristic – twice around the tree heuristic and its performance, Vehicle routing problem – optimal solution and heuristic solutions, Network optimization models, Terminology of networks, Minimum spanning tree problem, Shortest-path problem, Maximum flow problem, Minimum cost flow problem, Network simplex method.

Module 4 (12 hours)

Non-linear programming, Formulations, General non-linear programming problem, Unconstrained optimization problem – necessary and sufficient conditions for extrema, Constrained optimization with equality constraints – Lagrangean method, Constrained optimization with inequality constraints – Kuhn-Tucker conditions, Quadratic programming – Wolfe’s modified Simplex method.

References

1. Srinivasan, G., *Operations Research – principles and applications*, 2nd ed., Prentice-Hall of India, New Delhi, 2010.
2. Hillier, F.S., and Lieberman, G.J., *Introduction to Operations Research*, 8th ed., Tata McGraw-Hill, New Delhi, 2010.
3. Ravindran A., Philips, D.T., and Solberg, J.J., *Operations Research: Principles and Practice*, 2nd ed., John Wiley & Sons, 1987.
4. Taha, H.A., *Operations Research: An introduction*, 6th ed., Prentice-Hall of India, New Delhi, 1997.
5. Winston, W.L., *Operations Research: Applications and Algorithms*, Duxbury Press, 1993.
6. Rao, S.S., *Optimization: Theory and Applications*, 2nd ed., Wiley Eastern, 1994.

ME4127 ACCOUNTING AND FINANCE FOR ENGINEERS

Pre-requisite: Nil

Total Hours: 42 hours

L	T	P	C
3	0	0	3

Module 1 (10 Hours)

Finance and related discipline – scope – function, Time value of money, Stocks and bond valuation, Sources of corporate finance – capital market.

Module 2 (11 Hours)

Financial Accounting – need – concepts, Journal, Ledger, Trial balance, Profit and loss account – Construction, Balance sheet – Construction – accounting equation, accounting softwares.

Module 3 (11 Hours)

Financial statement analysis – ratio analysis, Statement of changes in financial position, Working capital basis.

Module 4 (10 Hours)

Financial planning – budgeting - working capital computation, Capital budgeting – traditional and discounted cash flow techniques – NPV – IRR comparisons

References

1. Khan M.Y. and Jain P.K., “*Financial Management*”, 3rd ed., Tata McGraw-Hill, 2003.
2. Jawahar Lal, “*Financial Accounting*”, 2nd ed., Wheeler publishing, 2000.
3. I.M. Pandey, “*Financial Management*”, 8th ed., Vikas publishing house, 2003.
4. Prasanna Chandra, “*Financial Management*”, 4th ed., Tata McGraw-Hill, 2003.

ME4128 SIMULATION MODELLING AND ANALYSIS

Prerequisite: Nil

Total Hours: 42

L	T	P	C
3	0	0	3

Module 1 (10 hours)

Systems and system environment, Components of a system, Discrete and continuous systems, Model of a system, Types of models, Steps in simulation study, Technique of simulation, Comparison of simulation and analytical methods, Monte Carlo simulation.

Module 2 (10 hours)

Simulation of queuing systems – simulation of inventory systems – Concepts in discrete event simulation, Random number generation – techniques for generating random numbers, Tests for random numbers – frequency tests and tests for autocorrelation, Random variate generation – inverse transform method and acceptance rejection technique.

Module 3 (10 hours)

Input modelling for simulation – data collection, Identifying the distribution with data, Parameter estimation, Goodness of fit tests – chi square and kolmogorov smirnov tests, Verification and validation of simulation models.

Module 4 (12 hours)

Output analysis for a single model – measures of performance and their estimation, Output analysis for terminating simulations and steady state simulations. Introduction to simulation software – simulation model building using ARENA and Excel.

References

1. Banks, J., Carson, J.S., Nelson, B.L., and Nicol, D.M., *Discrete–Event System Simulation*, Pearson Education, Inc., 2007.
2. Law, A.M., and Kelton, W.D., *Simulation Modelling and Analysis*, McGraw Hill International, 2000.
3. Gordon, G., *System Simulation*, Second Edition, Prentice Hall of India, 1995.
4. Ross, S.M., *Simulation*, Third Edition, Academic Press, 2002.
5. Fishman, G.S., *Concepts and Methods in discrete Event Digital Simulations*, Wiley, New York, 1973.
6. Oakshott, L., *Business Modelling and Simulation*, Pitman Publishing, 1997.
7. Carrie, A., *Simulation of Manufacturing Systems*, John Wiley & Sons Ltd., 1988.
8. Rossetti, M.D., *Simulation Modeling and ARENA*, John Wiley, 2009.

ME4129 MODELLING OF MANUFACTURING SYSTEMS

Pre-requisite: Nil

L	T	P	C
3	0	0	3

Total Hours: 42

Module 1 (8 hours)

Modelling automated manufacturing systems – role of performance modelling, Performance modelling tools – simulation models and analytical models, Automated manufacturing systems – input-output model, Plant configurations, Performance measures.

Module 2 (12 hours)

Computer controlled machines – NC machines, Pallets and fixtures, Machining centers, Automated inspection systems, Material handling systems – conveyors – industrial robots – automated guided vehicles – storage and retrieval systems, Facility layout – CRAFT – quadratic assignment problem, Group technology – coding schemes – production flow analysis – mathematical model, Flexible manufacturing systems – architecture of FMS – automated workpiece flow – automated assembly systems – deadlocks – performance measures.

Module 3 (10 hours)

Markov chain models, Geometric and exponential random variables, Stochastic processes – Poisson process, Discrete-time Markov chains, Continuous-time Markov chains, Markov model of a transfer line, Birth and death processes in manufacturing.

Module 4 (12 hours)

Basic queuing models – (M/M/1) – (M/M/m), Queues with breakdowns, Analysis of a flexible manufacturing center, Queuing networks – open – closed – product form, Queuing networks with blocking, Application of queuing models for manufacturing systems – simulation models for serials lines and flexible manufacturing.

References

1. Viswanadham, N., and Narahari, Y., *Performance modeling of automated manufacturing systems*, Prentice-Hall of India, New Delhi, 1996.
2. Askin, R.G., and Standridge, C.R., *Modeling and Analysis of manufacturing systems*, John Wiley & Sons, 1993.
3. Altiok, T., *Performance Analysis of Manufacturing Systems*, Springer, 1997.
4. Brandimarte, P., and Villa, A., *Performance modeling of automated manufacturing systems*, Prentice-Hall of India, New Delhi, 1996.
5. Curry, G.L., and Feldman, R.M., *Manufacturing systems modeling and analysis*, Springer, 2011.

ME4130 HUMAN FACTORS IN ENGINEERING AND DESIGN

Prerequisite: Nil

L	T	P	C
3	0	0	3

Total Hours: 42 hours

Module 1 (10 Hours)

Human factors and Systems, Nature of man-machine systems and characteristics, Information input and processing – information theory – displaying information – coding of information – mode of information processing, Perception, Attention, Mental Workload, Human Factors in information revolution

Module 2 (10 Hours)

Test, Graphics, Symbols and Codes, Visual capabilities – visual display terminal screens and text, Graphic representations, Symbolic designs – Quantitative visual displays – signals and warning lights, Representational displays – auditory – tactual and Olfactory Displays – Cutaneous senses – Speech communication.

Module 3 (12 Hours)

Human motor activity, Muscle physiology, Measure of physiological strain – physical workload – strength and endurance, Manual material handling, Recommended limits, Motor skills, Human control of systems.

Module 4 (10 Hours)

Anthropometry and work-space design – use of anthropometric data, Design of work surfaces – science of seating, General location of control and displays within work space, Interpersonal aspects of workplace design.

References

1. Sanders, M.S., and McCormick, E.J., *Human Factors in Engineering and design*, 7th ed., McGraw-Hill International.
2. Murrell, K.F.H., and Schnauber, H., *Ergonomics. Econ*, Munich, 1986.
3. Gavriel, S., *Handbook of Human Factors & Ergonomics*, Inter-science, 1997.