ME010 801 Design of Transmission Elements
(Common with AU010 801)

Teaching scheme **Credits:** 4

2 hours lecture, 2 hour tutorial and 1 hour drawing per week

Objectives

To provide basic design skill with regard to various transmission elements like clutches, brakes, bearings and gears.

Module I (20 Hrs)

Clutches - friction clutches- design considerations-multiple disc clutches-cone clutch- centrifugal clutch - Brakes- Block brake- band brake- band and block brake-internal expanding shoe brake.

Module II (17 Hrs)

Design of bearings - Types - Selection of a bearing type - bearing life - Rolling contact bearings - static and dynamic load capacity - axial and radial loads - selection of bearings - dynamic equivalent load - lubrication and lubricants - viscosity - Journal bearings - hydrodynamic theory - design considerations - heat balance - bearing characteristic number - hydrostatic bearings.

Module III (19 Hrs)

Gears- classification- Gear nomenclature - Tooth profiles - Materials of gears - design of spur, helical, bevel gears and worm & worm wheel - Law of gearing - virtual or formative number of teeth- gear tooth failures- Beam strength - Lewis equation- Buckingham's equation for dynamic load- wear load- endurance strength of tooth- surface durability- heat dissipation - lubrication of gears - Merits and demerits of each type of gears.

Module IV (16 Hrs)

Design of Internal Combustion Engine parts- Piston, Cylinder, Connecting rod, Flywheel

Design recommendations for Forgings- castings and welded products- rolled sections- turned parts, screw machined products- Parts produced on milling machines. Design for manufacturing - preparation of working drawings - working drawings for manufacture of parts with complete specifications including manufacturing details.

Note: Any one of the following data book is permitted for reference in the final University examination:

1. Machine Design Data hand book by K. Lingaiah, Suma Publishers, Bangalore/ Tata Mc Graw Hill
2. PSG Design Data, DPV Printers, Coimbatore.

Text Books

1. C.S,Sarma, Kamlesh Purohit, Design of Machine Elements Prentice Hall of India Ltd NewDelhi
2. V.B.Bhandari, Design of Machine Elements McGraw Hill Book Company
3. M. F. Spotts, T. E. Shoup, Design of Machine Elements, Pearson Education.

Reference Books

1. J. E. Shigley, Mechanical Engineering Design, McGraw Hill Book Company.
2. Juvinall R.C & Marshek K.M., Fundamentals of Machine Component Design, John Wiley
3. Doughtie V.L., & Vallance A.V., Design of Machine Elements, McGraw Hill Book Company.
4. Siegel, Maleev & Hartman, Mechanical Design of Machines, International Book Company.

ME010 802 Operations Management
(Common with AU010 802)

Teaching scheme **Credits:** 4

2 hours lecture and 2 hour tutorial per week

Objectives

- *To familiarize the main decision making scenarios (strategic, tactical and operative) an Operations Manager may come across.*
- *To develop an understanding of the main OM principles, techniques and tools to analyze, diagnose and then to improve processes.*

Module I (12 hours)

Introduction to Operations Management- Functions of Operations Management, Strategic, Tactical and Operational decisions. Forecasting in decision making: Factors affecting forecasting, Sources of data, Time series analysis, Demand patterns, Forecasting methods- Moving average, Regression, Exponential smoothing-problems, Qualitative methods- Measures of forecast accuracy.

Module II (12 hours)

Aggregate Planning: Aggregate planning strategies and methods, Transportation model for aggregate planning. Master Production Schedule- Materials Requirement Planning, Bill of materials, Lot sizing in MRP, MRP-II, CRP, DRP.

Module III (12 hours)

Introduction to Scheduling: Single machine scheduling, Flow shop scheduling, Job shop scheduling. Sequencing: Johnson's algorithm, Processing *n* jobs through two machines, processing *n* jobs through three machines, processing *n* jobs through *m* machines, processing two Jobs through *m* machines-problems.

Module IV (12 hours)

Maintenance Planning and Control: Types of maintenance, Need for replacement, Replacement problems, Individual replacement policy, Group replacement policy, TPM. Reliability – Bath tub curve- reliability improvement, Measures for maintenance performance, reliability calculations, FMECA, information system for maintenance management.

Module V (12 hours)

Modern concepts/ techniques in operations management: Just in time manufacturing, Lean manufacturing, Push Pull Production, Kanban systems, Flexible manufacturing systems, ERP.

Supply Chain management: Supply chain, objective of Supply Chain, Supply chain macro processes, Process view of a supply chain, Drivers of Supply Chain.

Text Books

1. Mahadevan B., *Operations Management*, Pearson Education.
2. Panneerselvam R., *Production and operations Management*, Prentice Hall of India.

Reference Books

3. Krajewski and Ritzman, *Operations Management*, Pearson Education.
4. Verma A.P., *Industrial Engineering*, S. K. Kataria & Sons.
5. Adam and Ebert, *Production and Operations Management*, Prentice Hall of India.
6. Chopra and Meindl, *Supply Chain Management*, Prentice Hall of India.

ME 010 803 Production Engineering

Teaching scheme **Credits:** 4

2 hours lecture and 2 hour tutorial per week

Module 1 (12 hours)

Theory of metal cutting: Scenario of manufacturing process – Deformation of metals, Schmid's law (review only) – Performance and process parameters – single point cutting tool nomenclature - attributes of each tool nomenclature - attributes of feed and tool signature on surface roughness obtainable, role of surface roughness on crack initiation - Oblique and orthogonal cutting – Mechanism of metal removal - Primary and secondary deformation shear zones - Mechanism of chip formation, card model, types of chip, curling of chips**,** flow lines in a chip, BUE, chip breakers, chip thickness ratio – Mechanism of orthogonal cutting: Thin zone and thick zone, Merchant's analysis – shear angle relationship, Lee and Shaffer`s relationship, simple problems – Friction process in metal cutting: nature of sliding friction, columb`s law, adhesion theory, ploughing, sub-layer flow – Empirical determination of force component.

Module 2 (12 hours)

Thermal aspects of machining: Source of heat, temperature distribution pattern in chip, shear plane and work piece, effect of speed, feed and depth of cut – tool temperature measurement - **Tool materials**: properties of tool material, Carbon steel, HSS (classification, structure, composition, properties) - cemented Carbides (structure, properties), indexable inserts, coated WC, cermets – alumina (ceramic), sialon, cubic Boron Nitride (cBN), diamond, diamond coated tools – **Tool wear**: flank and crater wear – Tool **wear mechanisms**: adhesion, abrasion, diffusion and fatigue – **Tool life**, Taylor's equation, applications - effect of rake angle, clearance angle, chip temperature and cutting time on tool life, simple problems - Tool **wear criterion**: allowable wear land etc - **Economics** of machining – **machineability** of Ti, Al, Cu alloys and machineability index – cutting force (quartz crystal dynamometer) - **Cutting fluids**: effect of specific heat on selection of fluids, functions, classifications, specific applications.

Module 3 (12 hours)

Powder Metallurgy: **Need** of P/M - **Powder Production** methods:- Atomization, electrolysıs, Reduction of oxides, Carbonyls (Process parameters, characteristics of powder produced in each method) – **Powder characteristics**: properties of fine powder, size, size distribution, shape, compressibility, purity etc.- **Mixing** – **Compaction**:- techniques, pressure distribution, HIP & CIP, – Mechanism of **sintering,** driving force, solid and liquid phase sintering - Impregnation and Infiltration Advantages, disadvantages and specific applications of P/M.

Micromachining: Diamond turn mechanism, material removal mechanism- Magnetorheological nano-finishing process: - polishing fluid, characteristics of MRP fluid, MRF and MRAFF process.

Module 4 (12 hours)

Ceramic Structures and properties**: -** coordination number and radius rations - AX, A_mX_p, $A_mB_mX_p$ type crystal structures – imperfections in ceramics- phase diagrams of Al_2O_3 – Cr_2O_3 and MgO- Al_2O_3 only – mechanical properties – mechanisms of plastic deformation – ceramic application in heat engine, ceramic armor and electronic packaging.

Fundamentals of **Composites: -** particle reinforced composites **–** large particle composites - fiber reinforced composites: influence of fiber length, orientation and concentration-fiber phase – matrix phase.

Module 5 (12 hours)

Advanced production methods: **Nontraditional machining**: EDM, ECM, USM, EBM, LBM, IBM, Abrasive water jet machining (principle, process parameters, material removal mechanism, MRR, surface roughness, HAZ and applications) – **Material addition process**:- stereo-lithography, selective laser sintering, fused deposition modeling, laminated object manufacturing, laser engineered net-shaping, laser welding, LIGA process.

TEXT BOOKS:

1. Armarego and Brown, The Machining of Metals, Prentice – Hall.
2. Bhattacharyya, Metal Cutting Theory and Practice**,** Central Publishers. Wiley
3. Paul. H. Black, Theory of Metal Cutting, McGraw Hill.

REFERENCES BOOKS:

1. ASM hand book Volume 16, Machining, ASM international, 1989
2. Boothroyd Geoffrey, Fundaments of Machining and Machine Tools, Marcel Dekker, 1990.
3. Brophy, Rose and Wulf, the Structure and Properties of Metals Vol.2, Wiley Eastern.
4. Dixon and Clayton, Powder Metallurgy for Engineers, Machinery Publishing Co. London.
5. Jain V.K., Introduction to Micromachining, Narosa publishers.
6. Juneja B.L. Fundamentals of metal cutting and machine tools, Wiley, 1987.
7. Komanduri R, Tool materials in Kirk Othmer Encyclopedia of chemical technology, 4^{th} edition, volume 24, 390, Wiley, 1997.
8. Lal G.K., Introduction to Machining Science, New Age Publishers.
9. Machining date hand book, Volume 1 and 2, Machinability date center, Cincinnati, 1990.
10. Shaw Milton C, Metal Cutting Principles, CBS Publishers.
11. Trent M. Edward, Metal Cutting, Butterworth.
12. Venkatesh V.C. and H.Chandrasekaran, Experimental techniques in metal cutting, Prentice Hall, 1987.

Electives - III

ME010 804 L01 Aerospace Engineering

Teaching scheme **Credits:** 4

3 hours lecture and 1 hour tutorial per week

Module 1 (12 hours)

The atmosphere: Characteristics of Troposphere, Stratosphere, Mesosphere and Ionosphere - International Standard Atmosphere – Pressure, Temperature and Density variations in the International Standard Atmosphere – Review of basic fluid dynamics – continuity, momentum and energy for incompressible and compressible flows – static, dynamic and stagnation pressures – phenomena in supersonic flows

Module 2 (12 hours)

Application of dimensional analysis to 2D viscous flow over bodies – Reynolds number – Mach number similarity – Aerofoil characteristics – Pressure distribution – Centre of Pressure and Aerodynamic Center – Horse shoe vortex

Module 3 (12 hours)

Momentum and Blade Element Theories – Propeller co-efficients and charts – Aircraft engines – Turbo jet, Turbo fan and Ram Jet engines – Bypass and After Burners

Module 4 (12 hours)

Straight and Level Flight – Stalling Speed – Minimum Drag and Minimum Power conditions – Performance Curves – Gliding – Gliding angle and speed of flattest glide – Climbing – Rate of Climb – Service and Absolute Ceilings – Take off and Landing Performance – Length of Runway Required – Circling Flight – Banked Flight – High Lift Devices – Range and Endurance of Air planes.

Module 5 (12 hours)

Air speed indicators – Calculation of True Air Speed – Altimeters – Rate of Climb meter – Gyro Compass – Principles of Wind Tunnel Testing – Open and Closed type Wind Tunnels – Pressure and Velocity Measurements – Supersonic Wind Tunnels (description only) – Rocket Motors – Solid and Liquid Propellant Rockets – Calculation of Earth Orbiting and Escape Velocities Ignoring Air Resistance and assuming Circular Orbit.

References

1. Mechanics of Flight - Kermode A. C.

2. Aerodynamics for Engineering Students - Houghton and Brock
3. Airplane Aerodynamic – Dommasch
4. Anderson J.D. Jr., (2007), Fundamentals of Aerodynamics, Tata McGraw-Hill, New Delhi.
5. Karamcheti K., (1966), Principles of Ideal-Fluid Aerodynamics, John Wiley & Sons Inc.
6. Bertin J.J., (2002), Aerodynamics for Engineers, 4th Ed. Prentice-Hall Inc.
7. Kuethe A. M. and Chow C.-Y., (1986), Foundations of Aerodynamics, John Wiley & Sons Inc.
8. Kundu P.K. & Cohen I.M., (2008), Fluid Mechanics, Elsevier Inc.

ME010 804L02 Advanced Machining Process

Teaching scheme **Credits:** 4

2 hours lecture and 2 hour tutorial per week

Objective: - To understand the need of smaller high quality parts and components.

Module 1 (12 hours)

Diamond turn machining (DTM):-Types of DTM - component of machine - components of DTM: spindle system, workpiece tool positioning system, machine support system, tool measurement system, machine control system – material removal mechanism in DTM – ductile regime machining – tools for DTM – tool geometries for single crystal diamond tools – tool setting – applications.

Abrasive jet micro machining (AJMM):- machining system – masking technology – erosion mechanism – metal, photo-resist and elastomer mask – erosion behavior – surface properties: hardness and roughness – pressurized power feed system – fluidized bed powder spray system – factors affecting in constant feeding – nozzle configuration – applications.

Module 2 (12 hours)

Magnetorheological nanofinishing processes: - Magnetorheological polishing fluid – rheological characteristics of fluid - Magnetorheological finishing (MRF) processes - Magnetorheological abrasive flow finishing processes (MRAFF) – performance analysis of MRAFF process - Magnetorheological jet finishing processes:- working principle, MR jet finishing machine, polishing performance.

Micro/nano finishing with flexible flow of abrasives:- process principle and description – process technology – selection of media – effect of process parameters of performance – mechanism of material removal – process capabilities - applications.

Module 3 (12 hours)

Ultrasonic micromachining (USMM):- machine tool – elements of USMM –abrasive slurry – workpiece – mechanism of material removal – process parameters: machine based parameters – performance characteristics: machining rate, surface roughness, accuracy and tool wear – effect of process parameters on quality characteristics – effect of process parameters on accuracy – process capabilities.

Module 4 (12 hours)

Electron beam micromachining: - mechanism of material removal in EB drilling – importance of vacuum – process parameters – effect of cutting speed, pulsed beam operation, heat affected zone, cross sectional area of a beam – theoretical aspects of electron beam – energy transfer to the work material – applications.

Focused Ion beam machining:- equipment – imaging with FIB system – interaction of ion with substrate – FIB milling – gas assisted FIB processing – applications.

Module 5 (12 hours)

Micro-electric discharge micromachining:-principle of micro –EDM **–** influence of pulse characteristics – high aspect ratio holes – heat affected zone.

Laser micromachining:-laser beam characteristics – laser material interaction – micromachining system – nanosecond, picoseconds, femtosecond pulse micromachining.

Text Book:

Jain V.K. Introduction to micromachining, Narosa publishers.

References

1. M. Madou, “Fundamentals of Microfabrication”
2. D. Dornfeld, S. Min and Y. Takeuchi, Recent Advances in Mechanical Micromachining, CIRP Annals - Manufacturing Technology, Volume 55, Issue 2, 2006, Pages 745-768.

ME010 804L03 Cryogenics

Teaching scheme **Credits:** 4

3 hours lecture and 1 hour tutorial per week

Objectives

- *To impart the basic concepts of Cryogenic Engineering*
- *To provide the learner with the fundamental knowledge about the properties of cryogenic materials, its storage and transfer systems*
- *To develop an understanding of various cryogenic liquefaction and refrigeration systems and their performances*

Module 1 (8 hours)

Introduction: Historical development- application of cryogenics -present areas involving cryogenic engineering-cryogenics in space technology- cryogenics in biology and medicine-superconductivity applications.

Module 2 (12 hours)

Basic thermodynamics applied to liquefaction and refrigeration process – isothermal, adiabatic and Joule Thomson expansion process -efficiency to liquefaction and coefficient of performances- irreversibility and losses. Low temperature properties of engineering materials: mechanical properties – thermal properties -electrical and magnetic properties. Properties of cryogenic fluids- superconductivity and super fluidity - materials of constructions for cryogenic applications.

Module 3 (15 hours)

Gas liquefaction systems: Production of low temperatures – general liquefaction systems-liquefaction systems for neon, hydrogen and helium.

Module 4 (15hours)

Cryogenic refrigeration systems: ideal refrigeration systems- refrigerators using liquids and gases as refrigerants- refrigerators using solids as working media - adiabatic demagnetization method.

Module 5 (10 hours)

Cryogenic storage and transfer systems: Cryogenic fluid storage vessels- cryogenic fluid transfer systems-cryo pumping.

Text Books

1. Barron R., *Cryogenic Systems*, Oxford Science Publications
2. Scott R.B., *Cryogenic Engineering*, Van Nostrand Co.

Reference Books

1. Mamata Mukhopadyay., *Fundamentals of Cryogenic Engineering*, PHI Learning
2. Haseldon G.G., *Cryogenic Fundamentals*, Academic Press
3. Flynn T.M., *Cryogenic Engineering*, Marcel Dekker.

ME010 804 L04 Acoustics and Noise Control

Teaching scheme **Credits:** 4

2 hours lecture and 2 hours tutorial per week

Objectives:

- *Elementary physical acoustics in 1D and its extension to simple 3D situations*
- *The significance of human factors in acoustics*
- *Fundamentals of architectural acoustics and noise control*

Module1 (12 hours)

Longitudinal wave propagation in a rod-Derivation of wave equation-Physical interpretation of the wave equation solution-One Dimensional Waves in a Gas-Acoustic Energy and Acoustic Intensity-Energy in a plane progressive wave-Acoustic Impedance

Module 2 (12 hours)

Sound Perception and the Decibel Scale-The ear-The decibel Scale-Combining Sound Levels in Decibels-Octave Bands-Loudness-The “A” Weighting-Legal requirements for noise control

Module 3 (12 hours)

Acoustic Resonance-Resonance of a pipe closed at both ends-Resonance of a pipe closed at one end, open at the other-Reflection & Transmission of Plane Acoustic Waves-Sound Transmission through layers and partitions-Transmission through a layer-Transmission through solid partitions

Module 4 (12 hours)

Room Acoustics-Acoustic Absorption-Reverberation Time-Sound Transmission between Rooms

The wave equation in 3 dimensions-Acoustic impedance of a spherical wave - near and far field effects-Source efficiency

Module 5 (12 hours)

Directionality of acoustic sources and receivers-Directivity index-Screens-Silencers

Helmholtz resonator design-Expansion chamber silencer design-Dissipative silencers

Active control of noise

References

1. Turner and Pretlove, Acoustics for Engineers, Macmillan, 1991
2. Kinsler, Frey, Coppens & Sanders. Fundamentals of Acoustics. 3rd Edition. John Wiley, 1982
3. Smith, Peters and Owen, Acoustics and Noise Control, Addison-Wesley-Longman, 2nd edition 1996
4. Bies and Hanson, Engineering Noise Control, theory and practice E&FN Spon, 2nd edition, 1996

ME010 804L05 Non Destructive Testing

Teaching scheme **Credits:** 4

2 hours lecture and 2 hour tutorial per week

Module 1 (12 hours)

What is NDT,Comparison between destructive and NDT, Importance of NDT, Scope of NDT, difficulties of NDT, future progress in NDT, economics aspects of NDT.

Visual Inspection - tools, applications and limitations - Fundamentals of visual testing: vision, lighting, material attributes, environmental factors, visual perception, direct and indirect methods - mirrors, magnifiers, boroscopes, fibroscopes, closed circuit television, light sources and special lighting, a systems, computer enhanced system.

Liquid Penetrant Inspection: principles, properties required for a good penetrants and developers - Types of penetrants and developers, and advantages and limitations of various methods of LPI - **Magnetic Particle Inspection** - LPI technique/ test procedure, interpretation and evaluation of penetrant test indications, false indication, and safety precaution required in LPI, applications, advantages and limitations.

Module 2 (12 hours)

Magnetic Particle Inspection (MPI)- Principles of MPI, basic physics of magnetism, permeability, flux density, cohersiveforce, magnetizing force, rentivity, residual magnetis - Methods of magnetization, magnetization techniques such as head shot tecnique, cold shot technique, central conductor testing, magnetization using products using yokes, direct and indirect metod of magnetization, continous testing of MPI, residual tecnique of MPI, system sensitivity, checking devices in MPI, interpretation of MPI, indications, advantage and limitation of MPI - **Acoustical Holography**: Principles, types, applications, advantages and limitations.

Module 3 (12 hours)

Ultrasonic Testing (UT): principle, types of waves, frequency, velocity, wavelength, reflection, divergence, attenuation, mode conversion in ultrasonic UT testing methods - contact testing and immersion testing, normal beam and straight beam testing, angle beam testing, dual crystal probe, ultrasonic testing techniques - resonance testing, through transmission technique, pulse echo testing technique, instruments used UT, accessories such as transducers, types, frequencies, and sizes commonly used, reference blocks wit artificially created defects, calibration of equipment, applications, advantages, limitations, A, B and C scan - Time of Flight Diffraction (TOFD).

Module 4 (12 hours)

Radiography Testing (RT): Principle, electromagnetic radiation sources: X-ray source, production of X-rays, high energy X-ray source, gamma ray source - Properties of X-rays and gamma rays - Inspection techniques like SWSI, DWSI, DWDI, panoramic exposure, real time radiography, films used in industrial radiography, types of film, speed of films, qualities of film, screens used in radiography, quality of a good radiograph, film processing, interpretation,

evaluation of test results, safety aspects required in radiography, applications, advantages and limitations of RT.

Module 5 (12 hours)

Eddy Current Testing (ECT) - Principle, physics aspects of ECT like conductivity, permeability, resistivity, inductance, inductive reactance, impedance - Field factor and lift of effect, edge effect, end effect, impedance plane diagram in brief, depth of penetration of ECT, relation between frequency and depth of penetration in ECT, equipments and accessories, various application of ECT such as conductivity measurement, hardness measurement, defect detection, coating thickness measurement, advantages and limitations of eddy current testing.

Thermography: Principles, contact and non contact inspection methods - heat sensitive paints - heat sensitive papers - thermally quenched phosphors liquid crystals - techniques for applying liquid crystals - calibration and sensitivity - other temperature sensitive coatings - non contact thermographic inspection - advantages and limitation - infrared radiation and infra-red detectors, instrumentations and methods, applications.

TEXT BOOKS:

1. Baldev Raj, Practical Non – Destructive Testing, Narosa Publishing House (1997).

REFERENCE BOOKS:

1. Hull B. and V.John, Non-Destructive Testing, Macmillan (1988).
2. Krautkramer, Josef and Hebert Krautkramer, Ultrasonic Testing of Materials, Springer-Verlag.

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ME010 804 L06 Advance Operations Research

Teaching scheme **Credits:** 4

2 hours lecture and 2 hour tutorial per week

Objectives

- *The course is designed to develop an understanding of advanced operation research and related techniques.*

Module I (12 hours)

Linear Programming: Problem Formulation, Simplex Method, Duality Theory, Dual Simplex Method, Revised Simplex Method, Sensitivity Analysis.

Module II (12 hours)

Network Techniques: Examples of Network Flow Problems, Transportation Problems Assignment Problems, Shortest Path Model, Dijkstra's Algorithm.

Module III (12 hours)

Integer Programming: Introduction, Basic Concepts and Simple Problems: Gomory's Cutting Plane Algorithm, Branch and Bound Method.

Module IV (12 hours)

Goal Programming: Introduction, Basic Concepts, Weights Method, Preemptive Method.
Dynamic Programming: Basic Concepts, Forward and Backward Computational Procedures, Application of Dynamic Programming - Stage coach problem, Cargo loading problem.

Module V (12 hours)

Simulation: Basic Concepts, Discrete and Continuous systems, Generation of Random Numbers, Monte-Carlo Simulation, Simulation software.

Text Books

1. Verma A.P., *Operation Research,* S. K. Kataria & Sons.
2. Pannerselvam R., *Operation Research*, Prentice–Hall of India.

Reference Books

1. Hamdy A Taha, *Operations Research, – An Introduction,* Pearson Education.
2. Ravindran A., *Operations Research – Principles and Practice,* Wiley India (P) Ltd.
3. Srinivasan G., *Operations Research- Principles and Applications,* Prentice–Hall of India.
4. Hillier & Lieberman, *Introduction to Operations Research-Concepts and Cases,* Tata Mcgraw Hill.

Electives IV

ME010 805G01 Industrial Safety

Teaching scheme **Credits:** 4

2 hours lecture and 2 hours tutorial per week

Objectives

- *To develop an understanding of the principles of safety,terminolgies in accident prevention and its theories..*
- *To understand the theory and practice of occupational health,ergonomics and hygiene,principle of fire engineering and fire fighting.*

Module-I (12 Hours)

Development of safety movement: - Need for safety-safety and productivity-planning for safety-planning procedure-safety policy-formulation of safety policy-safety budget-role and qualification of safety professional-safety committees-need, types and functions of committees-safety organizations.

Module II (12 Hours)

Accident prevention: - Basic philosophy of accident prevention-nature and causes of accidents-accident proneness-cost of accidents-accident prevention methods-Domino theory-safety education and training-training methods-motivation and communicating safety-personal protective equipments.

Module III (12 Hours)

Safety management techniques: - Safety inspection-Safety sampling technique-Safety audit-Safety survey-Incident recall technique-Job safety analysis-Damage control-Risk management.
*Involvement in safety***: -** Role of management-role of supervisors-role of workmen- role of unions-role of government

Module IV (12 Hours)

Occupational health and hygiene: - Functional units and activities of occupational health and hygiene-types of industrial hazards-physical, chemical, mechanical, electrical, social, biological, ergonomic and environmental hazards-factors impeding safety-house keeping-hearing conservation programme

Module V (12 Hours)

*Industrial fire protection***: -** Fire chemistry-classification of fires-fire prevention activities-fire risks-fire load -contributing factors to industrial fires-fire detection-industrial fire protection systems.

Text Books:-

1. Heinrich H.W, 'Industrial accident prevention', McGraw Hill Company, New York, 1980.

2. Frank P Lees, 'Loss prevention in process industries', Vol I, II, III, Butterworth, London, 1980.
3. R.P.Blake, "Industrial Safety", Prentice Hall of India, New Delhi

Reference books:-

1. "Accident prevention manual for Industrial Operations", National Safety Council, Chicago, 1989.
2. Brown D.B, "System Analysis and Design for safety", Prentice Hall, New Jercy.

ME010 805G02 Disaster Management

Teaching scheme **Credits:** 4

2 hours lecture and 2 hours tutorial per week

MODULE 1 (12 hours)

Importance of disaster management - Types of emergencies – major industrial disasters – Components of a major hazard control system – identification of major hazard control installations – purpose and procedures – safe operation of major hazard installations – mitigation of consequences – reporting to authorities. Implementation of major hazard control systems – group of experts – training – checklists – inspection – evaluation of major hazards – information to the public – manpower requirements – sources of Information

MODULE 2 (12 hours)

Emergency planning – On-site emergency planning – formulation of the plan and emergency services – Identification of resources – actions and duties – emergency procedure – mock drills. Off-site emergency planning – objectives and elements of off-site plan – role of administrative machinery – role of major hazard works management – role of the local authority. Emergency preparedness at local level – Awareness and preparedness for emergencies at local level (APELL) – The process and its partners.

MODULE 3 (12 hours)

Requirements of emergency plan as per Indian legislations like Factories Act, Manufacture, Storage and Import of Hazardous Chemicals Rules, Chemical Accidents (Emergency planning, Preparedness and Response) Rules-Applications of remote sensing and GIS in disaster management

MODULE 4 (12 hours)

Emergency planning and preparedness in international standards like ISO 14001, OHSAS 18001 and OSHA's Process Safety Management System, Emergency Planning in Seveso II directive – elements of emergency planning in IS : 18001 – Hazardous Materials / Spills Emergencies – contingency plans for road transportation of hazardous chemicals – contingency plans for oil spills in marine environment.

MODULE 5 (12 hours)

Natural Hazards – potentially hazardous natural phenomena – earthquakes – landslides – flooding – cyclones – hazards in arid and semi-arid areas – nature of the hazard – hazard management activities – disaster mitigation – natural hazard prediction – emergency preparedness – disaster, rescue and relief – post disaster rehabilitation and reconstruction – education and training activities – vulnerable elements to be considered in the development planning for natural hazard management .

TEXT BOOKS:

1. Petak, W.J and Atkisson, A.A.: *Natural Hazard Risk Assessment and Public Policy: Anticipating the Unexpected*

2. Frank P Lees, '*Loss prevention in process industries'*, Vol I, II, III, Butterworth, London, 1980

REFERENCES:

1. ILO, Geneva: *Major Hazard Control – a Practical Manual.*
2. UNEP, Paris : *APELL - A Process for responding to technological accidents , A Handbook,* Industry & Environment Office., 1998
3. *Accident Prevention Manual for Business and Industry, Vol. I* – National Safety Council, USA.
4. *Oil spill Response : The National Contingency Plan* - Institute of Petroleum, London
5. U.R. Rao : *Space Technology for Sustainable Development*

ME010 805G03 Nano Technology

Teaching scheme **Credits:** 4

2 hours lecture and 2 hours tutorial per week

MODULE 1 (12 hours)

Introduction to nano technology – definition – why nano – application in different fields - nano materials, solid state devices – carbon nano tubes: - structure, sythesis, growth mechanisms, properties, carbon nano tubes based nano objects, applications.

MODULE 2 (12 hours)

Nano tribology characterization studies – friction and wear on the atomic scale – nano mechanical properties of solid surface and thin films.

MODULE 3 (12 hours)

Mechanical properties of nano structures: - experimental techniques, indentation and scratch tests, bending tests; experimental results and discussion – nano tribology of ultra thin and hard amorphous carbon films.

MODULE 4 (12 hours)

Nano boundary lubrication – kinetics and energetic in nano lubrication - Nano tribology for data storage application

MODULE 5 (12 hours)

Industrial applications: - micro actuators for dual storage servo systems – MEMS/NEMS materials and applications – mechanical properties of micro machined structures.

TEXT BOOKS:

1. Bhushan – Springer Handbook of Nano technology.

REFERENCE BOOKS:

1. Nano manufacturing Handbook Busnaina CRC press.
2. Pradeep T., IIT Madras - NANO: The Essentials, Tata McGraw Hill

ME010 805 G04 Finite Element Analysis

Teaching scheme **Credits:** 4

2 hours lecture and 2 hours tutorial per week

Objectives

- *To learn the mathematical background of finite element analysis*
- *To solve structural mechanics problems using finite element approach*

Module I (12 hours)

Introduction to FEA:- Brief History, Applications of FEA in various fields, Advantages and disadvantages of FEA.

Review of Theory of Elasticity: - Degrees of freedom, rigid body motion, principle of minimum potential energy, stress and strain at a point, principal stresses, Von-Mises stress.

Basic equations of elasticity: - Stress-strain and, strain displacement relationships, 2D and 3D cases.

Basic steps in finite element problem formulation, importance of discretization, different types of elements, shape functions and stiffness matrices of 1D bar and beam elements.

Module II (12 hours)

Assembly of elements and matrices:- Concept of element assembly, 1D bar element assembly, boundary conditions, 1D problems. Analogous (1-D) problems of torsion and heat conduction.

Co-ordinate systems: - Global and local co-ordinate systems, transformation matrix

Module III (12 hours)

Structural analysis: - Plane truss problems, beam problems

2D finite element formulations: - Three nodded triangular element, four nodded rectangular element, compatibility, four nodded quadrilateral element, eight nodded quadrilateral element.

Variational methods : - Functionals - weak and strong form - essential and non- essential boundary conditions - Principle of stationary potential energy - Rayleigh-Ritz method -simple examples.

Module IV (12 hours)

Higher order Elements:- Quadratic and cubic elements, shape functions, Pascal's triangle, Pascal's pyramid, convergence criterion, Constant Strain triangle element and Linear Strain triangle element- stiffness matrices. Isoparametric elements, natural co-ordinates, area co-ordinates, linear triangle and quadratic triangle elements, Quadrilateral elements.

Module V (12 hours)

Modal analysis: - Eigen vectors and Eigen values, Consistent and lumped mass matrices. Mass matrices for bar element, truss element, beam element, frame element.

Finite element formulation of free vibration problems:- Natural frequencies and mode shapes of longitudinal vibration of bar element, flexural vibrations of beam element.

Structure of a FEA software package: - Pre-processor-solver-Post-processor.

Text Books

1. Hutton David V “Fundamentals of Finite Element Analysis”, TMH 2005
2. Daryl L.Logan, “A first course in the Finite Element Method”, Cengage Learning, Fourth edition, 2007.
3. Robert D.Cook, “Concepts and applications of Finite Element Analysis”, Wiley India, Fourth Edition, 2003.

Reference Books

1. Reddy J.N. “An Introduction to Finite Element Method”, McGraw-Hill, 2000.
2. Krishnamurthy, C.S., “Finite Element Analysis”, Tata McGraw-Hill, 2000.
3. Seshu P “A text book of Finite Element Analysis” PHI,2005

ME010 805 G05 Optimization Methods in Design

Teaching scheme **Credits:** 4

2 hours lecture and 2 hours tutorial per week

Module 1 (12 hours)

Nonlinear optimization: Introduction - one-dimensional optimization - elimination methods - unrestricted search, exhaustive scare Fibonacci and Golden section methods - Interpolation methods - quadratic and cubic interpolations, direct root methods.

Module 2 (12 hours)

Unconstrained nonlinear optimization: Direct search methods - random search methods - pattern search methods – method of rotating coordinates - descent methods - steepest descent, conjugate gradient, Quasi-Newton, and variable metric methods.

Module 3 (12 hours)

Constrained nonlinear optimization: Direct methods - the complex method, cutting plane method, methods of feasible directions - indirect methods - transformation techniques, interior and exterior penalty function methods.

Module 4 (12 hours)

Non-traditional optimization: Introduction to genetic algorithms, simulated annealing, particle swam optimization and ant colony optimization.

Module 5 (12 hours)

Static Applications: - Structural applications – Design of simple truss members - Design applications – Design of simple axial, transverse loaded members for minimum cost, weight – Design of shafts and torsionally loaded members – Design of springs.
Dynamic Applications:-Dynamic Applications – Optimum design of single, two degree of freedom systems.
Application in Mechanisms – Optimum design of simple linkage mechanisms.

Text Books

1 Singiresu S. Rao, *Engineering optimization: theory and practice,* 3rd Edition, Wiley Interscience, 1996
2. Kalyanmoy Deb, *Optimization for engineering design*, PHI, New Delhi, 2000
3. David E. Goldberg, *Genetic algorithms in search, optimization and machine learning,* Addison Wesley Pub. Co., 1989
4. Harvey M. Salkin, *Integer programming,* Addison-Wesley Pub. Co., 1975
5. Stephen C. Nash and Ariela Sofer, *Linear and nonlinear programming,* McGraw Hill College Div., 1995

Reference Books

1. Fred Glover, Manuel Laguna, and Fred Laguna, *Tabu search,* Kluwer Academic Publishers, 1997
2. Johnson Ray, C., “Optimum design of mechanical elements”, Wiley, John & Sons, 1990.
3. Goldberg, D.E., “Genetic algorithms in search, optimization and machine”, Barnen, Addison-Wesley, New York, 1989.

ME010 805 G06 Petrochemical Engineering

Teaching scheme **Credits:** 4

2 hours lecture and 2 hour tutorial per week

Objectives

• *To impart the basic concepts of science of petroleum drilling and transportation of oil.*

EXPLORATION AND DRILLING

Module 1 (12 Hours)

Methods of petroleum prospecting and exploration such as geophysical, seismic, etc. - drilling equipments such as rigs, platforms etc - techniques for offshore and onshore operation.

Directional Drilling: Objectives, Types of deflection tools, tool orientation, Directional well profiles, Well path deflection & correction.

Down Hole Motors: Positive displacement motors and Turbo-drills, motor description, Power calculation and applications - Auto-track and verti-track system - Rotary Steerable motors, Geo-steering tools.

Horizontal Well Drilling: Horizontal well objectives and selection, Different profiles, drilling techniques, Mud requirements & characteristics, casing and drill string requirements and completion programs. Problems.

Module 2 (12 Hours)

Slant Hole Drilling: Objectives and selections, Well profiles and applications.

Down the Hole Well Surveying: Well surveying objectives, surveying methods, Surveying Analysis methods and calculations for well coordinates.

Measurements While Drilling: Objectives of MWD/ LWD, MWD tools, Telemetry system and data interpretation.

Directional Drilling Problems and Their Remedies.

Special Methods of Drilling : Aerated drilling, Under-balanced drilling, Overbalanced drilling, HPHT Drilling, Variable pressure regime, Plasma drilling, Electrical Drilling, Top drive drilling, Re-entry drilling, Jet Drilling, Extended reach drilling, Multilateral drilling, Slim hole drilling, coil tubing drilling. Problems.

Drilling economics. Computer Application in Drilling.

DESIGN AND CONSTRUCTION OF PIPELINE

Module 3 (12 Hours)

Objective and scope of pipeline as a means of fluid transportation with special reference to crude oil/gas/refined products, Economics of Pipeline transportation.

Design of Pipeline: Factors influencing oil, gas and refined products as pipeline design; Hydraulic surge and water hammer; specific heat of liquids; river crossing; pipe size and station spacing etc.

Theory and different formulae of the flow of fluids in oil/gas pipelines; basic equations for the flow of fluids through pipes; different flow equations for laminar and turbulent flow of compressible and incompressible fluids (Newtonian); Introduction to the flow of Non-Newtonian fluids through pipes; multiphase flow and loop pipelines.

Module 4 (12 Hours)
Construction of pipelines; materials; project specifications; general equipment specifications (Pipes, valves and fittings); Installation of expansion loops and thermodymetric tapping plant. Pigging, Pigging Technology: pig launcher and receiver, intelligent pigging, types of pigs - Corrosion protection and control; Design of cathodic protection system, Pipeline automation. Problems.

Module 5 (12 Hours)
Offshore Pipeline: Design and control of Sag and Over bend; Description of stinger; and Riser, articulated stinger, construction of offshore pipeline, Method of underwater welding.
Hydrates, wax & scale - formation and prevention. Crude conditioning and use of additives to improve flow conditions. City distribution network of oil/gas. Lease and custody transfer.

References:

1. Berger B D, Anderson K E, “Modern Petroleum” Pennwell books
2. Bradley H B, “Petroleum Engineering Handbook”, SPE
3. Cole F W, Reservoir Engineering manual
4. Carl Gatlin, “Petroleum Engineering Drilling and Well Completions” Prentice Hall .
5. Mc Cray and Cole, “Oil Well Drilling Technology” Oklahoma Press

ME010 806 Mechanical Systems Laboratory

List of experiments

1. Test on reciprocating air compressor
2. Tests on blowers and rotary compressors
3. Free vibration analysis
4. Forced vibration analysis
5. Balancing of reciprocating and revolving masses
6. Assembling of mechanical systems
7. Test on refrigeration equipment
8. Test on air conditioning unit
9. Determination of thermal conductivity of conducting and insulating materials
10. Determination of emissivity of surfaces
11. Heat flow through lagged pipes
12. Heat flow through composite walls
13. Determination of overall heat transfer coefficient of heat exchangers
14. Free convection
15. Forced convection
16. Stefan-Boltzmann apparatus
17. Universal governor apparatus
18. Whirling of shafts
19. Gyroscope
20. Friction in hydrodynamic bearings
21. Heat pipe
22. Vortex tube
23. Critical heat flux

ME010 807 Project Work

Teaching scheme **credits: 4**

6 hours practical per week

The progress in the project work is to be presented by the middle of eighth semester before the evaluation committee. By this time, the students will be in a position to publish a paper in international/ national journals/conferences. The EC can accept, accept with modification, and request a resubmission.

The progress of project work is found unsatisfactory by the EC during the middle of the eighth semester presentation, such students has to present again to the EC at the end of the semester and if it is also found unsatisfactory an extension of the project work can be given to the students.

Project report: To be prepared in proper format decided by the concerned department. The report shall record all aspects of the work, highlighting all the problems faced and the approach/method employed to solve such problems. Members of a project group shall prepare and submit **separate** reports. Report of each member shall give details of the work carried out by him/her, and only summarise other members' work.

The student's sessional marks for project will be out of 100, in which 60 marks will be based on day to day performance assessed by the guide. Balance 40 marks will be awarded based on the presentation of the project by the students before an evaluation committee.

For Project, the minimum for a pass shall be 50% of the total marks assigned to the Project work.

ME010 808 Viva -Voce

Teaching scheme **credits: 2**

A comprehensive oral Viva-voce examination will be conducted to assess the student's intellectual achievement, depth of understanding in the specified field of engineering and papers published / accepted for publication etc. At the time of viva-voce, certified bound reports of seminar and project work are to be presented for evaluation. The certified bound report(s) of educational tour/industrial training/ industrial visit shall also be brought during the final Viva-Voce.

An internal and external examiner is appointed by the University for the Conduct of viva voce University examination.

For Viva-voce, the minimum for a pass shall be 50% of the total marks assigned to the Viva-voce.

Note: If a candidate has passed all examinations of B.Tech. course (at the time of publication of results of eighth semester) except Viva-Voce in the eighth semester, a re-examination for the Viva-Voce should be conducted within one month after the publication of results. Each candidate should apply for this 'Save a Semester examination' within one week after the publication of eighth semester results.