

SIXTH SEMESTER

Course Title	L	P	M
THEORY			
Environmental Science & Engineering	4	0	100
Heat and Mass Transfer	4	0	100
Operational Research	4	0	100
Plant layout and Material Handling	4	0	100
Design of Transmission Systems	4	0	100
Elective - I	4	0	100
 PRACTICAL			
Manufacturing Technology Lab – II	0	3	100
Thermal Engineering Lab	0	3	100

ENVIRONMENTAL SCIENCE AND ENGINEERING

1. INTRODUCTION AND COMPONENTS OF ENVIRONMENT 9

Definition - Scope and Role of Environmental Engineer - Components – Water, air and land – Inter-relationship between components – Subcomponents; Ecosystem – Structure and functional components of ecosystem – Development and evolution of ecosystem – Energy flow and material cycling in ecosystem.

2. ENVIRONMENTAL IMPACTS OF DEVELOPMENT 9

Natural and man made impacts on water, air and land; Environment and development – Concept of sustainable development - Environmental impacts of Development – sustainable development – Environmental pollution – Water, Air and Land.

3. PLANNING FOR WATER SUPPLY AND SEWERAGE SYSTEMS 9

Public water supply and sewerage systems – Objectives – Design period – Population forecasting – Water demand – Sources of water – Source Selection – Water quality – Characterization – Water quality standards – Sources of wastewater – Quantity of sanitary sewage – Estimation of storm runoff – Characteristics and composition of sewage and their significance – Effluent standards.

4. CONVEYANCE SYSTEM 9

Water supply – intake structures – Pipe materials - Hydraulics of flow in pipes – Transmission main design – Laying, jointing & testing of pipes – appurtenances – Pumps – Sewerage – Hydraulics of flow in sewers – Design of sanitary and storm sewers – Computer applications – Laying, jointing & testing of sewers – appurtenances – Pumps.

5. WATER SUPPLY AND DRAINAGE IN BUILDINGS 9

Principles of design of water supply and drainage in buildings – House service connection – Sanitary fixtures and fittings – Systems of sanitary plumbing – House drainage – House sewer connection.

Total Hours = 45

TEXT BOOKS:

1. Garg, S.K., Environmental Engineering, Vols. I and II, Khanna Publishers, New Delhi, 1994
2. C.S.Shah, Water Supply and Sanitation, Galgotia Publishing Company, New Delhi, 1994.

REFERENCES:

1. Manual on Water Supply and Treatment, CPHEEO, Ministry of Urban Development, Government of India, New Delhi, 1999.
2. Manual on Sewerage and Sewage Treatment, CPHEEO, Ministry of Urban Development, Government of India, New Delhi, 1993

3. H.S.Peavy, D.R.Rowe and George Tchobanoglous, Environmental Engineering, McGraw-Hill Book Company, New Delhi, 1995.

HEAT AND MASS TRANSFER

- 1. CONDUCTION** **9**
Basic Concepts – Mechanism of Heat Transfer – Conduction, Convection and Radiation – General Differential equation of Heat Conduction – Fourier’s Law of Conduction – Cartesian, Cylindrical and Spherical Coordinates – One Dimensional Steady State Heat Conduction – Conduction through Plane Wall, Cylinders and Spherical systems – Composite Systems – Conduction with Internal Heat Generation – Extended Surfaces – Unsteady Heat Conduction – Lumped Analysis – Use of Heislers Chart.
- 2. CONVECTION** **9**
Basic Concepts – Convective Heat Transfer Coefficients – Boundary Layer Concept – Types of Convection – Forced Convection – Dimensional Analysis – External Flow – Flow over Plates, Cylinders and Spheres – Internal Flow – Laminar and Turbulent Flow – Combined Laminar and Turbulent – Flow over Bank of tubes – Free Convection – Dimensional Analysis – Flow over Vertical Plate, Horizontal Plate, Inclined Plate, Cylinders and Spheres.
- 3. PHASE CHANGE HEAT TRANSFER AND HEAT EXCHANGERS** **9**
Nusselt’s theory of condensation and boiling, pool boiling nucleate boiling, film boiling correlations in boiling and condensation. Types of Heat Exchangers – LMTD Method of heat Exchanger Analysis – Effectiveness – NTU method of Heat Exchanger Analysis – Overall Heat Transfer Coefficient. Types of heat exchangers, compact heat exchangers – Fouling Factors.
- 4. RADIATION** **9**
Basic Concepts, Laws of Radiation – Stefan Boltzman Law, Kirchoff’s Law –Black Body Radiation –Grey body radiation, Shape Factor – Electrical Analogy – Radiation Shields – Introduction to Gas Radiation.
- 5. MASS TRANSFER** **9**
Basic Concepts – Diffusion Mass Transfer – Fick’s Law of Diffusion – Steady state Molecular Diffusion – Convective Mass Transfer – Heat and Mass Transfer Analogy, Convective Mass Transfer Correlations

Total:
45

Note: *(Use of standard heat and mass transfer data book is permitted in the University examination)*

TEXT BOOKS

1. Sachdeva R C, “Fundamentals of Engineering Heat and Mass Transfer” New Age International, 1995.
2. Yadav R “Heat and Mass Transfer” Central Publishing House, 1995.

REFERENCES

1. Ozisik M.N, "Heat Transfer", McGraw-Hill Book Co., 1994.
2. Nag P.K, " Heat Transfer", Tata McGraw-Hill, New Delhi, 2002
3. Holman J.P "Heat and Mass Transfer" Tata McGraw-Hill, 2000.
4. Kothandaraman C.P "Fundamentals of Heat and Mass Transfer" New Age International, New Delhi, 1998

DESIGN OF TRANSMISSION SYSTEMS

- 1. DESIGN OF TRANSMISSION SYSTEMS FOR FLEXIBLE ELEMENTS 10**
Selection of V belts and pulleys – selection of Flat belts and pulleys - Wire ropes and pulleys – Selection of Transmission chains and Sprockets. Design of pulleys and sprockets.
- 2. SPUR GEARS AND PARALLEL AXIS HELICAL GEARS 10**
Gear Terminology-Speed ratios and number of teeth-Force analysis -Tooth stresses - Dynamic effects - Fatigue strength - Factor of safety - Gear materials – Module and Face width-power rating calculations based on strength and wear considerations - Parallel axis Helical Gears – Pressure angle in the normal and transverse plane- Equivalent number of teeth-forces and stresses. Estimating the size of the helical gears.
- 3. BEVEL, WORM AND CROSS HELICAL GEARS 10**
Straight bevel gear: Tooth terminology, tooth forces and stresses, equivalent number of teeth. Estimating the dimensions of pair of straight bevel gears.
Worm Gear: Merits and demerits- terminology. Thermal capacity, materials-forces and stresses, efficiency, estimating the size of the worm gear pair.
Cross helical: Terminology-helix angles-Estimating the size of the pair of cross helical gears.
- 4. DESIGN OF GEAR BOXES 10**
Geometric progression - Standard step ratio - Ray diagram, kinematics layout -Design of sliding mesh gear box -Constant mesh gear box. – Design of multi speed gear box.
- 5. DESIGN OF CAM, CLUTCHES AND BRAKES 10**
Cam Design: Types-pressure angle and under cutting base circle determination-forces and surface stresses.
Design of plate clutches –axial clutches-cone clutches-internal expanding rim clutches-internal and external shoe brakes.

Total: 50

Note: (Usage of P.S.G Design Data Book is permitted in the University examination)

TEXT BOOKS

1. Juvinall R. C., Marshek K.M., “Fundamentals of Machine component Design”, – John Wiley & Sons Third Edition, 2002.
2. Bhandari, V.B., “Design of Machine Elements”, Tata McGraw-Hill Publishing Company Ltd., 1994.

REFERENCES

1. Maitra G.M., Prasad L.V., “Hand book of Mechanical Design”, II Edition, Tata McGraw-Hill, 1985.
2. Shigley J.E and Mischke C. R., “Mechanical Engineering Design”, McGraw-Hill International Editions, 1989.
3. Prabhu. T.J., “Design of Transmission Elements”, Mani Offset, Chennai, 2000,
4. Norton R.L, “Design of Machinery”, McGraw-Hill Book co, 2004.

5. Hamrock B.J., Jacobson B., Schmid S.R., "Fundamentals of Machine Elements", McGraw-Hill Book Co., 1999.

PLANT LAYOUT AND MATERIAL HANDLING

UNIT-I

PLANT LOCATION: 9

Factors to be considered-influence of location on plant layout, selection of plant site, consideration in facility planning and layout.

PHYSICAL FACILITIES: Equipments required for plant operation, capacity, serviceability and flexibility and analysis in selection of equipments, space requirement, and man power requirement.

UNIT-II

PLANT LAYOUT: 9

Need for layout, types of layout, factors influencing product, process, fixed and combination layout; tools and techniques for developing layout, process chart, flow diagram, string diagram, template and scale models-machine data. layout planning procedure. Visualization of layout, revision and improving existing layout, balancing of fabrication and assembly lines.

UNIT-III

MATERIAL HANDLING: 9

Importance and scope. Principles of material handling. Planning, operating and costing principle –types of material handling system, factors influencing their choice.

UNIT –IV:

INDUSTRIAL BUILDING AND UTILITY: 9

Centralized electrical, pneumatic water line system. Types of building, lighting, heating, air-conditioning and ventilation utilities, planning and maintenance. Water handling, statutory requirement, packing and storage of materials, importance of packing, layout of packing-packaging machinery-wrapping and packing of materials, cushion materials.

UNIT-V

ANALYSIS OF MATERIAL HANDLING: 9

Factor involved, motion analysis, flow analysis, graphic analysis, safety analysis, and equipment cost analysis, palletization analysis, analysis of operation, material handling surveys.

TOTAL :

45

TEXT BOOKS:

1. Industrial engineering – O.P.KHANNA, Edition 20,-Phi publisher
2. Plant layout and material handling- Dr K.R.GOVINDAN-Third Edn- Anuratha Agencies

REFERENCES:

1. Industrial engineering-P .Kumar, TMH Publisher, edition -I
2. Industrial engineering-A.P.Verma, Publication by S.K. Kataric & Sons, Edition-2002

3. Industrial engineering & Management System-S.Dalala, Mansoorali, MH Publication-
Edition-I.

4.A course in Industrial engineering & Operation management -S.K.Sharma, Savitha Sharma,
Publication- S.K. Kataric & Sons, Edition-II 2004.M.R.F DEEMED UNIVERSITY.

MANUFACTURING TECHNOLOGY LAB – II

LIST OF EXPERIMENTS

1. Shaping machine:
Making a square from a round rod, grooving , V grooving , dove tail – male and female.
2. Plain milling exercises.
3. Universal milling machine:
Spur gear cutting, helical gear cutting , bevel gear cutting.
4. Grooving and letter sinking – vertical milling machine.
5. Eccentric turning on lathe.
6. Grinding exercise to required accuracy:
Universal cylindrical grinder, Vertical spindle surface grinder, Horizontal spindle surface grinder.
7. Grinding and key-way cutting in vertical slotting machine.

TOTAL : 45

THERMAL ENGINEERING LAB

LIST OF EXPERIMENTS

1. Thermal conductivity of insulating material.
2. Thermal conductivity by Guarded hot plate method.
3. Heat transfer through composite walls.
4. Heat transfer by free and forced convection.
5. Heat exchanger test – parallel flow and counter flow.
6. Emissivity measurement apparatus.
7. Heat transfer from fins- natural and forced convection
8. Stefan-bolzman apparatus.
9. Boiler trial.
10. COP of a refrigerator.

TOTAL : 45

ELECTIVE - I
REFRIGERATION AND AIR CONDITIONING

1. REFRIGERATION CYCLES & REFRIGERANTS: 9

Vapour Compression Refrigeration Cycle-Simple saturated vapour compression Refrigeration cycle. Thermodynamic analysis of the above. Refrigerant Classification, Designation, Alternate Refrigerants, Global Warming Potential & Ozone Depleting Potential aspects.

2. SYSTEM COMPONENTS: 9

Refrigerant Compressors - Reciprocating Open & Hermetic type, Screw Compressors and Scroll Compressors - Construction and Operation characteristics. Evaporators - DX coil, Flooded type Chillers Expansion devices - Automatic Expansion Valves, Capillary Tube & Thermostatic Expansion Valves. Condensing Units and Cooling Towers.

3. CYCLING CONTROLS AND SYSTEM BALANCING: 9

Pressure and Temperature controls. Range and Differential settings. Selection and balancing of system components - Graphical method.

4. PSYCHROMETRY: 9

Moist air behaviour, Psychrometric chart, Different Psychrometric process analysis.

5. AIR CONDITIONING: 9

Summer and Winter Airconditioning, Cooling Load Calculations, Air Distribution Patterns, Dynamic and Frictional Losses in Air Ducts, Equal Friction Method, Fan Characteristics in Duct Systems.

Total hours: 45

TEXT BOOK:

1. W.F.Stocker and J.W.Jones, " Refrigeration & Air Conditioning " McGraw Hill Book Company, 1985.

REFERENCES:

1. R.J.Dossat, " Principles of Refrigeration ", John Wiley and Sons Inc., 1989.
2. Manohar Prasad, " Refrigeration and Air Conditioning ", Wiley Eastern Ltd., 1995.

TURBO MACHINERY

1. PRINCIPLES

9

Energy transfer between fluid and rotor, classification of fluid machinery, dimensionless parameters, specific speed, applications, stage velocity triangles, work and efficiency for compressors and turbines.

2. CENTRIFUGAL FANS AND BLOWERS

9

Types, stage and design parameters, flow analysis in impeller blades, volute and diffusers, losses, characteristics curves and selection, fan drives and fan noise.

3. CENTRIFUGAL COMPRESSOR

9

Construction details, types, impeller flow losses, slip factor, diffuser analysis, losses and performance curves.

4. AXIAL FLOW COMPRESSOR

9

Stage velocity triangles, enthalpy-entropy diagrams, stage losses and efficiency, workdone factor, simple stage design problems and performance characteristics.

5. AXIAL AND RADIAL FLOW TURBINES

9

Stage velocity diagrams, reaction stages, losses and coefficients blade design principles, testing and performance characteristics.

Total hours: 45

TEXT BOOK:

1. Yahya, S.H., " Turbines, Compressor and Fans ", Tata Mc Graw Hill Publishing Company, 1996.

REFERENCES:

1. Bruneck, Fans, Pergamom Press, 1973.
2. Earl Logan, Jr., " Hand book of Turbomachinery ", Marcel Dekker Inc., 1992.
3. Dixon, S.I., " Fluid Mechanics and Thermodynamics of Turbomachinery ", Pergamom Press, 1990.
4. Shepherd, D.G., " Principles of Turbomachinery ", Macmillan, 1969.
5. Stepanff, A.J., " Blowers and Pumps ", John Wiley and Sons Inc., 1965.
6. Ganesan .V., " Gas Turbines ", Tata Mcgraw Hill Pub. Co., New Delhi, 1999.

ADVANCED IC ENGINEERING

1. SPARK IGNITION ENGINES

9

Spark ignition Engine mixture requirements - Feedback Control Carburettors -Fuel - Injection systems - Monopoint and Multipoint injection - Stages of combustion - Normal and Abnormal combustion-Factors affecting knock - Combustion Chambers - Introduction to Thermodynamic analysis S.I. Engine combustion

2. COMPRESSION IGNITION ENGINES

9

States of combustion in C.I. Engine - Direct and indirect injection systems - Combustion chambers - Fuel spray behaviour - spray structure, spray penetration and evaporation - Air motion - Turbocharging - Introduction to Thermodynamic Analysis of C.I. Engine combustion.

3. POLLUTANT FORMATION CONTROL

9

Pollutant - Sources and types - formation of NO_x - Hydro-carbon Emission Mechanism - Carbon Monoxide Formation - Particulate emissions - Methods of controlling Emissions- Catalytic converters and Particulate Traps -Methods of measurements and Driving cycles.

4. ALTERNATIVE FUELS

9

Alcohol, Hydrogen, Natural Gas and Liquified Petroleum Gas - Properties, Suitability, Engine Modifications, Merits and Demerits as fuels.

5. RECENT TRENDS

9

Lean Burn Engines - Stratified charge Engines - Gasoline Direct Injection Engine - Homogeneous charge compression Ignition - Plasma Ignition - Measurement techniques.

Total hours: 45

TEXT BOOK:

1. John B. Heywood, "Internal Combustion Engine Fundamentals", McGraw Hill, 1988.

REFERENCES:

1. R.B.Mathur and R.P.Sharma, " Internal Combustion Engines ".
2. Rowland S.Benson and N.D.Whitehouse, " Internal combustion Engines ", Vol.I and II, Pergamon Press, 1983.
3. Duffy Smith, " Auto fuel Systems ", The Good Heart Wilcox Company, Inc., 1987.

INDUSTRIAL ROBOTICS

1. INTRODUCTION

9

Definition of a Robot - Basic Concepts - Robot configurations - Types of Robot drives - Basic robot motions - Point to point control - Continuous path control.

2. COMPONENTS AND OPERATIONS

9

Basic control system concepts - control system analysis - robot actuation and feedback, Manipulators – direct and inverse kinematics, Coordinate transformation - Brief Robot dynamics. Types of Robot and effectors - Grippers - Tools as end effectors - Robot/End - effort interface.

3. SENSING AND MACHINE VISION

9

Range sensing - Proximity sensing - Touch sensing - Force and Torque sensing. Introduction to Machine vision - Sensing and digitizing - Image processing and analysis.

4. ROBOT PROGRAMMING

9

Methods - languages - Capabilities and limitation - Artificial intelligence - Knowledge representation – Search techniques - AI and Robotics.

5. INDUSTRIAL APPLICATIONS

9

Application of robots in machining - Welding - Assembly - Material handling - Loading and unloading - CIM - Hostile and remote environments.

Total hours: 45

TEXT BOOK:

1. K.S. Fu., R.C.Gonzalez, C.S.G.Lee, " Robotics Control sensing ", Vision and Intelligence, McGraw Hill International Edition, 1987.

REFERENCES:

1. Mikell P. Groover, Mitchell Weiss, " Industrial robotics, technology, Programming and Applications ", McGraw Hill International Editions, 1986.
2. Richard D. Klafter, Thomas A. Chmielewski and Michael Negin, " Robotic engineering an Integrated Approach ", Prentice Hall Inc, Englewoods Cliffs, NJ, USA, 1989.

MECHANICAL VIBRATIONS

1. INTRODUCTION

9

Relevance of and need for vibrational analysis - Mathematical modelling of vibrating systems - Discrete and continuous systems - review of single-degree of freedom systems - free and forced vibrations, Various damping models.

2. TWO DEGREE-OF-FREEDOM SYSTEMS

9

General solution to free vibration problem - damped free vibration - Forced vibration of undamped system - dynamic vibration absorbers - Technical applications.

3. MULTI DEGREE-OF-FREEDOM SYSTEMS

9

Free and forced vibrations of multi-degree of freedom systems in longitudinal torsional and lateral modes - Matrix methods of solution-normal modes - Orthogonality principle-Energy methods, Introduction to vibrations of plates.

4. CONTINUOUS SYSTEMS

9

Torsional vibrations - Longitudinal vibration of rods - transverse vibrations of beams - Governing equations of motion - Natural frequencies and normal modes - Energy methods, Introduction to vibration of plates.

5. VIBRATION MEASUREMENT

9

Vibration monitoring - data acquisition - Vibration Parameter Selection-Vibration sensors-Accelerometers- Performance characteristics-Sensor location-Signal preamplification-Types of preamplifiers-Instrumentation-Tape recorders-Real time analysis-Digital Fourier transforms-FFT Analysis- Signature analysis and preventive maintenance: Vibration meters-vibration signatures-standards-vibration testing equipment-in-site balancing of rotors.

Total hours: 45

TEXT BOOK:

1. J.S.Rao and K.Gupta, " Introductory Course on Theory and practice of Mechanical Vibrations ", Wiley Eastern Ltd., 1991.

REFERENCES:

1. P.Srinivasan, "Mechanical Vibration Analysis", Tata-Mc Graw Hill, New Delhi, 1982.

2. G.K.Grover, " Mechanical Vibrations ", New Chand and Bros., Roorkey, 1989.
3. Seto, " Mechanical Vibrations ", Schaum Series, McGraw Hill Book Co.,
4. J.P.Den Hartog, " Mechanical Vibrations ", (4th Edition) McGraw Hill, New York, 1985.
5. L.Meirovitch, " Elements of vibration Analysis ", (2nd Edition) McGraw Hill, New York, 1985.

INDUSTRIAL TRIBOLOGY

1. SURFACES AND FRICTION

9

Topography of Engineering surfaces- Contact between surfaces - Sources of sliding Friction – Adhesion Ploughing- Energy dissipation mechanisms Friction Characteristics of metals - Friction of non metals. Friction of lamellar solids - friction of Ceramic materials and polymers - Rolling Friction - Source of Rolling Friction – Stick slip motion - Measurement of Friction.

2. WEAR

9

Types of wear - Simple theory of Sliding Wear Mechanism of sliding wear of metals - Abrasive wear – Materials for Adhesive and Abrasive wear situations - Corrosive wear - Surface Fatigue wear situations - Brittle Fracture wear - Wear of Ceramics and Polymers - Wear Measurements.

3. LUBRICANTS AND LUBRICATION TYPES

9

Types and properties of Lubricants - Testing methods - Hydrodynamic Lubrication - Elasto hydrodynamic lubrication- Boundary Lubrication - Solid Lubrication Hydrostatic Lubrication.

4. FILM LUBRICATION THEORY

9

Fluid film in simple shear - Viscous flow between very close parallel plates - Shear stress variation Reynolds Equation for film Lubrication - High speed unloaded journal bearings - Loaded journal bearings – Reaction torque on the bearings - Virtual Co-efficient of friction - The Somerfield diagram.

5. SURFACE ENGINEERING AND MATERIALS FOR BEARINGS

9

Surface modifications - Transformation Hardening, surface fusion - Thermo chemical processes – Surface coatings - Plating and anodizing - Fusion Processes - Vapour Phase processes - Materials for rolling Element bearings - Materials for fluid film bearings - Materials for marginally lubricated and dry bearings.

Total hours: 45

TEXT BOOK:

1. I.M. Hutchings, Tribology, " Friction and Wear of Engineering Material ", Edward Arnold, London, 1992.

REFERENCES:

1. T.A. Stolarski, " Tribology in Machine Design ", Industrial Press Inc., 1990. 2. E.P.Bowden and Tabor.D., " Friction and Lubrication ", Heinemann Educational Books Ltd., 1974.
2. A.Cameron, " Basic Lubrication theory ", Longman, U.K., 1981.
3. M.J.Neale (Editor), " Tribology Handbook ", Newnes. Butter worth, Heinemann, U.K., 1975.

COMBUSTION ENGINEERING

1. COMBUSTION OF FUELS

9

Combustion equations, Theoretical air, excess air, air fuel ratio, equivalence ratio, exhaust gas composition, Air- fuel ratio from exhaust gas composition, heating value of fuels.

2. THERMODYNAMICS OF COMBUSTION

9

Thermo-chemistry, First law analysis of reacting systems, Adiabatic combustion temperature, Second law analysis of reacting systems, criterion for chemical equilibrium, Equilibrium constant for gaseous mixtures, Evaluation of equilibrium composition, chemical availability.

3. KINETICS OF COMBUSTION

9

Rates of reaction, Reaction order and molecularity complex reactions, chain reactions, Arrhenius rate equation, Collection theory, activated complex theory, Explosive and general oxidative characteristics of fueled.

4. FLAMES

9

Laminar and Turbulent flames, Premixed and Diffusion flames, Burning velocity and its determination, Factors affecting burning velocity, Quenching, Flammability and Ignition, Flame stabilization in open burners.

5. ENGINE COMBUSTION

9

Combustion in SI and CI engines, stages of combustion in SI and CI engines, Normal combustion and Abnormal combustion, Emissions from premixed combustion, Emission from Nonpremixed combustion, Control of emissions

Total hours: 45

TEXT BOOK:

1. Stephen R. Turns, "An Introduction to Combustion", McGraw Hill Book Company, 1996.

REFERENCES:

1. Irwin Glassman, " Combustion ", Third Edition, Academic Press, 1996.
2. S.P. Sharma and Chandramohan, " Fuels and Combustion ", Tata McGraw Hill Book Co., 1984.
3. Samir Sarkar, " Fuels and Combustion ", Orient Longman, 1984.
4. K.K.Kuo, " Principles of Combustion ", John Wiley & Sons, 1984.
5. J.B. Heywood, " Internal Combustion Engine Fundamentals ", Mc Graw Hill Book Co., 1988.