Detailed Syllabi of the Courses for B. Tech. Degree in

Mechanical Engineering

(2006 Admission)

FIRST & SECOND SEMESTER: Common for all branches

THIRD SEMESTER

MAU201: Mathematics III

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Prerequisite: Nil

Module 1 (11 Hours)

Probability distributions:- 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 (11 Hours)

Sampling distributions and Inference concerning means:- Population and samples, the sampling distribution of the mean (σ known and σ unknown), Sampling distribution of the variance, Point estimation and interval estimation, Tests of hypothesis, Hypothesis concerning one mean, Inference concerning two means.

Module 3 (10 Hours)

Inference concerning variances proportions:- Estimation of variances, Hypothesis concerning one variance, Hypothesis concerning two variances, Estimations of proportions, Hypothesis concerning one proportion, Hypothesis concerning several proportions, Analysis of r x c tables, Ch – square test for goodness of fit.

Module 4 (10 Hours)

Regression Analysis: - Curve fitting, Method of least squares, Curvilinear regression, Correlation. Analysis of variance: - General principles, Completely randomised designs, Randomised block diagram, Latin square designs, Analysis of covariance.

Text Book:

1. Johnson R.A, Miller & Freund's Probability and Statistics for Engineers, 5th edn., PHI, 1995

References:

1. Levin R.I & Rubin D.S, Statistics for Management, 7th edn, PHI, 2000
2. Ross S.M, Introduction to Probability and Statistics for Engineers, John Wiley & Sons, 1987**.**

EEG201: Electrical Measurements and Machines

3	0	0	3

Prerequisite: Nil

Module 1 (9 hours)

Measurement of power (using 2 Wattmeter for 3 phase system) and Energy Electromagnetic Energy Conversion; Electromagnetic torque, Types of machines. Basics of rotating machines- Construction, Rotating magnetic field, Principles of operation, Emf and torque equation, Losses and efficiency.

Module 2 (9 hours)

DC Machines: principle of operation – generators and motors – classification – tests and characteristics – speed control- applications**.**

Module 3 (9 hours)

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

Module 4 (15 hours)

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

Induction machines: Principle of operation – types – tests – Torque slip and performance characteristics – startin – speed control schemes – applications. Single phase and special machines: FHP induction motors – universal motors - stepper motors – servo motors, tacho generators.

Text Books:

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

References:

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

MEU201: Mechanics of Fluids

3	1	0	3

Prerequisite: Nil

Module 1 (11 Hours)

Characteristics of fluids - Distinction between fluids and solids - concept of continuum - fluid properties - viscosity, compressibility and surface tension and their effects - Fluid statics - Basic equation for pressure field - Pressure in atmosphere - Forces on submerged surfaces and bodies - Stability of bodies in fluids - Fluid kinematics - Eulerian and Lagrangian flow descriptions - local and material rates of change - Deformation of a fluid element - strain rate - Graphical description of flow patterns - Streamlines, path lines, streak lines, stream tube - control volume and system approach - Reynolds transport theorem - continuity equation - Differential and integral forms of continuity equation, momentum equation and energy equation - use of these equations in few problems.

Module 2 (11 Hours)

Basic equation for one-dimensional flow through a stream tube and along a streamline - Euler's equation of motion - Energy equation - the Bernoulli’s equation, applications of Bernoulli’s equation - Pitot tube, venturimeter and other flow measuring devices - Fully developed flow through pipes - Reynolds experiment - types of flows - Hagen - Poissulle equation - Darcy-Wiesbach equation - Moody's chart - Minor losses in pipe flows.

Module 3 (11 Hours)

Some basic potential flows, - source, sink, vortex and doublet - concept of stream function - irrotationality - potential function - Relationship between stream function and

potential function - Complex potentials - combination of basic flow patterns - source in uniform stream - Half body - Rankine ovals - Flow around a circular cylinder.

Module 4 (9 Hours)

Flow past immersed bodies, Lift and Drag concepts - Boundary layer structure and thickness on a flat plate - Prandtl/Blausius layer solution - Momentum integral boundary layer equation for a flat plate and its use - Friction drag, pressure drag and drag coefficients.

Text Book

1. F. M. White, Fluid Mechanics, Fifth Edition, McGraw Hill New York, 2005.

References:

1. R.L. Daugherty, J.B. Franzini, Fluid Mechanics with Engineering Applications, Seventh Edition, McGraw Hill, New York, 1977.
2. S.K. Som, G. Biswas, Introduction to Fluid Mechanics and Fluid Machines, Second Edition, Tata McGraw Hill, New Delhi, 2005.

MEU202: Elements of Solid Mechanics

3	1	0	3

Prerequisite: ZZU101

Module 1 (11 hours)

Introduction: General concepts - definition of stress - stress tensor - stress analysis of axially loaded members - strength design of members - Axial strains and deformations in bars - stress-strain relationships - Poisson's ratio - Thermal strain - Saint Venant's principle - Elastic strain energy - Statically indeterminate systems - Strain tensor - Generalised Hooke's law for isotropic materials - Relationships between elastic constants - Introduction to anisotropy - orthotropy.

Module 2 (11 hours)

Bending stresses in beams: bending stresses - shear flow - shearing stress formulae - inelastic bending - strain energy in bending.

Axial force, shear force and bending moment diagrams - shear force and bending moments by integration and by singularity functions.

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 - conjugate beam concept - 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 rosettes.

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.

Textbook:

1. E.P. Popov, Engineering Mechanics of Solids, Prentice Hall of India, New Delhi, Second Edn., 2000.

References:

1. S.P. Timoshenko and D.H. Young, Elements of Strength of Materials, McGraw Hill.
2. Irving H. Shames, Introduction to Solid Mechanics, Prentice Hall of India, Second Edn.

3. S.H. Crandall, N.C. Dahl, and T.J. Lardner, Introduction to Mechanics of Solids, McGraw Hill.

MEV203: Materials Science and Metallurgy

3	0	0	3

Prerequisite: Nil

Prerequisite: Nil

Module 1 (11 Hours)

Engineering materials: classification, requirements, properties and selection of engineering materials. Crystal structure; crystal systems, atomic packing, stacking sequence, Miller indices of crystallographic planes and directions, inter planar spacing-BCC, FCC and HCP systems, X-ray diffraction, Crystal imperfections; point defects, line defects- edge and screw dislocations, interaction between dislocations, Frank-Reed source, surface defects, volume defects. Experimental techniques for metallographic studies, optical microscopy, electron microscopy (SEM and TEM), specimen preparation, etching, common etchants, grain size, grain size measurement, ASTM grain size number

Module 2 (11 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 (9 Hrs)

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 .Recent developments in materials science; smart materials, shape memory alloys, functionally graded materials, piezo-electric materials

Text Books:

1. Smith, Science of Engineering Materials, Prentice-Hall
2. Callister W. D., Materials Science and Engineering, John Wiley

References:

1. Avner S. H., Introduction to Physical Metallurgy, McGraw Hill
2. Van Vlack L. H., Elements of Materials Science, Addison Wesley
3. Shackelford J. F., Materials Science for Engineers, Prentice-Hall

4. Higgins R. A., Engineering Metallurgy *Part I*, Applied Physical Metallurgy, ELBS
5. Raghavan V., Material Science and Engineering, Prentice-Hall of India
6. Reed Hill, Physical Metallurgy Principles, Affiliated East-West Press
7. Jastrzebiski, Nature and Properties of Engineering *Materials*, John Wiley

MEU204: Machine Drawing

0	0	3	2

Prerequisite: ZZU103

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.

Welded joints: types of welds - nomenclature of welds - welding symbols - drawing of welded machine parts with details of welding.

Screwed fastenings: screw thread forms - V 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 (12 Hours)

Pipe joints: coupler joint - nipple joint - union joint - socket and spigot point - Integral and screwed flanged joints - Hydraulic joint and expansion joint.

Shaft joints: Cotter and pin joints - Socket and spigot joint - Gib and cotter joint - Sleeve and cotter joint and knuckle joint.

Couplings and keys: 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 - Bush bearings -Plummer block - Foot step bearing and pedestal bearing.

Module 3 (15 hours)

Assembly drawings: Types - Accepted norms.

Engine parts: Piston - Connecting rod - Eccentric - Stuffing box and crosshead.

Parts of a lathe: Tail stock - Head stock assembly - Tool post and carriage.

Valves: Stop valves - Safety valves - Check valves - Pressure relief valves and flow and direction control valves.

Miscellaneous assemblies: Vices - Screw jack.

Module 4 (6 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: Elements of Computer Aided Drafting - simple exercises using graphics packages.

Text Book:

1. Bhatt N.D., and Panchal V.M., Machine Drawing, Charotar Publishing House, 2006.

References:

1. Narayana K.L., Kannaiah P., and Reddy K.V., Machine Drawing, Wiley Eastern.
2. John K.C., and Varghese P.I., Machine Drawing, VIP Publication
3. Gill P.S., A Text Book of Machine Drawing, Karlson Publication
4. Pippenger J., and Hicks T., Industrial Hydraulics, McGraw Hill.
5. Sidheswar N., Kannaiah P, and Sastry V. V. S., Machine Drawing, Tata McGraw Hill.

EEG291: Electrical Measurements and Machines Lab

0	0	3	2

Prerequisite: Nil

List of experiments:

1. a) Linear and Non-linear Characteristics - Determination of V-I characteristics of a linear resistor and an incandescent lamp.
   b) Methods of measuring high and low resistance-Voltmeter/Ammeter method.
2. Measurement of Power in Single phase AC circuit- determination of impedance, admittance, power factor and real/reactive/apparent power drawn in RLC series circuits (using 3Ammeter, 3 Voltmeter and 1Wattmeter method)
3. a) Measurement of Energy using single-phase energy meter and verification by power /time measurements.
   b) Measurement of power in 3 phase circuits using two-wattmeter method.
4. Determination of the efficiency and regulation of single-phase transformer by direct loading.
5. Determination of efficiency and regulation at various loads conditions of a single-phase transformer by open circuit and short circuit tests.
6. a) Study of Starters for 3 phase Induction motors
   b) Determination of performance characteristics of Squirrel Cage induction motor by conducting load test.
7. Determination of performance characteristics of a Slip ring induction motor by conducting load test.
8. Determination of Open circuit characteristic and load characteristics of a dc shunt generator.
9. Determination of performance characteristics of a dc shunt motor by conducting load test.
10. Determination of performance characteristics of a dc series motor by conducting load test.
11. Determination of Open circuit characteristic of a 3-phase alternator.
12. Testing of Single phase motor

CEG291: Strength of Materials Lab

0	0	3	2

Prerequisite: Nil

1. Tension test on Mild Steel Rod
2. Double Sheartest on Mild Steel Rod
3. Hardness fests
   a. Rockwell Hardness test
   b. Brinnel Hardness test
   c. Vieker's Hardness test
4. Impact test on Mild Steel Specimen
   a. Charpy test

b. Ized test

5. Spring test
   a. Open coiled spring
   b. Close coiled spring
6. Bending test on Steel Beams
7. Torsion test on Mild Steel Rod
8. Compression test on concrete
9. Study of Extensometers and Strain Gauges
10. Fatigue test

FOURTH SEMESTER

MAU202: Mathematics IV

3	0	0	3

Prerequisite: Nil

Module 1 (11 hours)

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, Bessel functions of the second kind, Strum-Liouville's Problems, Orthogonal eigen function expansions.

Module 2 (11 hours)

Partial Differential Equations:- Basic concepts, 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 integrals and transforms, Laplace equation, Solution of a PDE by Laplace transforms.

Module 3 (10 hours)

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

Module 4 (10 hours)

Complex Analysis II - Complex Integration, Line integral in the Complex plane, Cauchy's integral theorem, Cauchy's integral formula, Derivatives of analytical 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:

1. Kreyszig. E Advanced Engineering Mathematics, 8th Edn., John Wiley & Sons, 2000

Reference:

1. Wylle, C.R & Barret L.C Advanced Engineering Mathematics, 6th Edn., Mc Graw Hill, New York, 1995

MEU211: Thermodynamics

3	1	0	3

Prerequisite: Nil

Module 1 (11 hours)

Thermodynamic systems - description of systems - properties, states, processes, and cycles - thermodynamic equilibrium - forms of energy - equation of state for gases - compressibility factor - PVT relationships for pure substances - property diagrams - temperature and Zeroth law of thermodynamics - the ideal gas temperature scale.

Module 2 (11 hours)

First law of thermodynamics - concept of heat and work - first law of thermodynamics applied to processes and cycles - definition of stored energy - open systems - general and steady flow - applications of first law to assess performance.

Module 3 (10 hours)

Second law of thermodynamics - thermal energy reservoirs – Kelvin-Planck and Clausius statements and their equivalence - reversible and irreversible processes - reversible cycle - Carnot corollaries - thermodynamic temperature scale - Clausius inequality - concept of entropy - calculation of entropy changes from Tds equations – availability - reversible work and irreversibility – increase of entropy principle - Helmholtz and Gibbs functions.

Module 4 (10 hours)

Thermodynamic property relations - Maxwell's equations - Clapeyron equation - general relations for internal energy, enthalpy and entropy in terms of p, v, T and specific heats - the Joule-Thomson coefficient Δh, Δu, Δs of real gases - mixture of gases – analysis - Gibbs-Dalton model - properties of gas mixtures based on Dalton model.

References:

1. P.K. Nag, Engineering Thermodynamics, Third Edition, Tata McGraw Hill, 2003.
2. M.W. Zemansky, Thermodynamics, Second Edition, McGraw Hill, 1985.
3. Y. A. Cengel, M.A. Boles, Thermodynamics-An Engineering Approach, Mc Graw Hill
4. Jones I.B. & Dugan R.E., Engineering Thermodynamics, Prentice Hall.

MEU213: Fluid Machinery

3	0	0	3

Prerequisite: MEU201

Module 1(11 Hours)

Integral form of continuity, momentum and energy equations – Flow of fluids over flat plates and curved surfaces – Force, work done and efficiency – Reaction principles – Dimensional analysis – Rayleigh's method and Buckingham Π theorem – principles of modelling and similitude as applied to Turbomachines – Non-dimensional parameters in fluid mechanics and fluid machinery such as capacity coefficient, head coefficient, power coefficient, Reynolds number, Mach number and specific speed.

Module 2 (10 Hours)

Euler's turbine equation – Analysis for turbines – Constructional features of Pelton, Francis and Kaplan turbines – Speed regulation of turbines – Study of performance – Model studies – Theory of draft tubes – Cavitation in turbines.

Module 3 (11 Hours)

Rotodynamic pumps – Whirling of fluid – Vortex motion – Free and forced vortex – Spiral flow – Features of rotodynamic and positive displacement pumps – Constructional features of centrifugal pumps – Principle of working – analysis – Euler's equation - Efficiencies – Types of centrifugal pumps – Pump characteristics – Theoretical and actual Head - Capacity relationship – Pump selection – Model studies – Cavitation in pumps.

Module 4 (10 Hours)

Reciprocating pumps – principle of working – Effect of acceleration and friction – Use of air vessels – Cavitation – Pump characteristics – Working principle of vane pump and gear pump Cavitation – Miscellaneous fluid devices – Intensifier and accumulator – Application to hydraulic devices – Operation of hydraulic ram and surge tank.

References:

1. Shepherd D.G., Principles of Turbo machinery, Macmillan Company, Newyork,1956
2. Jagdish Lal, Hydraulic Machines,sixth Edition, Metropolitan Book Co.Private Ltd.,New Delhi, 2001
3. A.J.Stepanof , Centrifugal & Axial Flow Pumps, 2nd Edition, John Wiley & Sons Inc.,Newyork, 1957
4. Austin H Church, Jagdish Lal, Centrifugal Pumps and Blowers, 1st Indian Edition Metropolitan Book. Co.Pvt. Ltd., New Delhi, 1973.

MEU214: Advanced Mechanics of Solids

3	1	0	3

Prerequisite: MEU202

Module 1 (11 hours)

Stress at a point: stress tensor; stress transformation; principal stresses; principal planes; Mohr's circle; octahedral stresses; hydrostatic and pure shear states.

Strain at a point: strain tensor; analogy with stress tensor

Module 2 (11 hours)

Equations of elasticity: equation of equilibrium, strain-displacement equations, compatibility equations, constitutive equations, Navier equations.

Boundary conditions: Traction, displacement and mixed boundary conditions.

Special problems in bending: unsymmetric bending; shear centre.

Module 3 (10 hours)

Simplification to 2-D problems: plane stress problems; plane strain problems; axisymmetric problems; Lame's problem; rotating disks and shrink fits.

Energy Techniques: introduction to energy methods; strain energy; principle of virtual work; minimum potential energy principle.

Module 4 (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; torsion of thin walled open and closed sections.

Introduction to plasticity: theory of plasticity, yield criteria for metals; stress strain relationships.

Textbook:

1. L.S. Srinath, Advanced Mechanics of Solids, Tata McGraw Hill, New Delhi, Second Edition, 2003.

References:

1. Den Hartog, Advanced Strength of Materials, McGraw Hill, New York.
2. S.P. Timoshenko and J.N. Goodier, Theory of elasticity, McGraw Hill International Edn., Third Edn., 1970.
3. 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.
4. Fred B. Seely and Smith, Advanced Mechanics of Materials, John Wiley and sons, New York.

5. W. Johnson, and P.B. Mellor, Engineering Plasticity, Van Nostrand Reinhold, 1973.

MEV216: Manufacturing Science

3	0	0	3

Prerequisite: Nil

Module I (11 hours)

Foundry; foundry materials- moulding and core sand- binders - additives, sand preparation- sand control tests, pattern and pattern making, mould and core making, expendable and non expendable moulds, mould assembly, melting furnaces and melting practice, pouring and fettling, solidification of pure metals and alloys, grain growth

Module 2 (11 hours)

Casting processes- sand casting, shell moulding, investment casting, slush casting, gravity and pressure die casting, centrifugal casting, casting design, gateway system design, riser design casting alloys, casting detects, inspection, testing- destructive and non-destructive, casting alloys, economics of casting.

Module 3 (10 hours)

Yield criteria of metals (von Mises, Tresca), representation in stress space, isotropic hardening, kinematic hardening. Plastic stress strain relationship. Metal forming Operations, Principle, process and equipment for drawing, extrusion, rolling, forging. Analysis of forming operations - load calculation for drawing, extrusion, rolling, forging.

Module 4 (10 hours)

Metal joining- classification, welding heat sources, arc welding machines, arc production, arc characteristics, metal transfer, welding electrode, gas welding, resistance welding, thermit welding, ultrasonic welding, electron beam welding, laser beam welding, gas and arc cutting. Welding metallurgy, weldability of ferrous and non-ferrous metals, design of weldments, joint design, residual stresses and distortion, testing of welded joints, brazing and soldering

Text Books:

1. Amithabha Ghosh & Asok Kumar Mallik, Manufacturing Science, Affiliated East west Press Ltd
2. Richard Heine & Philip Rosenthal, Principles of Metal Casting, Tata McGraw Hill.
3. Richard, A. Lttt1e, Welding and welding Technology, Tata McGraw Hill.

References:

1. Serope Kalpakjian, Manufacturing Engineering & Technology, Addison Wesley Pub
2. Oscar Hoffman & George Sachs, Introduction to Theory of Plasticity for Engineers, McGraw Hill
3. Flemings, M.C., Solidification Processes, McGraw Hill. American Welding Society, Welding Hand Book
4. Lawrence, E. Doyle, Manufacturing Processes & Materials for Engineers, Prentice Hall of India
5. Taylor Howard & Merton etal., Foundry Engineering, John Wiley & Sons Inc.
6. Metals Hand Book - Vol. 5., Welding Institute of Metals, USA.

MEV217: Metrology and Instrumentation

3	0	0	3

Prerequisite: Nil

Module 1 (11 Hours)

Basic Concepts- Measurement system elements, Experimental Test Plan- Random Tests, Replication & repetition, Calibration - Sensitivity, Range, Accuracy, Standards, Traceability. Signals - Types of waveforms, Signal analysis, Signal amplitude & frequency, Fourier transform, Frequency spectrum. Measurement Systems. Modelling- General model, First order systems, Second order systems, Transfer functions.

Module 2 (11 Hours)

Statistical Measurement theory- Confidence intervals for means and standard deviations, Regression analysis, Data outlier detection. Uncertainty analysis- Type A and Type B, Determining combined standard uncertainty- Uncorrelated and correlated input quantities, reporting. Sampling concepts, Digital devices, D/A & A/D conversion, Data acquisition systems.

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. Limits and fits, Tolerancing of gauges, Evaluation of geometric tolerances, Screw thread measurements, Gear measurements. Coordinate Measuring Machines- Construction, Operation & Programming, Software, Applications. Machine Vision.

Module 4 (9 Hours)

Instrumentation: Temperature measurement- Expansion thermometers, Resistance Temperature Detectors, Thermistors, Thermocouples, radiative measurements. Pressure measurements- Manometers, Elastic transducers. Strain measurements- Resistance & semiconductor strain gauges, circuits and arrangements. Force & Torque measurements.

Text Books:

1. Figliola, Richard S, & Beasley, Donald E, "Theory and Design for Mechanical Measurements", Third edition, John Wiley & Sons Inc.
2. Collett, CV, & Hope, AD, "Engineering Measurements", Second edition, ELBS/Longman.

References:

1. Doebelin, Ernest O., "Measurement Systems", 4th edition, McGraw-Hill International.
2. Thomas G. Beckwith, N. Lewis Buck and Roy D, Marangoni, Mechanical Measurements, Narosa
3. Anthony, D.M., Engineering Metrology, Pergamon Press
4. J.P. Holman, Experimental Methods for Engineers, McGraw-Hill Company
5. Groover, Mikell P, Automation, Production Systems, and Computer-Integrated Manufacturing, Pearson Education Asia.
6. American Society of Tool and Manufacturing Engineers, Handbook of Industrial Metrology, Prentice Hall of India Pvt. Ltd.
7. John A. Bosch, Coordinate Measuring Machines and Systems, Marcel Dekker, Inc.
8. ISO, "Guide to the expression of Uncertainty in Measurement", 1995.
9. Lissaman, A. J., and Martin, S. J., "Principles of Engineering Production"
10. Chapman, W. A. J., "Workshop Technology – Part 3" Oxford & IBH Publishing Co Pvt Ltd, New Delhi.

MEU292: Fluid Mechanics and Fluid Machinery Lab

0	0	3	2

Prerequisite: MEU201

Study of plumbing tools and pipe fittings - Measurement of Metacentric height and radius of gyration of floating bodies - Measurement of viscosity of fluids- Study of discharge measuring instruments - Measurement of pressure and velocity - Calibration of venturimeter- Orifice meter - Notches and weirs - Nozzle meters & Rotameters - pipe friction- Minor losses in pipes - Verification of Bernoulli's theorem - Demonstration of laminar and turbulent flow in pipes - Critical velocity - Forces on curved and plane surfaces- Evaluation of the performance of turbines - Main and operating characteristics - Muschel's curves. Performance of pumping and other machinery. Centrifugal pumps - Reciprocating pumps- Gear pumps - Hydraulic ram and Torque converter.

MEV294: Production Engineering Lab I

0	0	3	2

Prerequisite: Nil

Classifications of machine tools and machining processes - Specification of machine tool, power source, Centre lathe - general features, parts and functions - Machining on Centre lathe- Cutting tools - Materials, types; Grinding, Cutting variables - Selection of speeds, feeds and depth of cut - Use of cutting fluids - Methods of holding work - Lathe operations - straight, taper and eccentric turning, thread cutting, drilling, boring, profile turning, knurling - Tolerance and surface finish.

References :

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

FIFTH SEMESTER

MEV301: Principles of Management

3	0	0	3

Prerequisite: Nil

Module 1 (8 Hours)

Introduction to management theory – Management – Defined – Characteristic of Management – Management as an art-profession – System approaches to Management – Task and Responsibilities of a professional Manager – Levels of Manager and Skill required.

Module 2 (10 Hours)

Management – Process – Planning – Types – Mission – Goals – Strategy – Programmes – Procedures – Characteristics – Approaches – Organising – Principles of Organisation – Delegation – Span of Control – Organisation Structures – Directing – Leadership – Motivation – Controlling.

Module 3 (12 Hours)

Decision Making – Strategic and Tactical Decisions – Single stage decision making – Decision making under certainty – Risk – Uncertainty - Multistage Decision making – Decision Tree.

Project Management – Network construction – Arrow diagram – Redundancy – CPM and PERT Networks – Scheduling computations – PERT time estimates – Probability of completion of project – Introduction to crashing.

Module 4 (12 Hours)

Introduction to functional areas of management – Operations Management – Human resource management – Marketing management – Financial management.

Text Books:

1. Koontz & Weihrich, Management, 9th edn., McGraw Hill, 1999.
2. Ravindran, Philips and Solberg, Operations Research: Principles and Practice. Second edition, 2005, John Wiley & Sons.

References:

1. Stoner et-al, Management, 6th edn., Prentice Hall, 1999.
2. Mazda, Engineering Management, Addison Westey, 1999.
3. Certo S., Modern Management, 8th edn., Prentice Hall, 2003.
4. Wiest and Levy, A Management Guide to PERT/CPM with GERT/PDM/ DCPM and other Networks, Second edition, 1998, Prentice-Hall of India
5. Tersine, Production/Operations management, Second Edition, 1985, North-Holland

MEU302: Heat and Mass Transfer

3	1	0	3

Prerequisite: MEU201 and MEU211

Module 1 (10 Hours)

Heat transfer - basic modes of heat transfer - conduction heat transfer - energy balance - integral and differential approaches - general heat conduction equations in Cartesian, cylindrical and spherical coordinates - initial and boundary conditions, one-dimensional steady state conduction with heat generation - conduction shape factor - temperature dependence of thermal conductivity - applications like extended surface heat transfer and critical insulation thickness - unsteady state heat conduction in one dimension - lumped heat capacity system - semi infinite solids with sudden and periodic change in surface temperature - numerical methods in conduction problem.

Introduction to Heat Exchangers- LMTD, correction factors, heat exchanger effectiveness and number of transfer units.

Module 2 (10 Hours)

Convective heat transfer - Newton's law of cooling – Prandtl number, hydrodynamic and thermal boundary layer equations, laminar forced convection heat transfer from flat plates - similarity and integral solutions - internal flow and heat transfer - fully developed laminar flow in pipes - turbulent forced convection - Reynolds analogy - empirical relations in forced convection - natural convection - similarity and integral formulation of natural convection heat transfer from vertical plates - empirical relations in free convection - condensation and boiling - film and drop wise condensation - film boiling and pool boiling, empirical relations for heat transfer with phase change.

Module 3 (10 Hours)

Radiation heat transfer – electromagnetic radiation spectrum, thermal radiation, black body, gray body and white body, monochromatic and total emissive power, Planck’s law, Stefan-Boltzmann law - Wein's Displacement law - absorptivity – reflectivity - transmissivity - emissivity - Kichhoff's identity - radiation exchange between surfaces - shape factors for simple configurations - heat transfer in the presence of re-radiating surfaces - radiation shields - surface and shape resistances - electrical network analogy.

Module 4 (9 Hours)

Mass transfer - definition of terms like concentration, mass velocity and mass flux - Fick's law of diffusion - temperature and pressure dependence of mass diffusivity - diffusion in gases at low density - diffusion in liquids - multi-component systems and their governing equations - concentration distribution in solids and in laminar flow - example problems.

Text book:

1. Holman J.P., "*Heat Transfer*," McGraw Hill International Students Edition.

Reference Books :

1. Incorpera F.P. & De Witt D.P., "*Fundamentals of Heat and Mass Transfer*", John Wiley.
2. Kreith F., "*Heat Transfer*", International Text Book Company.
3. Gebhart B., "*Heat Transfer*", McGraw Hill.

ZZU301: Environmental Studies

3	0	0	3

Prerequisite: Nil

Unit 1: The Multidisciplinary nature of environmental studies (2 lectures)

Definition, scope and importance - Need for public awareness.

Unit 2: Natural Resources: (8 lectures)

Renewable and non-renewable resources:

Natural resources and associated problems.

Forest resources: Use and over-exploitation, deforestation, case studies. Timber extraction, mining, dams and their effects on forests and tribal people.

Water resources: Use and over-utilization of surface and ground water; floods, drought, conflicts over water, dams- benefits and problems.

Mineral resources: Use and exploitation, environmental effects of extracting and using mineral resources, case studies.

Food resources: World food problems, changes caused by agriculture and overgrazing, effects of modem agriculture, fertilizer-pesticide problems, water logging, salinity, case studies.

Energy resources: Growing energy needs, renewable and non-renewable energy sources, use of alternate energy sources. Case studies.

Land resources: Land as a resource, land degradation, man induced landslides, soil erosion and desertification.

Role of an individual in conservation of natural resources.

Equitable use of resources for sustainable lifestyles.

Unit 3: Ecosystems (6 lectures)

Concept of an ecosystem - Structure and function of an ecosystem - Producers, consumers and decomposers - Energy flow in the ecosystem - Ecological succession - Food chains, food webs and ecological pyramids - Introduction, types, characteristic features, structure and function of the following ecosystem: -

a. Forest ecosystem
b. Grassland ecosystem
c. Desert ecosystem
d. Acquatic (Ponds,streams,lakes,rivers,oceans)

Unit 4: Biodiversity and its conservation (8 lectures)

Introduction - Definition: genetic, species and ecosystem diversity - Biogeographical classification of India - Value of biodiversity: consumptive use, productive use, social, ethical, aesthetic and option values - Biodiversity at global, National and local levels. India as a mega- diversity nation - Hot-spots of biodiversity - Threats to biodiversity:

habitat loss, poaching of wildlife, man - wildlife conflicts. - Endangered and endemic species of India. - Conservation of biodiversity: In-situ and Ex-situ conservation of biodiversity

Unit 5: Environmental Pollution (8 lectures)

Definition - Causes, effects and control measures of: -

a. Air pollution
b. Water pollution
c. Soil pollution
d. Marine pollution
e. Noise pollution
f. Thermal pollution
g. Nuclear hazards

Solid waste Management: Causes, effects and control measures of urban and industrial wastes - Role of an individual in prevention of pollution - Pollution case studies - Disaster management: floods, earthquake, cyclone and landslides.

Unit 6: Social Issues and the Environment (7 lectures)

From Unsustainable to Sustainable development - Urban problems related to energy - Water conservation, rain water harvesting, watershed management - Resettlement and rehabilitation of people; its problems and concerns - Case studies - Environmental ethics: Issues and possible solutions - Climate change, global warming, acid rain, ozone layer depletion, nuclear accidents and holocaust. Case studies - Wasteland reclamation - Consumerism and waste products - Environment Protection Act - Air {Prevention and Control of Pollution) Act - Water (Prevention and control of Pollution) Act - Wildlife Protection Act - Forest Conservation Act - Issues involved in enforcement of environmental legislation - Public awareness.

Unit 7: Human Population and the Environment (6 lectures)

Population growth, variation among nations - Population explosion - Family Welfare Programme - Environment and human health - Human Rights - Value Education - HIV/AIDS - Women and Child Welfare - Role of Information Technology in Environment and human health - Case Studies.

Unit 8: Field work (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.200 1 Environmental Biology, Nidi Publ. Ltd.Bikancr.
2. Bharucha Erach, The Biodiversity of India, Mapin Publishing Pvt. Ltd , Ahmedabad - 380013, India, Email: m~pin(Ci).icenet.net (R)
3. Brunner R.C., 1989, Hazardous Waste Incineration, McGraw Hill Inc.480p
4. Clark.R.S., Manne Pollution, Clanderson Press Oxford (TB)
5. Cunningham, W.P.Cooper, T.H.Gorhani, E & Hepworth, M: T.2001, Environmental Encyclopedia, Jaico Publ. House, Mumbai, 1196p
6. De A.K., Environmental Chemistry, Wiley Eastern Ltd.
7. Down to Earth, Centre for Science and Environment(R)
8. Gleick, H.P. 1993. Water in crisis, Pacific Institute for Studies in Dev.,Environment & Security. Stockholm Env. Institute. Oxford Univ. Press. 473p
9. Hawkins R.E, Encyclopedia of Indian Natural History, Bombay Natural History Society, Bombay (R) 10.

10. Heywood, V.H & Watson, R.T. 1995 . Global Biodiversity Assessment. Cambridge Univ. Press 1140p
11. Jadhav, H & Bhosale, V.M. 1995. Environmental Protection and Laws. Himalaya -Pub. House, Delhi 284 p.
12. Mckinney, M.L. & Schocr, R.M, 199p. Environmental.Science systems & Solut.ions, Web enhanced edition. 63.9p.
13. Mhaskar A.K, Matter Hazardous, Techno-Science Publications (TB)
14. Miller T.G. Jr., Environmental Science, Wadsworth Publishing Co.(TB)
15. Odum, E.P. 1971. Fundamentals of Ecology. W.B.Saunders Co. USA, 574p 16. Rao M N.& Datta, A.K. 1987.
16. Waste Water treatment. Oxford & IBH Publ. Co. Pvt.Ud..345p
17. Sharma B.K., 2001. Environmental Chemistry. Goel Publ. House,Meerut
18. Survey of the Environment, The Hindu (M)
19. Townsend C. , Harper J, and Michael Begon, Essentials of Ecology, Blackwell Science (TB)
20. Trivedi R.K., Handbook of Environmental Laws, ,Rules, Guidelines, Compliances and Standards, Vol I and II, Enviro Media (R)
21. Trivedi R.K. and P,K. -Goel, Introduction to air pollution, Techno-Science Publications (TB)
22. Wagner K.D.,1998. Environmental Management. W.B. Saunders Co. Philadelphia, USA 499p

(M) Magazine (R)Reference (TB) Textbook

MEV303: Machining Science and Machine Tools

3	1	0	3

Prerequisite: Nil

Module 1 (10 hours)

Kinematic elements in metal cutting. Tool nomenclatures. Mechanics of chip formation, orthogonal and oblique cutting, shear angle, velocity relationship. Merchant's analysis of cutting forces, cutting power estimation. Inserts- chip groove geometries; nomenclature, selection and applications in turning, milling, drilling. Carbide grade design, carbide coatings. Advances in cutting tool materials. Effect of cutting variables on forces. Tool failure analysis, theories of tool wear, measurement of tool wear. Tool dynamometers, thermal aspects of machining, Tool life and economics of machining, CNC machining. Micro machining.

Module 2 (12 hours)

Basic concepts of machine tools: Tool –work motions, machine tools for various machining processes, kinematics of machine tools and gear boxes, feed and speed mechanism, machine tool drives, machine tool dynamics, gear manufacture- milling, hobbing and shaping, special purpose machine tools, hydraulic control of machine tools, components of hydraulic circuits, control circuits and their characteristics, testing of machine tools for positioning accuracy and repeatability.

Module 3 (10 hours)

Modern machining processes: Mechanics of AJM, EDM, USM, EBM and ECM, process parameters and applications.

Module 4 (10 hours)

Jigs and fixtures, basic principles of location, type and mechanics of locating and clamping elements, design of jigs and fixtures.

References:

1. A. Ghosh & A.K. Mallik; Manufacturing Science, Affiliated East West Press.

2. B.L. Juneja & G.S. Skekhon; Fundamentals of Metal Cutting and machine Tools, Wiley Eastern
3. Sen & Bhattacharya; Principles of Machine Tools, New Central Agency.
4. A. Bhattacharyya; Metal Cutting: Theory & Practice, Central book publishers.
5. M.C. Shaw; Metal Cutting Principles, CBS Publishers.
6. HMT; Production Technology - Tata Mc Graw Hill.
7. Serope Kalpakjian and Steven R. Schmid, "Manufacturing Engineering and Technology, Pearson Education.
8. N.K. Mehta; Machine Tool Design and Numerical Control, Tata Mc Graw Hill
9. Geoffrey Boothroyd & W.A. Knight; Fundamentals of Machining and Machine Tools, Marcel Dekkel
10. ASTME; Fundamentals of Tool Design, Prentice-Hall of India.
11. Chapman; Workshop Technology, Vol. 1, Vol. 2, Vol.3.
12. Khaimovitch; Hydraulic control of Machine tools, Pergamon Press
13. Anthony Esposito; Fluid Power with Applications, Pearson Education.
14. Ernst; Oil Hydraulics Power, Industrial Applications, McGraw Hill Book Company
15. Kempster, M.H.A.; An Introduction to Jig and Tool Design, ELBS
16. Donaldson, Lecain and Goold; Tool design, Tata Mc Graw Hill

MEU304: Mechanics of Machinery

3	0	0	3

Prerequisite: ZZU102

Module I (12 Hours)

Introduction to Kinematics and Mechanisms: Various mechanisms, Kinematic diagrams, Degree of freedom.

Position and displacement analysis: Graphical and analytical methods

Velocity analysis: Relative motion, Graphical and analytical methods, Instant center, Mechanical advantage.

Acceleration analysis: Graphical and analytical methods, Coriolis acceleration

Computer oriented methods in kinematic analysis

Module II (8 Hours)

Topics from Path-Curvature Theory: Fixed and moving centrodes, Velocities, Accelerations, Inflection points and inflection circle, The Euler-Savary equation.

Cam Design: Cam and follower types, Displacement diagrams, Advanced cam profile techniques. Cam profile synthesis – graphical and analytical methods.

Module III (12 Hours)

Gears: Involute spur gears, Involutometry, Spur gear details, Interference,

Gear standardisation, Backlash, Internal gear, Cycloidal gear, Non-standard gears.

Theory and details of Bevel, Helical and Worm gearing.

Gear Trains: Simple and compound gear trains, Planetary gear trains, Solution of planetary gear train problems, Applications.

Module IV (10 Hours)

Kinematic Synthesis: Tasks of kinematic synthesis, Type and dimensional synthesis, Graphical synthesis for motion, path and prescribed timing, Function generator, Overlay method.

Analytical Synthesis Techniques: Complex number modeling, Freudenstein's equation, Loop closure equation technique.

Case studies in synthesis of mechanisms.

Textbooks:

1. Shigley, J.E., and Uicker, J.J. Jr., Theory of Machines and Mechanisms, McGraw Hill, Second Edition, 1995.

References:

1. Erdman, A.G., and Sandor, G.N., Mechanism Design: Analysis and Synthesis, Vol. I & II, Prentice Hall of India.
2. Mabie, H.H., and Reinholtz, C.F., Mechanisms and Dynamics of Machinery, John Wiley & sons.
3. Ghosh, A., and Mallik, A.K., Theory of Mechanisms and Machines, Affiliated East West Press.
4. Martin, George T., Kinematics and Dynamics of Machines, McGraw Hill.
5. Nikravesh, P.E., Computer Aided Analysis of Mechanical Systems, Prentice Hall.

MEV393: Metrology and Instrumentation Lab

0	0	3	2

Prerequisite: Nil

1. Measurement of thread parameters using UMM, three wire method
2. Measurement of tool angles of single point tool using TMM
3. Measurement of gear parameters using Profile projector
4. Evaluation of straightness error using Autocollimator
5. 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.
1. Study and measurement of surface finish using surface roughness tester
2. Study and measurements with CMM
3. Experiments on limits and fits
4. Study and use of ultrasonic flaw detector
5. Preparation of psychometric chart
6. Exercises on measurement system analysis
7. Study and making measurements with thread micrometer, Disc micrometer, thread pitch gauge, height gauge, slip gauges, optical flat, three pin micrometer, pyrometer, RTD, etc.

MEV394: Production Engineering Lab II

0	0	3	2

Prerequisite: Nil

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 -surface, slot, key way and gear milling-Vertical milling machine. Turning Exercises-Limits and Fits. Grinding Exercises. Non – traditional Machining, NC/CNC Machining.

References:

1. HMT, Production Technology, Tata McGraw Hill.
2. ASTME, Tool Engineer's Gandbook.
3. Chapman W. A. J., Workshop technology part 2 & 3, ELBS.
4. Rao P. N., Manufacturing Technology, Tata McGraw Hill.
5. Groover & Zimmer, CAD/CAM, Prentice Hall.
6. Metha N. K., Machine Tool Design – Tata McGraw Gill.

SIXTH SEMESTER

MEU311: Dynamics of Machinery
Prerequisite: MEU304

3	1	0	3

Module 1 (13 Hours)

Kinematics and kinetics of rigid bodies: aspects of motion of rigid body referred to local and global frames – energy and impulse – momentum methods for rigid bodies – energy methods – impulse-momentum methods – impulse–momentum equations – dynamics of general rigid body motion – Euler's equation of motion – applications – equations of motion using Euler angles – gyroscope – torque-free motion.

Module 2 (10 Hours)

Introduction to Lagrangian dynamics: work and energy – principle of virtual work - D'Alembert's principle – generalised coordinates – Lagrange's equation of motion – introduction to calculus of variations – Hamilton's principle.

Module 3 (10 Hours)

Force analysis of machinery: static and dynamic force analysis of plane motion mechanisms – graphical method – principle of superposition – matrix methods – method of virtual work – complex number method.

Force analysis of spur, bevel, helical and worm gears.

Module 4 (9 Hours)

Flywheel analysis – balancing – static and dynamic balancing – balancing of masses rotating in several planes – balancing of reciprocating masses – balancing of multi cylinder engines – balancing machines.

Introduction to vibration: single degree freedom systems, two-degree freedom systems, vibration measuring instruments.

Text Books:

1. Shames, I.H., Engineering Mechanics, Prentice Hall of India, Fourth Edn., 2001.
2. Meirovitch, L., Elements of Vibration Analysis, McGraw Hill, Second Edn., 1986.
3. Geenwood, P.T., Classical Dynamics, Prentice Hall, 1979.
4. Holowenko, A.R., Dynamics of Machinery, John Wiley & Sons, 1965.

References:

1. Beer, F.P., and Johnston, E.R. Jr., Vector Mechanics for Engineers – Dynamics, McGraw Hill.
2. Meirovitch, L., Methods of Analytical Dynamics, McGraw Hill.

3. Shigley, J. E., and Uicker J. J. Jr., Theory of Machines and Mechanisms, McGraw Hill, Second Edn., 1995.
4. Forray, M. J., Variational Calculus in Science and Engineering, McGraw Hill.

MEU312: Thermal Engineering I

3	0	0	3

Prerequisite: MEU211

Module 1 (12 Hours)

Analysis of Gas power cycles: - Value of Carnot cycle in engineering – air-standard cycles - assumptions Otto, Diesel & Dual-combustion cycles – comparison among these cycles, Miller and Stirling cycles. Real air-fuel cycles - SI engine cycle at part throttle and supercharged conditions. Four stroke and Two stroke engines – Valve timing & Port -timing diagrams – Effect of Scavenging-ratio, Scheme of scavenging, Scavenging-pressure, Speed, Stroke-bore ratio etc. on Scavenging efficiency.

Module 2 (16 Hours)

Classification of IC engines – Terminology, variables and abbreviations. Simple Carburettor, Fuel Injection Pump and Injectors. Engine systems – Intake and Exhaust, Transmission, Cooling, Lubrication, Ignition and Starting systems. Thermochemistry - fuels for IC engines – stoichiometric air – Equivalence Ratio – Self Ignition temperature – Ignition lag (delay) Normal combustion in SI engines, Engine knock – effect of variables on tendency to knock – Octane Number – Pre-ignition. Normal combustion in CI engines, Diesel knock – Cetane Number – Alternate fuels for diesel engines - Multiple Port Fuel Injection (MPFI), Throttle–body fuel Injection – Stratified charge engines - IC Engine performance – constant speed and variable speed characteristics - different methods to determine Friction Power – Variation of volumetric efficiency with speed and load – Heat Balance - Engine Emission and Air pollution – catalytic converters and EGR.

Module 3 (14 Hours)

Analysis of Gas Turbine cycles - Brayton cycle – Regeneration, Reheat and Inter-Cooled cycles – Ericsson cycle – Ideal Jet propulsion cycles – modifications to turbojet engines - Actual Brayton cycle - Open and Closed cycles – combustion chambers for gas turbines – A/F ratio and stability loop- centrifugal and axial flow compressors.

Text Books:

1. Y. A. Cengel and M.A. Boles, Thermodynamics – An engineering approach, 4th Edition, Tata McGraw Hill, 2005
2. W.W. Pulkrabek, Engineering Fundamentals of Internal combustion Engines, Pearson Education PTE Ltd., Singapore, 2003.
3. H. Cohen, Gas Turbines Theory, 4th Edition, Longman, 1996.
4. V.Ganesan,Gas Turbines,Tata Mc Graw Hill, New Delhi, 1999.
5. L. Mathur and R.P. Sharma, Course in Internal Combustion Engines, Dhanpat Rai Publications (P) Ltd., Madras, 2005.

MEV314: CAD/CAM

3	0	0	3

Prerequisite: Nil

Module 1 (10 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 (10 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, learn production and agile manufacturing.

References:

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

MEV316: Management of Production Systems

Prerequisite: MAU101 and MAU201

3	1	0	3

Module 1 (12 Hours)

Types of production systems – Modern production management systems - Decisions in production management – Forecasting – Time series analysis – Components of time series – Moving average – Simple exponential smoothing – Simple regression – Error measurement – Tracking signal – Production Planning and Control – Framework – Material requirement planning (MRP) – Technical Issues – System Dynamics – Production activity control.

Module 2 (10 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 independent demand systems: probabilistic models – Basic concepts of supply chain management.

Module 3 (10 Hours)

Facilities Planning – Objectives of facility planning-Facilities planning strategies-Product design-Process design- 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. Reading assignments on method study and time study

Module 4 (10 Hours)

Quality Management – Quality costs – 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.

Text Books:

1. Chase, Acquilano and Jacobs, Operations Management for Competitive Advantage, Tenth Edition, 2003, Tata McGraw-Hill Edition
2. Richard J. Tersine, Principles of Inventory and Materials Management, Fourth Edition, 1994, Prentice Hall International
3. Vollmann, Berry, Whybark, and Jacobs, Manufacturing Planning and Control for Supply Chain Management, 2005, Fifth Edition, Tata McGraw-Hill
4. Tomkins, White, Bozer, Frazelle, Tanchoco and Trevino, Facility Planning, Second Edition, John Wiley & Sons
5. Francis, *et al.*, Facility Layout and Location, Second Edition, 1999, Prentice Hall of India.

MEU394: Heat Transfer Lab

0	0	3	2

Prerequisite: MEU302

Introduction to fundamentals of heat transfer – condensation and boiling, heat exchangers and experimental techniques in thermal sciences.

Exercises

a. Performance studies on a shell and tube heat exchanger.
b. Performance studies on parallel and counterflow arrangements in a concentric pipe heat exchanger.
c. Emissivity measurement of radiating surface.
d. Measurement of solar radiation.
e. Thermal conductivity of a metal rod.
f. Measurement of unsteady state conduction heat transfer.
g. Experimental study on forced convection heat transfer.
h. Experimental study of drop wise and film wise condensation.
i. Experiments on boiling heat transfer.
j. Measurement of bumout heat flux.
k. Experimental study on natural convection heat transfer from cylinder at various orientations.
l. Experimental studies on extended surfaces of various cross sections.

Reference Books

1. Holman J.P., 'Heat Transfer', McGraw Hill.
2. Beckwith & Buck, 'Mechanical Measurements', McGraw Hill.

MEU398: Industrial Training/ Mini Project

0	0	3	1

Prerequisite: Nil

Students may undertake short research projects under the direction of members of the faculty, normally 3 hrs/week. A written, detailed report describing the project and results is required. Students are expected to undertake fabrication work of new experimental set up/devices or develop software packages for the various laboratories in the department.

Students may opt to undertake with help from the Department of Training and Placement, Internship in the field of Mechanical Engineering by undergoing in-plant training of at least one-month duration in reputed industries/research centers in the country. The industrial training is expected to be undertaken during the semester recess. The student writes a final report on this training and makes an oral presentation before an evaluation committee.

SEVENTH SEMESTER

MEV401: Operations Research
Prerequisite: MAU101, MAU102, and MAU201

3	1	0	3

Module 1(12 Hours)
Methodology of operations research-Linear programming: N-dimensional vector spaces - Linear dependence - Basic solutions - Convex sets - Extreme points - Mathematical formulation of linear programming problems - Graphical solution - Theory of simplex method - Two-phase method -Charne's M method - Special cases in simplex method application: Degeneracy, alternative optima, unbounded solutions and infeasible solutions.

Module 2 (9 Hours)
Duality in Linear Programming - Primal-dual relationships. Transportation Problems: Formulation and solution. Assignment Problems: Formulation and solution.

Module 3 (9 Hours)
Games Theory: Rectangular games - Saddle points - Pure and mixed strategies - Solving zero-sum games using linear programming formulations - Dominance - Graphical solution.

Module 4 (12 Hours)
Dynamic Programming: Characteristics of dynamic programming problems - Bellman's principle of optimality – Deterministic dynamic programming problems with a finite number of consecutive decisions. Queueing Theory: Basic structure of queueing models – The role of exponential distribution - Steady state solution of single server model (Poisson input and exponential service times) - Finite queue model.

Text Books:

1. Hadley, G., Linear Programming, Addison Wesley/Narosa, Narosa Publishing House, 1994.
2. Taha, H.A., Operations Research: An introduction, Seventh Edition, Prentice Hall of India Private Limited, New Delhi, 2003.

References:

1. Hillier, F.S., and Liberman, G.J., Introduction to Operations Research: Concepts and Cases, Eighth Edition, McGraw-Hill International Edition, 2005.
2. Ravindran A., Philips, D. and Solberg, J.J., Operations Research: Principles and Practice, Second Edition, John Wiley & Sons Inc., 2005.

3. Murthy, K.G., Linear and Combinatorial Programming, John Wiley & Sons, 1976.

MEU402: Machine Design - I

3	0	0	3

Prerequisites: MEU202

Module 1 (11 Hours)

Introduction to Design: Steps in design process; design factors; principles of standardization; selection of materials; tolerances & fits; strength of mechanical elements; stress concentration; theories of failure; impact load; fatigue loading; consideration of creep and thermal stresses in design.

Module 2 (11 Hours)

Threaded fasteners: Thread standards; stresses in screw threads; preloading of bolts; bolted joints; eccentric loading; gasketed joints, analysis of power screws.

Keys: Types of keys and pins; stresses in keys and pins; design of keys; design of cotter and pin joints. Riveted joints: Stresses in riveted joints; strength analysis; boiler and tank joints; structural joints.

Module 3 (10 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 4 (10 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 couplings; design of couplings.

References:

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

Data Handbooks (allowed for reference during examinations also):

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

MEU403: Gas Dynamics

3	1	0	3

Prerequisites: MEU201 and MEU211

Module 1 (10 Hours)

Basic equations of fluid flow: Reynolds transport equation, integral and differential formulations, integral form of the equations of continuity, momentum and energy equations, use of the integral equations, differential form of these equations, Stokes postulates and constitutive equations, Navier-Stokes equations and energy equations for Newtonian fluids.

Module 2 (11 Hours)

Introduction to compressible flows: Basic concepts, equations for one-dimensional flow through stream tubes, Variation of pressure, temperature and density in the atmosphere, Speed of sound and Mach number, qualitative difference between incompressible, subsonic and supersonic flows, Karman's rules of supersonic flows, characteristic velocities, the adiabatic flow ellipse. Isentropic flow through a duct: Criterion for acceleration and deceleration, stagnation quantities, isentropic relations, use of gas tables and charts, operation of nozzles at off-design conditions.

Module 3 (11 Hours)

Normal shocks in one-dimensional flow: Occurrence of shocks, Analysis of normal shocks, Prandtl's equation, Rankine - Hugoniot equation and other normal shock relations, moving shocks. Oblique shocks and expansion waves: oblique shock relations, θ-β-M relations, shock polar, supersonic flow over a wedge, expansion waves, Prandtl-Meyer function, intersection of shocks, detached shocks, Mach deflection, shock expansion theory.

Module 4 (10 Hours)

Flow with friction: Fanno lines and Fanno flow relations, effect of friction on properties, choking, isothermal flows. Flow with simple heat transfer: Rayleigh lines, effect of heat addition, thermal choking. Generalised on dimensional flows: One-dimensional flow with several effects like mass addition, friction and heat transfer, Analysis of sub-sonic diffusers, types of diffusers, criterion for diffusion, diffuser efficiency.

References:

1. Rathakrishnan E., Gas dynamics, Prentice Hall India, New Delhi, 1995.
2. Shapiro A.H., Dynamics and Thermodynamics of Compressible fluid flow, Ronald Press.
3. Zuckrow M.J. and Hoffman. D.H., Gas Dynamics, McGraw Hill, New York.

MEU491: Thermal Engineering Laboratory

0	0	3	2

Prerequisites: MEU312

1. Constant speed characteristics of Petrol and Diesel engines.
2. Determination of friction power at any given speed and load by Willian's Line, Morse test, Retardation test and Motoring test.
3. Variable speed characteristics of Petrol and Diesel engines.
4. Heat balance in constant speed and variable speed conditions.
5. Determination of valve-timing diagrams of high speed and low speed engines.
6. Determination of the Higher and Lower Calorific Values of solid, liquid and gaseous fuels.
7. Determination of Flash point, Fire point, Viscosity & Pour point of different lubricants.
8. Constant speed characteristics of blowers and compressors (reciprocating and rotary).

MEV494: CAD/CAM Laboratory

0	0	3	2

Prerequisite: Nil

Introduction to Computer Graphics – Viewing transformations, Curves and Surfaces generation – Familiarity with Boolean operations – Sweep, Revolve, Loft, Extrude, Filleting, Chamfer, Splines etc. Windowing, View Point, Clipping, Scaling and Rotation Transformations. Usage of commercial solid modeling packages like IDEAS, Pro-E, CATIA, etc. Introduction to FEM-Mesh generation, Linear and Non Linear analysis-Static Dynamic analysis, Post Processing, Exercises on Heat Conduction, fluid flow and Elasticity. Usage of commercial FEM packages like ANSYS, ABAQUS etc. 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, Exercises in Process Control using PLC-PID control strategy, CNC Part Programming fundamentals-Manual Part Programming and Computer Aided Part Programming. Exercises on CNC Lathe and Machining Center/Milling machines., Rapid Prototyping, Hands on training on industrial robots-manual and programmed path planning, Demonstration of the capability of Coordinate Measuring Machine using sample component e.g.: Engine Block – Concepts of Reverse Engineering and Rapid Prototyping.

References:

1. Rogers, D.F. & Adams, J.A., Mathematical Elements for Computer Graphics, McGraw Hill.
2. Rogers David F., Procedural Elements for computer Graphics, McGraw Hill.
3. Cook, Robert Davis et al., Concepts & Applications of Finite Element Analysis, John Wiley & Sons.
4. Koren, Yoram, Computer Control of manufacturing System, McGraw Hill.
5. Kundra, Rao & Tewari, Numerical Control & Computer Aided Manufacturing, Tata McGraw Hill.
6. Ramamurthy, V., Computer Aided Mechanical Design, Tata McGraw Hill.
7. Fu, K.S., Gonzalez R.C. & Lee C.S.G., Robotics: Control, Sensing, vision & Intelligence, McGraw Hill.
8. Koren, Yoram, Robotics for Engineers, McGraw Hill.
9. John A Bosch, Coordinate measuring Machines &Systems, Marcel Decker Inc., New York.

MEU498: Project

0	0	3	3

Students are required to enroll in this course to complete the degree requirements. The project work commenced in VII Semester shall be continued in VIII Semester, normally 3 hours/week. At the end of seventh semester, a mid term evaluation will be conducted by a project evaluation committee.

EIGHTH SEMESTER

MEU411: Machine Design – II

3	1	0	3

Prerequisites: MEU202 and MEU304

Module 1 (12 Hours)

Design of Clutches & Brakes, Belts and Chain Drives: Friction clutches and brakes; uniform pressure and uniform wear assumptions; design of disc and cone types of

clutches and brakes; design of external contracting and internal expanding elements; band type clutches and brakes; centrifugal clutches; Belt and chain drives of common types; design of flat and V belt drives; selection of roller chains.

Module 2 (12 Hours)
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 3 (11 Hours)
Lubrication & Journal 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; selection of tapered roller bearings; lubrication; seals, shaft, housing and mounting details.

Module 4 (7 Hours)
Product Design for Manufacturing: General design recommendations for rolled sections, forgings, screw machine products, turned parts, machined round holes, parts produced on milling machine, welded parts and castings; modification of design for manufacturing easiness for typical products.

References:

1. J.E. Shigley, Mechanical Engineering Design, McGraw Hill, First Metric Edn., 1986.
2. J.E. Shigley, and C.R. Mischke, Mechanical Engineering Design, Tata McGraw Hill, Sixth Edn., 2003.
3. M.J. Siegel, V.L. Maleev and J.B. Hartman, Mechanical Design of Machines, International Textbook Company
4. R.M. Phelan, Fundamentals of Mechanical Design, Tata McGraw Hill
5. V.L. Doughtie and A.V. Vallance, Design of Machine elements, McGraw Hill.
6. R.C. Juvinall and K.M. Marshek, Fundamentals of Machine Component design, John Wiley & Sons
7. R.L. Norton, Machine Design, Pearson Education
8. James G. Bralla, Handbook of Product Design for Manufacture, McGraw Hill

Data Hand Books (allowed for reference during examinations):

1. Prof. B.R. Narayana Iyengar and Dr. K. Lingaiah, Machine Design Data Handbook
2. P.S.G. Tech., Machine Design Data Handbook

MEU412: Thermal Engineering–II
Prerequisites: MEU211

3	1	0	3

Module 1(7 Hours)
Properties of steam – use of steam tables and Mollier chart – Separating and Throttling Calorimeter - properties of mixtures of steam and atmospheric air-psychrometric chart – solution of problems on Evaporative cooling towers and Wet cooling towers.
Module 2(7 Hours)

Vapour and combined power cycle; Carnot vapour cycle – Ideal Rankine cycle – deviations in an actual Rankine cycle – methods to increase the efficiency of the Rankine cycle – Reheat and Regenerative cycles – open and closed Feedwater Heaters –Deaerator -co-generation – combined gas power cycles.

Module 3(7 Hours)

Steam generators: Fire tube (Lancashire, Locomotive and Nestler) boilers and Water-tube (Babcock & Wilcox and Bent-tude) boilers – mountings and accessories – schematic diagram of a modern steam generator – Combustion equipment – over feed & under feed stokers – Travelling-grate and Spreader stokers – pulverized coal burners – cyclone furnace – Fluidized-bed combustion.

Module 4(7 Hours)

Steam nozzles – condition for maximum discharge – design for throat and exit areas – effect of friction – supersaturated flow – steam turbines – classification – velocity diagrams – efficiencies – end thrust - blade height – turbine performance and governing.

Module 5(7 Hours)

Condensers: purpose of a condenser in a steam power plant – surface and mixing condensers - sources of air - vacuum efficiency - SJAE – different types of modern wet and dry cooling towers.

Module 6(7 Hours)

Power Plant Economics: – load curve and load duration curve – load, diversity, capacity and use factors – selection of size and number of units – scheduling of operation – depreciation and replacement – environmental aspects of thermal power systems – dust collectors.

Text Books*:*

1. Y.A. Cengel, M.A. Boles, Thermodynamics - An engineering approach, 4th Edn., Tata McGraw Hill, New Delhi, 2005.
2. M.M. El-Wakil, Power Plant Engineering, 1st Edn., McGraw Hill, New York, 1985.
3. W.A. Vopat, B.G.A. Skrotzki, Power Station Engineering and Economy, Tata McGraw Hill, New Delhi, 1999.
4. R.K. Rajput, Thermal Engineering, Laxmi Publications, New Delhi, 2006.

SHU417: Industrial Economics

3	0	0	3

Prerequisite: Nil

Module I (11 hours)

The scope of Industrial Economics and its History. Industrial efficiency: Concepts and Measmement. Meaning of the concept. The Detenninants of efficiency levels. Some efficiency conditions in the theory of production, Efficiency and decision making process. The organisational fOlDl and alternative motives of the fimt. Types of organisational fOlDl. Business Motives.

Module 2 (10 hours)

Demand Analysis - The Theory of Demand. The elasticity concept. Demand for the Products of Individual firms in an Industry. Demand forecasting. The cost theory and optimum size of the firm. The theory of cost and production. The efficiency and size of the firm.

Module 3 (11 hours)

The Elements of Market Structure - Some concepts - standard forms of Market structure - The concept of workable competiton. The conceptual frame work of the study of Industrial Economics. Market stroctw"e and Innovation. The process of innovation,

concepts and Relationships, Measuremerit of innovation activities - The Theory of technological innovation. Diffusion of New Technology.

Module4 (10 hours)

Industrial Finance and Accounting - The need for finance - types of Finance - sources of finance - contribution of various sources finance in Indian situation. Choice of Funding: Internal VB External somces. An evaluation of Indian Industrial policy. The ways and means of Government regulation of Industry. Labour productivity – concept of labour productivity and its measurement - the detemtinants of labour producti'\'ity.

References:

1. R.R. Barthwal - Industrial Economics, John Wiley.
2. W. Stewart, Industrial Economics: An applied approach (Macmillan)
3. Rogar Clark - Industrial Economics Blackwall- Oxford.
4. Bhagawati and P. Desai, India: planning for Industrialisation.
5. Sharad S. Martha, Regulation and development: India's experience.
6. A Bagchi and n. Banetjee, changing structure of industrial fInance in India.(K.P. Bahi and Co.)
7. P.J. Devons etal. An introduction to Industrial Economics.(Allen and Wlwin.)

MEU493: Seminar

0	0	3	1

Prerequisite: Nil

Each student shall prepare a technical paper and make a 20 – 30 minute oral presentation on a current research topic relevant to mechanical engineering to the rest of the class, after scrutiny and approval of the faculty- in charge of seminar. The oral presentation and a final technical report (in the format of an ASME journal paper of not less than 12 pages) are evaluated by faculty members in charge of seminar. Appropriate weights may be given for communications skills (both verbal and written) as well as for capacity to impress the audience and ability to handle question & answer (Q&A) sessions.

MEU499: Project

0	0	6	5

Prerequisite: MEU498

Students are required to enroll in this course to complete the degree requirements. The project work commenced in VII Semester shall be continued in VIII Semester, normally 3 hours/week. At the end of the semester, a thesis written in an acceptable style describing an original research project, and a successful oral defense of the thesis topic before a project evaluation committee are required.

Electives:

MEU321: Unconventional Energy Systems

3	0	0	3

Prerequisite: MEU211

Module 1 (12 Hours)

Introduction: Energy problem – Finite fossil reserves – Energy & Environment – Need for renewables and energy efficiency. Solar Energy: Thermal analysis of flat plate collectors – Measurement and Testing procedures – Solar pond – Parabolic collectors – Paraboloid dish - Central receiver – Energy storage systems – Residential water heating, industrial heating & power generation.

Module 2 (10 Hours)
Biomass Systems: Biomass conversion routes – Combustion, gasification, aerobic digestion, pyrolysis & co-generation – Performance analysis & testing – Thermal applications & power generation.
Module 3 (10 Hours)
Wind Energy & Small Hydro: Wind distribution – Types & Operation of wind turbines and their characteristics – Generators & control strategies – classification of hydro turbines – performance analysis – Selection & sizing - Power generation using OTEC – Wave & tidal energy.
Module 4 (10 Hours)
Scope and Economics: Calculation of energy cost from renewables – Comparison with conventional fuel driven systems – Calculation of CO_2 reduction – Incremental costs for renewable options – Introduction to integrated energy systems.
References:

1. S.P. Sukhatne: Solar Energy – Principles of Thermal Collection & Storage, 2e, Tata McGraw Hill, 1996.
2. H.P. Garg: Advances in Solar Energy Technology, D. Reid Publishing House, 1997.
3. G.N. Tiwari & S. Suneja: Solar Thermal Energy Systems, Narosa Publishing House, 1997.
4. A.N. Mathur and N.S. Rathore: Biogas Production, Management and Utilization, Himansu Publications, 1992.
5. K.C. Khandelwal & S.S. Mandi: Practical Hand Book of Biogas Technology, 1990.
6. L.L. Freris: Wind Energy Conversion Systems, Prentice Hall, 1990.

MEU331: Computational Methods in Engineering

3	0	0	3

Prerequisite: Nil

Module I (9 Hours)
Introduction to computational methods; Computational procedure-method of selection, programming languages, development of computer code; Numerical errors and accuracy - round-off error, truncation error, accuracy of numerical results, numerical stability; Iterative convergence – condition of convergence, rate of convergence, termination of iteration; Numerical parameters – step size, convergence criterion, other arbitrarily chosen variables.
Module 2 (10Hours)
Roots of equations- search method for real roots, bisection method, regula falsi method, and secant method, Newton-Raphson method, modified Newton's method; Method of least squares for a best fit – basic considerations, linear regression, best fit with a polynomial, nonpolynomial forms; Lagrange interpolation, Newton's divided – difference interpolating polynomial, numerical interpolation with splines.
Module 3 (9 Hours)
Numerical differentiation- direct approximation of derivatives; Taylor series approach and accuracy- finite difference approximation of the derivatives; polynomial fitting approach; Numerical Integration – the trapezoidal rule, truncation error; Simpson's rules for numerical integration, truncation errors; higher - accuracy methods- Newton – Cotes formulae; Gauss quadrature.

Module 4 (14 Hours)

Numerical solution of simultaneous linear algebraic equations - Gaussian elimination, tridiagonal matrix algorithm, LU decomposition; Iterative methods - Jacobi method, Gauss - Seidel method; Solution of simultaneous non-linear equations- Newton- Raphson method, modified Jacobi and Gauss Seidel methods; Numerical solution of ordinary differential equations – Eulers method, Runga- Kutta methods, predictor- corrector methods; Numerical solution of boundary value problems - shooting methods, finite difference methods.

Text Book:

1. S. C. Chapra, R. P. Canale, Numerical Methods for Engineers, Fourth Edition, Tata McGraw-Hill, 2002.
2. Y. Jaluria, Computer Methods for Engineering, Allyn and Bacon, Inc., 1988.

References:

1. M. L. James, Applied Numerical Methods for Digital Computations, Third Edition, Harper and Row, 1985.
2. D. V. Griffiths, I. M. Smith, Numerical Methods for Engineers: A Programming Approach, CRC Press, 1991.

MEV323: Introduction to Marketing

3	0	0	3

Prerequisite: Nil

Module 1 (10 Hours)

Defining marketing, scope and concepts – building customer satisfaction and value – analysing marketing opportunities and planning.

Module 2 (11 Hours)

Consumer markets and buyer behaviour – business markets dealing with competition – market segmentation – product life cycle – strategies.

Module 3 (11 Hours)

Marketing Channels – advertising, sales promotion, direct marketing, managing sales force.

Module 4 (10 Hours)

Special topics in marketing – marketing communication-global market offering – changing marketing practices.

Text Book:

1. Kotler. P, "Marketing Management", 10th edition, Prentice Hall India Ltd, New Delhi (2000).

References:

1. Ramaswamy V.S and Namkumari S., "Marketing Management", Macmillan India Ltd, New Delhi (1997).
2. Keegan, "Global Marketing Management", Pearson Education India, New Delhi (2002).
3. Saxena, "Marketing Management", 2nd edition, Tata McGraw Hill (2002).

MEV324: Design and Analysis of Information Systems

3	0	0	3

Prerequisite: Nil

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, Fifth edition, John Wiley & Sons, New York, 1989.
2. Hawryszkiewycz, I. T., "Introduction to Systems Analysis and Design", Prentice Hall of India, 1989.
3. Ian Sommerville, Software Engineering, 6th Edition, Pearson Education Asia, 2001.
4. Lucas, Henry C., Analysis, Design, and Implementation of Information Systems, 4th edition, McGraw Hill, New York, 1992.
5. O' Brien J. A., Management Information Systems, 4/e, Tata McGraw Hill, 1999.

MEV330: Design for Manufacturability

3	0	0	3

Prerequisite: Nil

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 – Paining, powder coating, metal spraying. Design for Heat Treatment. Design for Tastening & Joining – Design guidelines for fasteners, adhesive assembly, and welded assemblies. Design for Materials: Plastics, Composites, Ceramics, Powder Metallurgy

Text book:

1. Chitale, AK and Gupta, RC, 1997, "Product Design and Manufacturing", Prentice Hall of India Pvt. Ltd.

References:

1. Dieter, George Elwood, "Engineering Design – A Materials and Processing approach", McGraw Hill International.
2. Bakerjian, Ramon, Ed., Design for Manufacturability, 1992, Tool & Manufacturing Engineers Handbook, Society of Manufacturing Engineers, Michigan.

MEU322: Introduction to Finite Element Methods

3	0	0	3

Prerequisites: MAU101 and MAU102

Module 1 (11 Hours)

Linear vector spaces – linear transformations and functionals – linear, bilinear and quadratic forms – theory of normed spaces – theory of inner product spaces – concepts from variational calculus – variational methods of approximation – Ritz method – Weighted residual methods: Galerkin method – subdomain method – collocation method.

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 – approximation errors in the finite element method – 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) – isoparametric elements and numerical integration.

Module 4 (9 Hours)
Alternative formulations – the least square formulation – the mixed formulation – 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).

Text Books:
1. Reddy, J.N., An Introduction to the Finite Element Method, Tata McGraw Hill, Third Edn., 2005.
2. Reddy, J.N., Applied Functional Analysis and Variational Methods in Engineering, McGraw Hill International Edition, 1987.

References:
1. Huebner, K. H., The Finite Element Method for Engineers, John Wiley
2. Zienkiewicz, O. C., The Finite Element Method, Tata McGraw Hill Edition.
3. Zienkiewicz, O.C., and Morgan, K., Finite Elements and Approximation, John Wiley & Sons, 1983.
4. Cook, R.D., Malkus, D.S., Plesha, M.E., and Witt, R.J., Concepts and Applications of Finite Element Analysis, John Wiley & Sons, Fourth Edn., 2004.

MEU325: Experimental Stress Analysis

Prerequisite: MEU202 or Equivalent (Consent of teacher)

3	0	0	3

Module 1 (9 hours)
Stress at a point, strain at a point, stress-strain relations, principal stresses and principal strains, compatibility conditions.
Basic equations in elasticity theory: Formulation of the problem, 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: The rectangular rosette 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.

Text Book:

1. James. W. Dally, and William E. Riley, Experimental Stress Analysis; McGraw Hill, Third Edn., 1991.

References:

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

MEU326: Fluid Power Control
Prerequisite: MEU205

3	0	0	3

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 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 Time-dependent control, Combined control, Program Control, Electro-pneumatic control and air-hydraulic control. Applications in Assembly, Feeding, Metalworking, materials handling and plastics working.

References:

1. Blackburn, J. F., G. Reethof, and J. L. Shearer, Fluid Power Control, New York: Technology Press of M. I. T. and Wiley.
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 International.
10. Herbert E. Merritt: Hydraulic control systems, John Wilely 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 No. 7301, Esslingen Germany, 1979.
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.

MEV328: Technology Management

3	0	0	3

Prerequisite: Nil

Module 1 (10 Hours)

Technology – Concepts – definition – Technological change – scope – implication

Module 2 (11 Hours)

Approach to technology management – technology cycle – technology flow process – basic tenets of management of technology.

Module 3 (11 Hours)

Technology acquisition-forecasting generation – development-technology transfer.

Module 4 (10 Hours)

Technology absorption – diffusion – evaluation and assessment – intellectual property rights.

Text Book:

1. Hawthorn E. P, "The Management of Technology", McGraw Hill (2000)

Reference Books:

1. Babcock D. L., "Managing Engineering Technology", Printice Hall (1998).
2. Burgelman *et al*., "Strategic Management of Technology and Innovation", Tata McGraw Hill (2001).
3. Cleland and Bursic, "Strategic Technology Management", A Macom Publishers, Newyork (1999).
4. Betz. F., "Managing Technology – Competing through new ventures, innovation and corporate research", Prentice Hall (1998).

MEU329: Theory of Metal Forming

3	0	0	3

Prerequisite: MEU214 or MEU218

Module I (10hrs)

Review of the theory of stress and strain, transformation laws, principal stresses and strains, Mohrs circle, stress strain relations, Material properties. Introduction to the theory of plasticity: behavior of metals under uni-axial tension and compression, true stress-true strain plots, work hardening, bollarding and barreling, empirical stress strain relations for work hardening materials.

Module 2 (10hrs)

Yield criterion, stress space representation of yield criterion, Tresca, von Mises and other 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 Hrs)

Analysis of problems in the elastic and plastic range, elastic plastic bending and torsion, problems with spherical symmetry and cylindrical symmetry, Plane strain problems, slip line field theory, simple slip line fields, bound theorems and their application.

Module 4 (10 hrs)

Mechanics of metal forming operations, plasticity analysis of extrusion and drawing of wires and plane strips, analysis of tube drawing with and without mandrels, analysis of rolling and forging operations.

References:

1. Chakrabarty, J., Theory of Plasticity, McGraw Hill, Second Edn., 1998.
2. Johnson, W., and Mellor, P.B., Engineering Plasticity, van Nostrand Reinhold Co., London, 1973.
3. Hoffman, O., and Sachs, G., Introduction to the Theory of Plasticity for Engineers, McGraw Hill Book Co. New York, 1953.

MEU332: Control System Engineering

3	0	0	3

Prerequisite: Nil

Module 1 (10 Hours)

Introduction To System Dynamics – Mathematical Modeling Of Dynamic Systems – Solving Linear, Time Invariant Differential Equations using Laplace Transform – Mathematical Modeling of Simple Mechanical Systems – Work, Energy, and Power – Example Problems Transfer – function approach to modeling dynamic systems – Block Diagrams – Partial – Fraction Expansion with MATLIB – Transient – Response Analysis with MATLIB – Example Problems.

State-space approach to modeling dynamic systems – Transient – Response Analysis of Systems in State – Space Form with MATLIB – State-Space Modeling of Sytems with No input Derivatives – State-Space Modeling of Systems with Input Derivatives – Transformation of Mathematical Models with MATLIB – Example Problems

Module 2 (10 Hours)

Electrical Systems And Electromechanical Systems:-Fundamentals of Electrical Circuits – Mathematical Modeling of Electrical Systems – Analogous Systems – Mathematical

Modeling of Electromechanical Systems – Mathematical Modeling of Operational – Amplifier Systems – Example Problems. Fluid Systems And Thermal Systems:- Mathematical Modeling of Liquid – Level Systems – Mathematical Modeling of Pneumatic Systems – Linearization of Nonlinear Systems – Mathematical Modeling of Hydraulic Systems - Mathematical Modeling of Thermal Systems – Example Problems.

Module 3 (11 Hours)

Time-Domain Analysis Of Dynamic Systems:- Introduction – Transient – Response Analysis of First – Order and Second – Order Systems – Transient – Response Analysis of Higher Order Systems – Solution of the State Equation – Example Problems.

Frequency-Domain Analysis Of Dynamic Systems:- Introduction – Sinusoidal Transfer Function – Vibrations in Rotating Mechanical Systems Vibration Isolation – Dynamic Vibration Absorbers – Free Vibration in Multi-Degrees-of-Freedom Systems – Example Problems.

Module 4 (11 Hours)

Time-Domain Analysis And Design Of Control Systems:- Introduction – Block Diagrams and their Simplification – Automatic Controllers –Transient – Response Analysis – Transient – Response specifications – Improving Transient – Response and Steady – State Characteristics – Stability Analysis – Root-Locus analysis – Root – Locis Plots with MATLIB – Tuning Rules for PID Controllers – Example Problems.

Frequency-Domain Analysis And Design Of Control Systems:- Introduction – Bode Diagram Representation of the Frequency Response – Plotting Bode Diagrams with MATLIB – Nyquist Plots and the Nyquist Stability Criterion – Drawing Nyquist Plots with MATLIB – Design of Control Systems in the Frequency Domain Example Problems.

Textbook:

1. Ogata K, “System Dynamics”, fourth Edition, Pearson Education Inc., 2004.

Reference Books:

1. Ogata K, “Moderan Control Engineering”, Fourth edition, Prentice-Hall of India, 2002.
2. Benjamin C. Kuo, Automatic Control Systems, EEE, 7th Edition, 1995.
3. Chen C. T., “Linear System Theory and Design”, Third Edition, Oxford University Press, 1999.
4. Franklin, G. F., J. D. Powell, and A. Emami-Naeini, “Feedback Control of Dynamic Systems”, 4th edition, Prentice Gall, 2002.
5. Dort R. C., and R. H. Bishop, “Modern Control Systems”, 9th edition, Prentice-Hall, 2001.
6. John J. D. Azzo & Constantine H. Houpis, Linear Control System Analysis and Design, McGraw Gill, inc., fourth edition, 1995.
7. Francis H. Raven, Automatic Control Engineering, McGraw Hill, fifth edition, 1995.
8. D. K. Anand, Introduction to Control Systems, Pergamon Press Inc.

MEV333: Quality Engineering and Management

3	0	0	3

Prerequisite: MAU201

Module 1 (10 Hours)

Quality Management And Basic Statistical Methods - Meaning of quality, History, Quality Philosophies - Modeling Process Quality – Describing Variation, Important

discrete and continuous distributions - Inferences about process quality – Sampling Distributions, Inference for a single sample and Two samples, Analysis of Variance.

Module 2 (11 Hours)

Methods of Statistical Process Control - Methods and philosophy – Chance and assignable Causes, Choice of control limits, Sample size and frequency, Rational subgroups, Analysis of patterns, Implementation issues. Control Charts for Variables – Development and use of Average and Range charts, Interpretation, operating characteristic function, Average Run length, x bar and S charts, individual charts. Control charts for Attributes – Development and use of p chart, c chart. Variable sample size process problem. Operating characteristics - Process Capability Analysis – Capability ratios, Gage and Measurement system capability studies.

Module 3 (11 Hours)

Process Design and Improvement with Designed Experiments - Experimental Design – Guidelines, factorial experiments, the 2^k factorial design, addition of center points, blocking and confounding, fractional replication - Process Optimization – Response surface methods and Designs, Process Robustness studies.

Module 4 (10 Hours)

Acceptance Sampling and Reliability - Acceptance sampling for Attributes – The Acceptance sampling problem, Single, Double and Multiple sampling plans, OC curves, Rectifying Inspection - Reliability – Failure rates, distributions, System reliability, Data analysis, Accelerated tests.

Textbook:

1. Montgomery, Douglas C., 2001, "Introduction to Statistical Quality Control" – fourth edition, John Wiley & Sons Inc. New Delhi.

References:

1. Besterfield, Dale H., Besterfield – Michna, Carol, Besterfield, Glen H., Besterfield – Scare, Mary, 2003, "Total Quality Management" – third edition, Pearson Education, New Delhi.
2. Wadsworth, Harrison M., Stephens, Kenneth S., Godfrey, Blanton A., 2002, "Modern Methods for Quality Control and Improvement" – Second Edition, John Wiley & Sons Inc., New Delhi.
3. Lawson, John & Erjavec, John, 2000, "Modern Statistics for Engineering and Quality Improvement", Thomson Duxburg, Indian EPZ edition.

MEV334: Work Design and Ergonomics

3	0	0	3

Prerequisite: MAU201

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.

Text Books:

1. Chase, Acquilano and Jacobs, Operations Management for Competitive Advantage, Tenth Edition, 2003, Tata McGraw-Hill Edition
2. Richard J. Tersine, Principles of Inventory and Materials Management, Fourth Edition, 1994, Prentice Hall International
3. Vollmann, Berry, Whybark, and Jacobs, Manufacturing Planning and Control for Supply Chain Management, Fifth Edition, 2005, Tata McGraw-Hill
4. Tomkins, White, Bozer, Frazelle, Tanchoco and Trevino, Facility Planning, Second Edition, John Wiley & Sons
5. Francis, *et al.*, Facility Layout and Location, Second Edition, 1999, Prentice Hall of India.

MEU335: Advanced Thermodynamics

3	0	0	3

Prerequisite: MEU211

Module I (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 Thermostatic, Second Edition, John Wiley and Sons, 1985.
2. Rao, Y.V.C., Postulational and Statistical Thermodynamics, Allied Publishers, 1994.

3. Zemansky, M.W., Abbot, M.M., 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., Advance Thermodynamics for Engineers, McGraw-Hill, 1995.

MEU337: Nonlinear Dynamics and Chaos

3	0	0	3

Prerequisites: MAU101, MAU102, ZZU102 and Consent of Teacher

Module I (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 (12 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, Poincare' maps.

Bifurcation: Local and global bifurcation of continuous systems, Static and dynamic bifurcations Symmetry breaking, Cyclic fold, Period doubling, Transcritical and Hopf bifurcations.

Quasiperiodic solutions: Poincare' maps, Circle map, Construction of quasiperiodic solutions.

Module 3 (10 Hours)

Chaotic solutions of maps: Dynamics of logistic equation, Bifurcation diagram of one-dimensional maps, Henon map.

Chaotic solutions of 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-Attractor reconstruction-embedding dimension and time delay, Fourier spectra, Poincare' sections and maps, Lyapunov exponents.

Module 4 (10 Hours)

Fractals and dynamical systems: Examples of fractals: Koch curve, Cantor set etc, Fractal dimension, Measures of fractal dimension

Computational methods: Numerical schemes such as shooting method, harmonic balance method Determination of Lyapunov exponents, Fractal dimensions

References:

1. S.H. Strogatz, *Nonlinear Dynamics and Chaos*, Westview Press, 1994.
2. A.H. Nayfeh and B. Balachandran, *Applied Nonlinear Dynamics*, John Wiley & Sons, 1995
3. J.M.T. Thomson and H.B. Stewart, *Nonlinear Dynamics and Chaos*, John Wiley & Sons, 1986.
4. F.C. Moon, *Chaotic and Fractal Dynamics*, John Wiley & Sons, 1987.

5. G.L. Baker and J.P. Gollub, *Chaotic Dynamics*, Cambridge University Press, Second Edn., 1996.
6. Peitgens, Jurgens, and Saupe, *Chaos and Fractals*, Springer Verlag, 1992.
7. E.R. Scheinerman, *Invitation to Dynamical Systems*, Prentice hall, New Jersey, 1996.
8. P.G. Drazin, *Nonlinear Systems*, Cambridge University Press, 1992.
9. R.L. Devaney, *An Introduction to Chaotic Dynamical Systems*, Addison-Wesley, Second Edn., 1989.

MEV421: Mechanical Behaviour and Testing of Materials

3	0	0	3

Prerequisite: MEV203

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, Brinnel, Rockwell and Vickers hardness, flow of metal under the identer, 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.

Text Book:

1. Dieter M. George, Mechanical Metallurgy, McGraw – Hill Inc., 2001.

References:

1. Deformation and fracture mechanics, Richard W Hertzberg John Wiley & Sons
2. Mechanical behaviour of Materials, Frank A McCLINOCK and ALI S ARGON
3. Physical Metallurgy Principles, Reed Hill and Robert E, East West Press.
4. Structure and properties of Mateials, Hyden W. M. Vol. 3, McGraw Hill.
5. Plastic deformation of Metals, Honeycombe, Arnold Press.

MEU423: Automobile Engineering

Prerequisites: Nil

3	0	0	3

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-crank Cooling – purpose of cooling - types of cooling systems - air cooling - water cooling - steam cooling – radiator - types of radiators-constructional details-thermostat-temperature indicators.

Module 2 (10 Hours)

Lubrication- purpose of lubricating systems- grading of oils- service ratings 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-compensating system-full power circuit-choke – petrol injection system-diesel pump-injectors ignition system- battery and coil ignition-magneto ignition.

Module 3 (13 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 –different components of braking systems and their functions-constructional details. Steering mechanism – steering geometry-steering gears-worm and wheel gears-power assisted steering-wheel alignment-caster, camber, toe in, toe out; king pin inclination.

Module 4 (10 Hour)

Chassis and suspension – chassis lay out-road springs-shock absorbers-independent suspension – torsion bars – air suspension systems – independent rear suspension-wheel balancing-tyres and tubes. Starting mechanism – starter drives-bendix drive-over running clutch. Electrical equipments – battery-battery charging-charging circuit-regulating generator output-wiring circuit. Engine trouble shooting. Modern trends in automobile engines – Hybrid cars, electric cars and gas turbine cars – air pollution and control – pollution rating.

References:

1. Joseph Heitner, Automotive mechanics, 2nd Edition, D.Van Nostrand Company Inc., New York,1968.
2. K. Newton,W. Steeds, Motor Vehicle, 9th Edition, ELBS Publishers, London,1976.
3. W.H.Crouse, D.L.Anglin, Automotive Engines, 8th Edition, Mc GrawHill, NewYork, 1995.
4. W.H.Crouse, D.L.Anglin, Automotive fuel, lubricating and cooling systems, 5th Edition, Mc GrawHill, NewYork,1976.
5. W.H.Crouse, D.L.Anglin, Automotive chassis and body, 5th Edition, Mc GrawHill, NewYork, 1976.
6. W.H.Crouse, Automotive electrical equipments, 7th Edition, Mc GrawHill, NewYork, 1971.
7. W.H.Crouse, D.L.Anglin, Automotive mechanics, 10th Edition, Tata Mc GrawHill, New Delhi, 2004.

MEU424: Industrial Tribology

3	0	0	3

Prerequisite 1: MEU201 or MEU205
Prerequisite 2: MEV213 or MEU214

Module 1 (11 Hours)
Introduction: Basic equations; Navier Stoke's equations; Derivation of Reynolds equation from Navier-Stoke's 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; Bearing design; Analysis of Externally pressurized and gas lubricated bearings.

Module 3 (10 Hours)
Costs of wear; Surface topography; Toughness measurements; Hertzian contact; Real area of contact; Theories of friction; Friction of metals; Friction of non-metals; Temperature of sliding surface; Stick-slip; Rolling friction.

Module 4 (10 Hours)
Wear of metal; Adhesive wear; Abrasive wear; Corrosion and corrosion wear; Erosion; Fatigue and impact wear; Wear of elastomers; Wear of ceramics and composite materials; Measurement of friction and wear.

References:

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

MEV425: Supply Chain Management

3	0	0	3

Prerequisite: MAU101 and MAU201

Module 1 (10 Hours)
Supply chain definition - flows in supply chains - Evolution of Supply Chain Management (SCM) from logistics management - Decision phases in a supply chain - Performance measures for SCM - Competitive and supply chain strategies - Achieving strategic fit - Supply chain drivers and obstacles - Information technology and SCM - Enterprise resource planning and SCM.

Module 2 (10 Hours)
Purchasing: Role of purchasing in SCM - Objectives - Basic operating policies - General procurement procedures - Purchasing records - Computer based systems/Electronic Data Interchange (EDI) - Sources of supply - Outsourcing and Make or Buy decisions - Handling rush orders - Handling small orders - Evolving ordering arrangements.

Module 3 (11 Hours)

Managing Inventories in a Supply Chain: Inventory models with constraints - Working capital, space constraints - Exchange curve - Role of safety inventory in a supply chain - Measuring demand uncertainty - Measuring product availability - Replenishment policies - Evaluating cycle service level and fill rate given a replenishment policy - Impact of supply uncertainty on safety inventory - Impact of replenishment policies on safety inventory.

Module 4 (11 Hours)

Transportation in a supply chain: Factors affecting transportation decisions - Modes of transportation and their performance characteristics - Design options for a transportation network - Routing and scheduling in transportation.

Facility Decisions: Factors influencing network design decisions - Models for facility location and capacity allocation.

Text Books:

1. Chopra, S. and Meindl, P., Supply Chain Management: Strategy, Planning and Operation, Pearson Education, Inc., Singapore, Second Edition, 2004.
2. Dobler, D. W. and Burt, D. N., Purchasing and Supply Management: Text and Cases, Sixth Edition, Tata McGraw-Hill Publishing Company Limited, New Delhi, 1996.
3. Tersine, R. J., Principles of Inventory and Materials Management, Fourth Edition, Prentice-Hall Inc., New Jersey, 1994.

References:

1. Christopher, M., Logistics and Supply Chain Management, Second Edition, Financial Times Professional Limited, 1998.
2. Narasimhan, S. L., McLeavy, D. W. and Billington, P. J., Production Planning and Inventory Control, Second Edition, Prentice Hall of India Private Limited, 1995.
3. Raghuram, G. and Rangaraj, N., Logistics and Supply Chain Management: Cases and Concepts, Macmillan India Limited, New Delhi, 2000.
4. Arnold, J. R. T. and Chapman, S. N., Introduction to Materials Management, Fourth Edition, Prentice-Hall Inc., 1998.
5. Burt, Dobler and Starling, World Class Supply Management: Key to Supply Chain Management, Tata McGraw-Hill, 7th Edition, 2003.

MEV426: Cost Analysis and Control

3	0	0	3

Prerequisite: Nil

Module 1 (11 Hours)

Meaning – nature and managerial need of cost analysis – cost concepts –classification– income determination – profit planning – control – decision making – elements of cost.

Module 2 (11 Hours)

Allocation of costs – absorption of overheads – depreciation methods of competition– cost volume profit relationships – analysis.

Module 3 (10 Hours)

Cost accounting system – process costing job costing – unit costing.

Module 4 (10 Hours)

Absorption costing and variable costing – standard costing and variance analysis.

Text Book:

1. Khan M.Y. and P.K. Jain, "Management Accounting", 3rd edition, Tata McGraw Hill (2002).

References:

1. Duccan Williamson, "Cost and Management accounting", Prentice Hall of India, (1999).
2. Hilton *et al*., "Cost Management", 2nd edition Tata McGraw Hill (2002).
3. Khan M.Y. and Jain P.K., "Cost Management", TMH outline series, 2nd edition (2000).

MEU427: Aerodynamics

Prerequisite: MEU201 and MEU211

3	0	0	3

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 Jowkowski 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-Lachester theory, Biot- Savarat law, General series solution, Glauret method, Multhop's method, Horseshoe effects, Ground effects, Lineraised compressible flows in two dimensions, Flow past a wavy wall, Similarity rules, Aerofoil in compressible flows.

References:

1. J. D. Anderson Jr., Fundamentals of Aerodynamics, McGraw Hill, New York, 1985
2. A.M.Kuethe, C. Chow, Foundations of Aerodynamics, Fourth Edition, Wiley Eastern, New Delhi, 1986.
3. J. Katz, A. Plotkin, Low Speed Aerodynamics, McGraw Hill, New York, 1991.
4. E.L.Houghton,, A.E.Brock, Aerodynamics for Engineering Students, Edward Arnold, London, 1960.

MEV428: Introduction to Computer Graphics

Prerequisite: CSU101

3	0	0	3

Module 1 (11 Hours)

Introduction to computer graphics-Overview of computer graphics, Representing and interfacing with pictures, Description of graphic devices, Raster Scan Graphics, Line drawing algorithm, Circle generation, Fundamentals of initializing.

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 Surfaces, Linear coon surfaces, Bezier surfaces, B-Spline surface, B-Spline surface filling, Introduction to solid modeling, Hidden lines and Hidden Surfaces.
Computer program oriented term projects and term papers are essential for this course.

Text Books:
1. David F. Rogers & J H Adams, Mathematical Elements of Computer Graphics, 2nd Edition; McGraw Hill International Editions.
2. David F Rogers, Procedural Elements for Computer Graphics, McGraw Hill International Editions.

References:
1. Donald Hearn & M Pauline Baker, Computer Graphics; Second edition, Prentice Hall of India Private Limited.
2. Foley, Van Dam Feiner & Hughes, Computer Graphics Principles and Practice, Second Edition, Addison-wesley Publishing Company.
3. Michael E Mortenson, Geometric Modeling, John Wiley & Sons.

MEV429: Human Behaviour in Organisation

3	0	0	3

Prerequisite: Nil
Module 1 (11 Hours)
Introduction to Organizational Behaviour (OB): - Development and challenges, assumptions of contemporary OB. Foundations of individual behavior 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.
Text Book:
1. Robbins, "Organisational Behavior", 9/e, Pearson Education, (2002).

References:
1. Greenberg and Baron, "Behavior in Organisations", 7/e, Pearson Education, (2002).
2. Machane and Vonglinow, "Organisational Behavior", 2/e, TMH, (2003).
3. Hersey, Balaschard and Johnson, "Management of Organisational Behavior", 8/e, Pearson Education, (2002).

MEV437: Manufacturing Planning and Control
Prerequisite: MEV316

3	0	0	3

Module 1 (12 Hours)
Evolution of manufacturing planning and control system – 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)
Aggregate planning and master Production Scheduling: Nature of aggregate planning – Strategic variables – Relevant cost – Quantitative methods. Master production scheduling (MPS) environment – MPS technique – Final assembly schedule – freezing and time fencing.
Module 3 (10 Hours)
Material requirement 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 – Shop-floor control techniques-Advanced concepts in scheduling.

Text Books:
1. Vollmann, Berry, Whybark, and Jacobs, Manufacturing Planning and Control for Supply Chain Management, 2005, Fifth Edition, Tata McGraw-Hill
2. John M. Nicholas, Competitive Manufacturing Management: Continuous Improvement, Lean production and Customer – Focussed Quality, 2001, Tata McGraw Hill publishing Company Limited.

References:
1. Narasimhan, S. l., McLeavy, D. W., and Billington, P. J., Production planning and Inventory Control, Second Edition, 2000, Prentice-Hall of India.
2. Tersine, R. J., Principles of Inventory and Materials Management, Fourth Edition, Prentice-Hall Inc., New Jersey, 1994.
3. Monks, J. G., Operations Management: Theory and Problems, Third Edition, 1987, McGraw Hill, International Edition.
4. Panneerselvam, R., Production and Operations Management, 2001, Prentice-Hall of India, New Delhi.

MEU446: Heating Ventilation and Air Conditioning

3	0	0	3

Prerequisite: MEU302
Module 1 (11 Hours)
Principles of refrigeration – Carnot refrigeration cycle – unit of refrigeration, capacity, Coefficient of performance (COP). Refrigeration systems: Vapour compression system – theoretical and practical cycles – System components – Compressors – Condensers – Expansion devices – Evaporators – Refrigerants. Air refrigeration cycle – Vapour absorption system.
Module 2 (11 Hours)
Psychrometry – psychrometric processes – determination 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 – 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 – 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 and noise control. Installation and charging of refrigeration unit – testing for leakage – cause for faults and rectification.

References:

1. Stoecker, Refrigeration & Air conditioning, McGraw Hill, New York, 1958.
2. Dossat, Refrigeration & Air conditioning, 2nd Edition, Wiley Eastern Limited, New Delhi, 1989.
3. Jordan & Priester, Refrigeration & Air conditioning, 2nd Edition, Prentice Hall India Pvt. Ltd, 1985.
4. Arora, Refrigeration & Air conditioning, Tata McGraw Hill, New Delhi, 1995.
5. Noman Harris, Modern Air conditioning Practice, 3rd Edition, McGraw Hill Int. Edition, New Delhi, 1983.
6. Stoecker, 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.

MEU449: Vehicle Dynamics

3	0	0	3

Prerequisite: MEU305 or MEU311

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-Transient rollover-Dynamic axle Loads - 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- Basic Tyre modeling considerations-Tyre forces on hard surfaces-Tyre-soil interaction-Characterizing typical terrains for mobility analysis

Module 4 (10 Hours)

Sensors-Actuators-Cruise control- ABS -Traction control-Directional control -Vehicle stability controls-Active suspension-Computer aided analysis/Simulation- Simulation with MATLAB-Simulink and ADAMS

Textbook

1. Thomas D Gillespie, Fundamentals of Vehicle Dynamics, Society of Automotive Engineers, 1992.

References

1. J Y Wong, Theory of Ground Vehicles, John Wiley and sons, Third Edn., 2001
2. Hans Pacejka, Tyre and Vehicle Dynamics, SAE Publications, Second Edn., 2005
3. M. Blundell, and D. Harty, The Multi body Systems Approach to Vehicle Dynamics, Elsevier Publications, 2004.

MEV403: Introduction to Mechatronics

Prerequisite: ZZU191 and ECU101

3	0	0	3

Module I (10 Hours)

Introduction To Mechatronics System: Key elements-Mechatronics Design Process-Types of Design-Traditional and Mechatronics Designs-Advanced Approaches in Mechatronics-Real Time Interfacing –Elements of Data Acquisition System.

Module 2 (11Hours)

Actuators, Sensors&Transducers: Fluid Power and Electrical Actuators-Piezoelectric Actuator; Sensors for position, motion, force and temperature-Flow sensors-Range sensors-Ultrasonic sensors-Fibre Optic Sensors-Magnetostrictive transducer-Selection of Sensors.

Module 3 (11Hours)

Signals, System & Controllers: 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-Introduction to Microprocessors, Micro-controllers and Programmable Logic Controllers-Components-PLC programming.

Module 4 (10 hours)

Advanced Applications In Mechatronics: Sensors for Condition Monitoring-Mechatronics Control in Automated Manufacturing-Artificial Intelligence in Mechatronics-Fuzzy Logic Application in Mechatronics-Microsensors in Mechatronics-Case Studies of Mechatronics Systems.

Text Books

1. Bolton, W, Mechatronics, Pearson education Asia 2004.
2. Devadas Shetty, Richard A Kolk, Mechatronics System Design, Thomson Learning, 2001

References

1. Dan Necsulescu Mechatronics, Parson education Asia 2002.
2. HMT Ltd, Mechatronics, TMH 1998.
3. B.P.singh, Microprocessors and Microcontrollers, Galgotia Pub First Edn, 1997.
4. Frank D.Petruzella, Programmable Logic Controllers, TMH, 1989.
5. Krishna Kant, Computer Based Industrial Control, PHI, 1999.

MEV430: Consumer Psychology in Marketing

3	0	0	3

Prerequisite: Nil

Module 1 (10 Hours)

Introduction: Diversity in the market place, market segmentation, C. B. as discipline and Science, Ethics in marketing.

Module 2 (11 Hours)

Consumers as individuals: - Consumer motivation, consumer perception, consumer learning, personality and life styles, attitudes, attitude change, communications and CB.

Module 3 (11 Hours)

Consumers as decision –makers: - Consumer influence and diffusion of innovations, individual decision making, group influence and opinion leadership.

Module 4 (10 Hours)

Consumers in their social and cultural settings: - Social class and CB, influence of culture, subculture and CB, income, Age, Ethnic, racial and religion subcultures.

Text Book:

1. Schiffman & Kanuk, "Consumer Behavior", 7/e, Pearson Education, (2000).

References:

1. Solomon, "Consumer Behavior", 5/e, Pearson Education, (2001).
2. Peter & Olson, "Consumer Behavior and Marketing Strategy", 6/e, TMH, (2001).
3. Arnould, Linda and Zinkhan, "Consumers", TMH, (2001).

MEV439: Powder Metallurgy

3	0	0	3

Prerequisite: Nil

Module I (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 II (11 hours)

Compaction and shaping-cold and iso-static compaction, Die compaction ,Pressing equipments and tooling; Powder Injection Moulding, Slip casting Extrusion and rolling. Hot compaction-axial and isostatic, Hot Iso-static Pressing (HIP) process variants, equipments, tooling and applications; Explosive compaction.

Module III (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 IV (11 hours)

Production routes in practice; Products of PM- Bearing materials, Friction materials, Tool materials, Cermets, Electric and magnetic parts and ceramic components.

Text Book:

An introduction to Powder Metallurgy by F Thummler and R Oberacker, The Institute of Materials, The University Press, Cambridge Great Britain. ISBN 0-901716-26-X

References:

1. ASM Handbook: Powder Metal Technologies and Applications (ASM Handbook, Vol 7).
2. Fundamentals of Powder Metallurgy by Leander F and William G West, 2002 Metal Powder Industries Federation, USA ISBN: 1878954865
3. Powder Metallurgy Technology by G S Upadhyaya, Cambridge International Science Publishing Co, 1993.
4. Powder Metallurgy by Anil Kumar Sinha, Dhanpat Rai Publications, 2003

MEU440: Refrigeration and Air Conditioning Systems

3	0	0	3

Prerequisite: MEU302

Module 1 (10 Hours)

Principles of refrigeration – Methods of refrigeration – Carnot refrigeration cycle – unit of refrigeration – capacity – coefficient of performance – Air – cycle refrigeration system - Bootstrap system – Regenerative system – Steam jet refrigeration.

Module 2 (11 Hours)

Vapour compression refrigeration system – theoretical and practical cycles – simple and multi-pressure systems – thermodynamic analysis. 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.

Module 3 (11 Hours)

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, semihermetic 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 convection and forced convection coils – flooded evaporators – direct expansions coils.

Module 4 (10 Hours)

Psychrometry – psychrometric properties and processes – determination of air entering conditioned space air conditioning system – summer, winter and year – round air conditioning systems – central and unitary systems – human comfort – comfort chart and limitations – effective temperature – factors governing effective temperature – design consideration - cooling load calculation – 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 – air distribution systems – heating systems – heat pump.

References:

1. W. F. Stocker, J. W. Jones, Refrigeration and Air Conditioning, Second Edition, Tata McGraw Hill, New Delhi, 1982.
2. W.F. Stocker, Refrigeration and Air Conditioning, Second Edition, Tata McGraw Hill, New Delhi, 1986.

3. R.C. Jordan, G. B. Priester, Refrigeration and Air conditioning, Second Edition, Prentice Hall of India, New Delhi, 1981.
4. C. P. Arora, Refrigeration and Air conditioning, Second Edition, Tata McGraw Hill, New Delhi, 2000.
5. R. J. Dossat, Principles of Refrigeration, Second Edition, Pearson Education, 2003.
6. N. C. Harris, Modern Air Conditioning Practice, Third Edition, McGraw Hill, 1983.
7. W. H. Carrier, Modern Air conditioning, Heating and Ventilating, Pitman, 1940.
8. Carrier Air conditioning Company (Corporate author), Hand Book of Air Conditioning System Design, McGraw Hill, New York, 1965.

MEV441: Accounting and Finance for Engineers

3	0	0	3

Prerequisite: Nil

Module 1 (10 Hours)

Finance and related discipline – scope – function – time value of money – sources of corporate finance – capital market.

Module 2 (11 Hours)

Financial Accounting – need – accounting concepts – journal – ledger – trial balance – profit and loss account – balance sheet – 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 (simple treatment).

Text Book:

1. Khan M.Y. and Jain P.K., "Financial Management", 3rd edition, Tata McGraw Hill (2003)
2. Jawahar Lal, "Financial Accounting", 2nd edition, Wheeler publishing (2000).

References:

1. I.M. Pandey, "Financial Management", 8th edition, Vikas publishing house (2003).
2. Prasanna Chandra, "Financial Management", 4th edition, Tata McGraw Hill (2003).

MEV442: Introduction to Robotics

3	0	0	3

Prerequisite: ZZU102

Module 1(11 Hours)

Manipulator Kinematics: Introduction to robotics, classification of robots, workspace analysis, Convention for affixing frames to links – DH Representation, Derivation of Direct kinematic equations for various types of robots. Inverse Manipulator Kinematics: Solvability, algebraic vs. geometric, Pipers solution when three axes intersect, Examples of inverse manipulator kinematics, repeatability and accuracy.

Module 2 (11 Hours)

Jacobians: Velocities and static forces: 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.

Module 3 (10 Hours)

Trajectory Generation: General consideration in path description and generation, joint space schemes, collision free path planning, Robot programming.

Module 4(10 Hours)

Sensing and vision – range sensors, proximity sensors, touch sensors, force and torque sensors – Low level and high-level vision. Robot intelligence and task planning.

Reference Books:

1. K S Fu R C Gonzales, C S G Lee: Robotics Control, Sensing, Vision and intelligence, McGraw Hill.
2. John J Craig, Introduction to Robotics, Mechanics and control, second edition Addison – Wesley, 1999.
3. Mark W Spong & M Vidyasagar, Robot Dynamics and Control, John Wiley & Sons, 1989.
4. R P Paul: Robot Manipulators Mathematics Programming, Control, The computer control of robotic manipulators, The MIT Press.
5. Robert J Schilling: Fundamentals of Robotics, Analysis and Control. Prentice Hall of India 1996.
6. Gonzalez/Woods, Digital Image Processing, Addison Wesley, 1993.

MEV443: Discrete Event System Simulation

3	0	0	3

Prerequisite: MAU201 and CSU101

Module 1 (10 Hours)

System concepts - Components of a system - Discrete and continuous systems - System modeling - Types of models - System simulation - Steps in a simulation study - Monte Carlo simulation - Examples of simulation of single server, single queue systems and simple inventory systems - Concepts in discrete event system simulation - Event scheduling/time advance algorithm.

Module 2 (11 Hours)

Random number generation: Techniques for generating random numbers - Linear congruential method - Tests for random numbers: Frequency tests.

Random variate generation: Inverse transformation method - Exponential, uniform, empirical discrete and empirical continuous distributions.

Input modeling for simulation: Data collection - Identifying the distribution using histograms - Parameter estimation - Goodness of fit test.

Module 3 (12 Hours)

Verification and validation of simulation models: Verification - Validation: Face validity, validation of model assumptions and validating input-output transformations.

Output analysis for a single model: Types of simulations with respect to output analysis - Measures of performance and their estimation - Output analysis for terminating simulations - Confidence interval estimation for a fixed number of replication - confidence intervals with specified precision - Output analysis for steady state simulations - Initialization bias - Replication method - Sample size determination for a specified precision - Batch means method.

Module 4 (9 Hours)

Simulation modeling and analysis of manufacturing systems: Objectives and performance measures - Issues in simulation of manufacturing systems - Modeling downtimes and failures.

Introduction to simulation software for manufacturing applications: Salient features of ARENA.

Text Book:

1. Banks, J., Carson, J.S., and Nelson, B.L., Discrete-Event System Simulation, Second Edition, Prentice Hall of India Private Limited, 1996.

References:

1. Deo, N., System Simulation with Digital Computer, Prentice Hall of India Private Limited, 1996.
2. Gordon, G., System Simulation, Prentice Hall of India Private Limited, 1996.
3. Kelton, W.D., Sadowski, R.P and Sturrock, D.A., Simulation with ARENA, McGraw-Hill Higher Education, Fourth edition, 2007.
4. Law, A.W., and Kelton, W.D., Simulation Modeling and Analysis, Third Edition, McGraw-Hill International Edition, 2000.

MEV444: Management of Human Resources

3	0	0	3

Prerequisite: Nil

Module 1 (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 2 (11 Hours)

Behavioural Science and Industrial Psychology: Organisational Behaviour – Human Relations Movement – Hathorne Studies – Introduction to Psychology – Dimensions of Human Behaviour – Measurement – PsychologIical Tests – Individual Behaviour – Concept of Personality – Determinants – Perception – Motivation – Theories of Motivation – Learning Theories – Modification of Organizational Behaviour – Group Behaviour – Formal and informal – Communication in Business – Leadership Process and Styles.

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. Fred Luthans, "Organizational Behaviour", McGraw Hill, 10th Edition, 2005.
2. Dwivedi, R.S., "Manpower Management – An Integrated Approach to Personnel Management and Labour Relations", PHI, 1984.
3. Yoder D., and Staodohar P. D., "Personnel Management and Industrial Relations", PHI 1986.

4. Monappa A., and Saiyadain M. S., “Personnel Management”, TMH, 1988.
5. Kapoor N. D., “Introduction to Commercial and Industrial Law”, Sultan Chand & Sons, New Delhi, 1986.
6. Monappa A., “Managing Human resource”, Macmillan, Second Edition, 1998