DEPARTMENT OF CIVIL ENGINEERING

Scheme of Instruction

and

Syllabi of

B.E. V & VI - SEMESTERS

2017-2018

UNIVERSITY COLLEGE OF ENGINEERING
(AUTONOMOUS)
OSMANIA UNIVERSITY
HYDERABAD – 500 007, TELANGANA

CBCS CURRICULUM
V & VI SEMSTERS SCHEME & SYLLABUS
CIVIL ENGINEERING

SCHEME OF INSTRUCTION FOR B.E. (CIVIL ENGG) - V SEMESTER

S.No.	Course Code	Course Title	Scheme of Instruction			Contact hr/week	Scheme of Examination		Credits
			L	T	P		CIE	SEE	
1	PC 501CE	Hydraulic Machines	3	1	-	4	30	70	3
2	PC 502CE	Theory of Structures-I	3	1	-	4	30	70	3
3	PC 503CE	Design of Steel Structures	3	1	-	4	30	70	3
4	PC 504CE	Soil Mechanics	3	-	-	3	30	70	3
5	PC 505CE	Concrete Technology	3	-	-	3	30	70	3
6	PC 506CE	Water Resource Engg-I	3	-	-	3	30	70	3
7	HS 501MB	Managerial Economics and Accountancy	3	-	-	3	30	70	3
8	PC 551CE	Fluid Mechanics-II lab	-	-	2	2	25	50	1
9	PC 552CE	Concrete Technology lab	-	-	2	2	25	50	1
10	PC 553CE	Soil Mechanics Lab	-	-	2	2	25	50	1
			21	**03**	**06**	**30**	**285**	**640**	**24**

SCHEME OF INSTRUCTION FOR B.E. (CIVIL ENGG) -VI SEMESTER

S.No.	Course Code	Course Title	Scheme of Instruction			Contact hr/week	Scheme of Examination		Credits
			L	T	P		CIE	SEE	
1	PC 601CE	Theory of Structures-II	3	1	-	4	30	70	3
2	PC 602CE	Foundation Engg	3		-	3	30	70	3
3	PC 603CE	Environmental Engg	3	-	-	3	30	70	3
4	PC 604CE	Water Resources Engg-II	3	1	-	4	30	70	3
5	PC 605CE	Transportation Engg-I	3	-	-	3	30	70	3
6		Professional Elective-I	3	-	-	3	30	70	3
7	PC 606CE	Pre-Stressed Concrete	3	-	-	3	30	70	3
8		Open Elective-I	3	-	-	3	30	70	3
8	PC 651CE	Environmental Engg lab	-	-	2	2	25	50	1
9	PC 652CE	Transportation Engg Lab	-	-	2	2	25	50	1
10	PW661CE	Survey Camp						50	2
11		Summer Internship							
			24	**02**	**04**	**30**	**290**	**710**	**28**

PROFESSIONAL ELECTIVE-I			OPEN ELECTIVE-I		
1	PE 601CE	Structural Dynamics	1	OE 601BM	Micro Electro Mechanical Systems (MEMS)
2	PE 602CE	Hydro Power Engineering	2	OE 602CE	Disaster Management
3	PE 603CE	Infrastructure Development	3	OE 603CE	Geo-spatial Techniques
4	PE 604CE	Soft Computing Techniques in Civil Engg	4	OE 664CS	Operating Systems
			5	OE 665CS	OOPS with JAVA
			6	OE 601EC	Embedded Systems
			7	OE 602EC	Digital System design using Verilog HDL
			8	OE 601EE	Reliability Engineering
			9	OE 601ME	Industrial Robotics
			10	OE 602ME	Material Handling
			11	OE 601 LA	Intellectual Property Rights

SCHEME OF INSTRUCTION FOR B.E. (CIVIL ENGG) -VI SEMESTER

S.No.	Course Code	Course Title	Scheme of Instruction			Contact hr/week	Scheme of Examination		Credits
			L	T	P		CIE	SEE	
1	PC 601CE	Theory of Structures-II	3	1	-	4	30	70	3
2	PC 602CE	Foundation Engg	3		-	3	30	70	3
3	PC 603CE	Environmental Engg	3	-	-	3	30	70	3
4	PC 604CE	Water Resources Engg-II	3	1	-	4	30	70	3
5	PC 605CE	Transportation Engg-I	3	-	-	3	30	70	3
6		Professional Elective-I	3	-	-	3	30	70	3
7	PC 606CE	Pre-Stressed Concrete	3	-	-	3	30	70	3
8		Open Elective-I	3	-	-	3	30	70	3
8	PC 651CE	Environmental Engg lab	-	-	2	2	25	50	1
9	PC 652CE	Transportation Engg Lab	-	-	2	2	25	50	1
10	PW661CE	Survey Camp						50	2
11		Summer Internship							
			24	**02**	**04**	**30**	**290**	**710**	**28**

PROFESSIONAL ELECTIVE-I			**OPEN ELECTIVE-I**		
1	PE 601CE	Structural Dynamics	1	OE 601BM	Micro Electro Mechanical Systems (MEMS)
2	PE 602CE	Hydro Power Engineering	2	OE 602CE	Disaster Management
3	PE 603CE	Infrastructure Development	3	OE 603CE	Geo-spatial Techniques
4	PE 604CE	Soft Computing Techniques in Civil Engg	4	OE 664CS	Operating Systems
			5	OE 665CS	OOPS with JAVA
			6	OE 601EC	Embedded Systems
			7	OE 602EC	Digital System design using Verilog HDL
			8	OE 601EE	Reliability Engineering
			9	OE 601ME	Industrial Robotics
			10	OE 602ME	Material Handling
			11	OE 601LA	Intellectual Property Rights

V – SEMESTER

DETAILED SYLLABUS

PC 501 CE

HYDRAULIC MACHINES

Instruction	*: 3L+1T periods per week*
Duration of Semester End Examination	*: 3 hours*
CIE	*: 30 marks*
SEE	*: 70 marks*
Credits	*: 3*

Objectives:

- Concepts of dimensional analysis and model studies
- Introduction to velocity triangles due to impact of jets
- Knowledge of forces and efficiencies in the hydraulic turbines
- Study of pumping devices under different conditions of operation

Outcomes:

- Application of basic principles in the design of Hydraulic Machines
- Assimilation of turbine/pump laws and constants for the hydraulic design
- Knowledge about selection of hydraulic turbines and pumps

UNIT - I

Dimension analysis and model studies: Dimensional analysis and a tool in experimental hydraulics, Buckingham's Pie theorem, applications, geometric, kinematic and dynamic similarity, similarity laws, significance of Reynolds, Froude and Mach similarity laws, different types of models and their scale ratios.

UNIT - II

Impact of Jets: Force exerted by a fluid jet on a stationary, and moving flat, and curved vanes striking symmetrically, and tangentially at one of the ends

UNIT - III

Hydraulic turbines: Classification, specific speed, velocity triangles, power developed, efficiencies, principles of design of impulse and reaction turbines, turbine laws and constants, characteristic curves, selection of turbines.

UNIT - IV

Centrifugal pumps: Components, work done and efficiency, minimum starting speed, Euler head equation, specific speed and characteristic curves of centrifugal pump, pumps in series and parallel.

UNIT - V

Reciprocating pumps: Classification, work done, effect of acceleration of the piston on velocity and pressure in the pipes, effect of variation of velocity on friction in pipes, pressure diagram, air vessels, indicator diagram with air vessels.

Suggested Reading :

1. S. K. Som, and Biswas, G, *'Fluid Mechanics and Fluid Machines'*, Tata McGraw-Hill Publishing Co., New Delhi, 1998
2. Yuan, S. W., *'Foundation of Fluid Mechanics'*, Prentice-Hall India Pvt. Ltd., New Delhi, 1976
3. C.S.P. Ojha, R.Berndtsson, P.N. Chandramouli, *'Fluid Mechanics and Machinery'*, Oxford University Press, New Delhi, 2010
4. A.K.Mohanty, *'Fluid Mechanics'*, Prentice-Hall India Pvt. Ltd., New Delhi,1994
5. P.N. Modi, '*Hydraulics and Fluid Mechanics Including Hydraulics Machines'*, 2013Standard Book House, New Delhi

PC 502 CE

THEORY OF STRUCTURES - I

Instruction	: 3L +1T periods per week
Duration of Semester End Examination	: 3 hours
CIE	: 30 marks
SEE	: 70 *marks*
Credits	: 3

Objectives:

- Understand the advantage of statically indeterminate structure over the statically determinate structure.
- Understand basic methods for the analysis of statically indeterminate beams and frames and know the difference between different methods.
- Evaluate the displacements and redundant forces using energy principles.
- Identify the various straining action in arches and analyze them with varying degrees of indeterminacy

Outcomes:

- Solve statically indeterminate beams and portal frames using classical methods
- Sketch the shear force and bending moment diagrams for different loading condition for indeterminate structures.
- Calculate the deflections in beams and pin jointed trusses.
- Analyze the three hinged and two hinged arches.

UNIT - I

Slope deflection method: Application of the method to continuous beams with and without sinking of supports, single bay - portal frames (Degree of freedom not exceeding three), loading on each span may be point load(s) or uniformly distributed load on whole span, shear force and bending moment diagrams.

UNIT - II

Moment distribution method: Application of the method to continuous beams with and without sinking of supports, portal frames (static indeterminacy not exceeding three), loading on each span may be point load(s) or uniformly distributed load on whole span, shear force and bending moment diagrams.

UNIT - III

Kani's Method: Application of the method to continuous beams with and without support sinking, portal frames (static indeterminacy not exceeding three), and loading

on each span may be point load(s) or uniformly distributed load on whole span, shear force and bending moment diagrams.

UNIT - IV

Strain energy method: Deflections of statically determinate trusses and frames using unit load method.

Redundant trusses and frames: Analysis of plane trusses with one degree of redundancy (internal / external) and plane frames with one degree of redundancy, Lack of fit and temperature effect.

UNIT - V

Elastic theory of arches: Eddy's theorem, three hinged parabolic and segmental arches, determination of horizontal thrust, bending moment, normal thrust and radial shear for static loading, influence lines for horizontal thrust, bending moment, normal thrust and radial shear.

Two hinged arches: parabolic and segmental, determination of horizontal thrust, bending moment, normal thrust and radial shear for static loading.

References:

1. D.S. Prakash Rao, *Structural Analysis - A Unified Approach*, University Press, 1996
2. B.C. Punmia and A.K. Jain, *Theory of structures*, Laxmi Publications, New Delhi, 2004.
3. Pandit, G .S., S. P. Gupta and R. Gupta, *Theory of Structures*, Vol.l, Tata McGraw Hill, New Delhi, 1999.
4. S.B. Junarkar, *Mechanics of Structures* (Vol. 1 &2), Charotar Publishing House Anand, 1992.
5. C.S.Reddy, *Basic Structural Analysis*, Tata McGraw-Hill Publishing Co. Ltd., New Delhi.
6. *Analysis of Structure*s – Vol. I & II by Bhavikathi, Vikas publications.
7. *Analysis of structures* – Vol. I & II by Vazirani & Ratwani – Khanna publications.

PC 503 CE

DESIGN OF STEEL STRUCTURES

Instruction	*: 3L+1T periods per*
weekDuration of Semester End Examination	*: 3 hours*
CIE	*: 30 marks*
SEE	*: 70 marks*
Credits	*: 3*

Note: All relevant latest IS codes necessary for this course may be referred (i.e. IS 800-2007 etc)

Objectives:

- Know the IS codal provisions as applicable for the designs.
- Understand the material behavior and basics of design of steel structures.
- Learn the design of various members along with the connections.
- Explain the design principles of roof trusses.

Outcomes:

- Learn IS codal provisions and basics of design of steel structures
- Learn the design of different types of connections.
- Learn the design of tension, compression members, column bases and beams.
- Learn the design of roof trusses.

UNIT - I

Materials and Specifications: Chemical composition of steel, types of Structural Steel, Residual stresses, Stress Concentration.

Basis of Structural Design: Codes and Specifications, Design Philosophies, working Stress Method, Limit State Method.

Loading and Load Combinations: Characteristic Loads, Dead Loads, Imposed Loads, Earthquake Loads, Wind Loads and Load Combinations. Partial safety factors for materials and loads.

Bolted Connections (Limit state method): Bolted Connections, Behavior of Bolted Joints, Design Strength of Ordinary Black Bolts, Design Strength of High Strength Friction Grip Bolts, Pin Connections, Simple Connections and Eccentric Connections.

Welded Connections (Limit State Method): Advantages of Welding, Types of Welds and Joints, Simple Connections and Eccentric Connections.

UNIT - II

Design of Tension Members (Limit State Method): Types of Tension Members, Design of Strands, Slenderness Ratio, Modes of Failure, Factors Effecting Strength of Tension Members, Design of Tension Members (Angles, Other sections and Rods), Lug Angles, Tension Member Splice.

UNIT - III

Design of Compression Members (Limit state method): Introduction, Possible Failure Modes, Behavior of Compression Members, Elastic Buckling of Slender Compression Members, Behavior of Real Compression Members, Sections of Compression Members, Effective Length, Design of Compression Members with Single Section and Built-up Sections (Symmetric in both directions), Lacing and Battening, Column Splices. Design of Column Bases (Limit state method): Design of Slab Base and Gusseted Base for Columns.

UNIT - IV

Design of Beams (Limit state method): Types of Beams, Section Classification, Lateral Stability of Beams, Buckling of Real Beams, Behaviour of Beams in Bending, Design of Laterally Supported and Unsupported Beams, Design of Compound Beams, Shear Strength of Beams, Maximum Deflection, Web Buckling and Web Crippling, Biaxial Bending and Unsymmetrical Bending.

UNIT - V

Design of Roof Trusses (Limit state method): Types of Trusses, End Bearings, Spacing of Trusses and Purl ins, Estimation of Loads with different Roof Coverings, Self-weight of Truss, Wind Effects, Design of Purlins for Dead Load, Imposed Load and Wind Loads. Detailed Design of Roof Trusses including Joints and Supports (only Angular Trusses).

References:

1. Subramanian. N, *Design of Steel Structures*, Oxford University Press, 2008.
2. Duggal S.K., *Design of Steel Structures*, Tata McGraw Hill Publishing, 2009.
3. Shiyekar M.R., *Limit State Design in Structural Steel*, PHI Learning Pvt. Ltd., 2010.
4. Bhavikatti, S.S., "*Design of Steel Structures*", I.K. International Publishing House Pvt. Ltd. 2010.

PC 504 CE

SOIL MECHANICS

Instruction	*: 3 periods per week*
Duration of Semester End Examination	*: 3 hours*
CIE	*: 30 marks*
EE	*: 70 marks*
Credits	*: 3*

Objectives:

- Introduction of Particulate Mechanics further to the solid and fluid mechanics
- Characterization and classification of soils based on laboratory and field experiments
- Understand Seepage, Strength and Compressibility characteristics of soils and learn the analysis of applications involving them

Outcomes:

- Competence in understanding the soil and the mechanisms associated with it.
- Ability to analyze the systems involving soil mechanics
- Competence for application of principles of soil mechanics in Foundation Engineering to be learned in the next semester.

UNIT - I

Origin & Classification of Soils: Soil as a pseudo-elastic three phase particulate medium Physical Properties of soil: Weight ratios (Water content, Density, Unit weights, Specific Gravity); Volume ratios (void ratio, porosity, degree of saturation, relative density); Interrelationships, Laboratory tests for determination of Index properties. Classification and Identification of soils for general and engineering purposes as per IS: 1498-1970.

UNIT - II

Soil moisture states: Held and Free moisture

Capillarity in Soils: Surface tension and capillary rise in soil, Capillary tension, Capillary pressure. pF value.

Permeability of Soils: Darcy's law for flow through soils - validity of Darcy's Law - Factors affecting permeability - Laboratory tests for determination of co-efficient of permeability (constant head, variable head permeability tests) - Field tests (Pumping in and pumping out tests) - Equivalent permeability of stratified soils.

Seepage in Soils: Seepage flow, seepage pressure - Flow nets - Locating phreatic line in a homogeneous earthen dam using Kogeny's parabola - Computation of seepage quantity.

Stress in Soils: Total, effective and neutral stress distribution in different ground conditions

Quick Sand phenomena: Critical Hydraulic gradient, Remedial measures.

UNIT - III

Compaction Process: Compaction Mechanism; factors affecting compaction. Laboratory determination of compaction characteristics - standard and modified Proctor tests - IS Light and Heavy compaction tests; Field surface compaction: compaction equipment, procedure, quality control.

Consolidation Process: Spring analogy - Void ratio and effective stress (e Vs log p) relationship - Terazaghi's theory of one dimensional consolidation - Assumptions and derivation of GDE - Computation of magnitude of settlement (using C_c, m_v) and rate of settlement (c_v , Tv, d).

UNIT - IV

Shear Strength: Significance of Shear strength in soils - Mohr - Coulomb equation - shear parameters - Laboratory tests for determination of shear strength - Direct shear test, Tri-axial compression test, Un-confined compression test, Vane shear test, Factors affecting shear strength of cohesion-less and cohesive soils.

UNIT - V

Earth Pressure: States of earth pressure - Active, passive, at rest condition; Rankine's theory: computation of active and passive earth pressure in c-less and cohesive soils; Coulomb's Wedge theory: Rehbhan's graphical solution: stability of earth retaining gravity wall.

Slope stability: Definition and classification of slopes -types of slope failure - Factors of safety with respect to cohesion., angle of shearing resistance, Height - Analysis of stability of slope using Swedish slip circle method and Taylor's stability number.

Suggested Reading:

1. Lambe, T.W. and Whitman, R.V., "*Soil Mechanics*", John Wiley & Sons Inc., NY, 1969.
2. Coduto, "*Geotechnical Engineering",* Mc Graw Hill Publications
3. Venkataramaiah, C., "*Geotechnical Engineering",* New Age Publishers, 2006.
4. Murthy, V.N.S., "*Soil Mechanics and Foundation Engineering*". Dhanpat Rai & Sons, 2006.
5. Arora, K.R., "*Soil Mechanics and Foundation Engineering*", Standard Publishers Distributors, revised and enlarged sixth edition, 2007.
6. Relevant IS Codes.

CONCRETE TECHNOLOGY

Instruction	*: 3 periods per week*
Duration of Semester End Examination	*: 3 hours*
CIE	*: 30 marks*
SEE	*: 70 marks*
Credits	*: 3*

Objectives:

- Understand the characteristics and behavior of the concrete
- Describe design aspects of mix design with of different methods
- Impart knowledge regarding the different types of special concretes

Outcomes:

- Functional role of ingredients in production of high quality concrete
- Explain the properties of fresh and hardened properties of concrete
- Design concrete mixes and apply statistical quality control techniques to prepare quality concrete

UNIT - I

Constituents of Concrete:

Cement: Types of cements and their composition- manufacture of portland cement - hydration of cement and hydration product, Structure of hydrated cement- heat of hydration, Gel theories, tests on properties of cements.

Aggregate: Classification of aggregates, particle shape and texture, bond strength of aggregates and its influence on strength of concrete, porosity, absorption and moisture content and their int1uence, soundness of aggregate, alkali aggregate reaction, sieve analysis and grading of aggregate, tests on properties of aggregates.

Properties of Fresh Concrete: Mixing and hatching, workability, factors effecting workability, various test procedures, segregation and bleeding, vibration of concrete, types of vibrators and their influence on composition, analysis of fresh concrete.

UNIT-II

Properties of Hardened Concrete: Strength of concrete, water cement ratio, Gel space ratio, effective water in the mix, short term and long term properties of concrete, test and procedure, influence of various parameters on strength of concrete, relationship between various mechanical strengths of concrete, curing of concrete,

maturity concept, influence of temperature on strength of concrete, stress-strain curves for concrete, durability of concrete.

Strength of Concrete - Shrinkage and temperature effects - creep of concrete - permeability of concrete - durability of concrete - Corrosion - Causes and effects - remedial measures- Thermal properties of concrete - Micro cracking of concrete.

UNIT-III

Mix Design of Concrete: A basic consideration, process of mix design, factors influencing mix proportions-mix design by ACI method and IS code method, design of high strength concrete, quality control, various methods of mix design, IS code method, British and ACI methods.

UNIT-IV

Admixtures used in Concrete: Classification of admixtures. Chemical and mineral admixtures. Influence of various admixtures on properties of concrete. Admixtures used in preparation of self compacting concrete. Applications, concept of ready mix concrete, fly ash concrete-properties and proportion of fly ash, applications, silica fume, rice husk ash concrete.

UNIT - V

Special Concrete: High strength concrete, ferrocement mass concrete, light weight concrete, high density concrete, poly-polymer modified concrete, pre-stressed concrete, self-consolidating concrete, cellular concrete, nano concrete, recycled aggregate concrete, geo polymer concrete, their specialties and applications, Fibre reinforced concrete: Need for fibre reinforced concrete (FRC), Mechanism of FRC, types of Fibres, Fibre shotcrete.

Suggested Reading :

1. Mehta, P. K. and Paulo, J. M. M. "*Concrete Microstructure-properties and Material*." McGraw- Hill Publishers,1997.
2. Neville, A.M. and Brooks, J.J. "*Concrete Technology*" Pearson Education Ltd., India,
   Neww Delhi,2003.
3. Shetty, M.S. "*Concrete Technology, Theory & Practice*." S.Chand and Co. Pvt., Ltd,2004.
4. Krishna Raju, N. "*Design of concrete mix*." CBS Publishers,1985.
5. Gambhir, M.L. "*Concrete Technology*." Tata McGraw Hill, 2004.
6. Santha Kumar, A. R. (2007). "*Concrete Technology*." Oxford University press, New Delhi.
7. Remedios, A. P. (2008). "*Concrete Mix Design hand book*." Himalya Publishing House, Hyderabad.

PC 506 CE

WATER RESOURCES ENGINEERING – I

Instruction	*: 3 periods per week*
Duration of Semester End Examination	*: 3 hours*
CIE	*: 30 marks*
SEE	*: 70 marks*
Credits	*: 3*

Objectives:

- Creating an awareness about water rights and water quality management principles
- Description regarding planning and design aspects of different types of water storage and regulatory systems
- Imparting knowledge regarding the fixation of different levels of reservoirs

Outcomes:

- Awareness about water rights and water quality management principles
- Application of principles of planning and design to different types of water retention and regulatory systems
- Knowledge regarding the fixation of different levels of reservoirs

UNIT - I

Water Resources Projects: Single and multipurpose projects, general principles of irrigation water rates, components of water allocation systems, riparian rights, groundwater rights, environmental and water quality management aspects of reservoir system operations. Storage works: Purpose, selection of site, zones of storage, computation of storage capacity, fixation of different levels of reservoirs (L WL, FRL, MWL), evaporation reduction techniques.

UNIT - II

Dams: Classification of dams, selection of site for a dam, physical factors governing the selection of types of a dam.

Gravity dams : Forces acting on a gravity dam, modes of failure and criteria for structural stability of gravity dams, principal and shear stresses, gravity method of stability analysis, elementary and practical profiles of a gravity dam, high and low gravity dams, functions, and types of galleries in gravity dams, foundation treatment for gravity dams.

UNIT - III

Earth dams: Types of earth dams, causes of failure of earth dams, criteria for the safe design of an earth dam, computation of seepage from flow net, phreatic line in an earth dam (for homogeneous sections with and without filter cases), design of earth dams to suit available materials, embankment and foundation seepage control measures.

UNIT - IV

Tank irrigation: Types, site selection, causes for the failure of tank weirs, design of tank weirs, and general specifications for the construction of tank weirs.

Spillways: Different types of spillways, energy dissipation below spillways, different types of spillway crest gates, stilling basin appurtenances (descriptive details only).

UNIT - V

Energy Dissipators: Design of different types (1-7) of energy dissipation arrangements as per USBR guidelines

Suggested Reading :

1. Wurbs, R A. and James, W.P., *'Water Resources Engineering'*, Prentice-Hall of India, New Delhi, 2002.
2. U.S. Bureau of Reclamation, *'Design manual for concrete gravity dams'*, Denver, 1976
3. U. S. Army Corps of Engineers, *'Engineering and Design'*, CECW-ED Publication, 1995
4. Punmia B.C. and Pande Lal B.B., *'Irrigation and Water Power Engineering'*, Lakshmi Publishers, New Delhi,1993.
5. Garg S.K., *'Irrigation Engineering and Hydraulic Structures'*, Standard Book House, New Delhi, 2010

CM 355 UE *With effect from the Academic Year 2017 – 2018*

MANAGERIAL ECONOMICS AND ACCOUNTANCY

Instruction	*4 Periods per week*
Duration of University Examination	*3 Hours*
University Examination	*75 Marks*
Sessional	*25 Marks*
Credits	*4*

Objectives:

- To learn important concepts of Managerial Economics and apply them to evaluate business decisions.
- To understand various parameters that determine the consumers' behavior.
- To evaluate the factors that affect production.
- To understand the concepts of capital budgeting and payback period.
- To study the concepts of various book-keeping methods.

Unit-I

Meaning and Nature of Managerial Economics: Managerial Economics and its usefulness to Engineers, Fundamental Concepts of Managerial Economics-Scarcity, Marginalism, Equimarginalism, Opportunity costs, Discounting, Time Perspective, Risk and Uncertainty, Profits, Case study method.

Unit-II

Consumer Behavior: Law of Demand, Determinants, Types of Demand; Elasticity of Demand (Price, Income and Cross-Elasticity); Demand Forecasting, Law of Supply and Concept of Equilibrium. (Theory questions and small numerical problem can be asked)

Unit - III

Theory of Production and Markets: Production Function, Law of Variable Proportion, ISO quants, Economics of Scale, Cost of Production (Types and their measurement), Concept of Opportunity Cost, Concept of Revenue, Cost-Output relationship, Break-Even Analysis, Price - Output determination under Perfect Competition and Monopoly (theory and problems can be asked)

Unit-IV

Capital Management: Significance, determination and estimation of fixed and working capital requirements, sources of capital, Introduction to capital budgeting, methods of payback and discounted cash flow methods with problems. (Theory questions and numerical problems on estimating working capital requirements and evaluation of capital budgeting opportunities can be asked)

Unit-V

Book-keeping: Principles and significance of double entry book keeping, Journal, Subsidiary books, Ledger accounts, Trial Balance, concept and preparation of Final Accounts with simple adjustments, Analysis and interpretation of Financial Statements through Ratios.

(Theory questions and numerical problems on preparation of final accounts, cash book, petty cash book, bank reconciliation statement, calculation of some ratios)

Suggested Reading:

1. Mehta P.L., *Managerial Economics* —Analysis, Problems and Cases , Sulthan Chand & Sons Educational Publishers, 2011
2. Maheswari S.N., *Introduction to Accountancy* , Vikas Publishing House, 2005
3. Pandey I.M., *Financial Management* , Vikas Publishing House, 2009

PC 551 CE

FLUID MACHANICS-II - LABORATORY

Instruction	*: 3 periods per week*
Duration of Semester End Examination	*: 3 hours*
CIE	*: 30 marks*
SEE	*: 70 marks*
Credits	*: 3*

Objectives:

- Practical applications of open and curved channels
- Application of force concepts on jets and hydraulic machines
- Determination of characteristic curves of turbines and pumps

Outcomes

- Competence in understanding floe phenomenon in open channels
- Ability to analyze the force acting due to jets concept and it's application in hydraulic machines.
- Competence in working principles of hydraulic pumps and turbines

1. Determination of roughness coefficient in an open channel
2. Determination of a vane coefficient
3. Study of universal characteristic curves of a Pelton wheel
4. Study of universal characteristic curves of a Francis turbine
5. Determination of super elevation in an open channel
6. Determination of basic characteristics of a hydraulic jump
7. Verification of Froude's Model law in an open channel
8. Determination of critical slope of an open channel
9. Study of main characteristic curves of a Centrifugal pump
10. Study of universal characteristic curves of a Kaplan turbine

Suggested Reading :

1. S. K. Som, and Biswas, G, *'Fluid Mechanics and Fluid Machines'*, Tata McGraw-Hill Publishing Co., New Delhi, 1998

2. Yuan, S. W., *'Foundation of Fluid Mechanics'*, Prentice-Hall India Pvt. Ltd., New Delhi, 1976
3. C.S.P. Ojha, R.Berndtsson, P.N. Chandramouli, *'Fluid Mechanics and Machinery'*,
   Oxford University Press, New Delhi, 2010
4. A.K.Mohanty, *'Fluid Mechanics'*, Prentice-Hall India Pvt. Ltd., New Delhi,1994
5. P.N. Modi, '*Hydraulics and Fluid Mechanics Including Hydraulics Machines'*, 2013
   Standard Book House, New Delhi

PC 552 CE

CONCRETE LABORATORY

Instruction	*: 2 periods per week*
Duration of Semester End Examination	*: 3 hours*
CIE	*: 25 marks*
SEE	*: 50 marks*
Credits	*:1*

Course Objectives:

- Determine behavior of materials through physical tests.
- Infer suitability of materials in construction.
- Able to prepare concrete as per the standards

Course Outcomes:

- Exposure to a variety of established material testing techniques.
- Design and prepare concrete mix using Indian Standard method
- Knowledge in Non destructive tests on concrete

1. (a) Determination of Specific gravity of cement
   (b) Determination of unit weight /bulk density of cement

2. Determination of normal consistency of cement

3. (a) Determination of initial setting time of cement
   (b) Determination of final setting time of cement

4. (a) Preparation of mortar cubes for compressive strength
   (b) Tests on mortar cubes for compressive strength

5. Fineness of cement by sieving and by air permeability method

6. (a) Determination of specific gravity of fine aggregate
   (b) Determination of bulk density of fine aggregate

7. (a) Determination of specific gravity of coarse aggregate
   (b) Determination of bulk density of coarse aggregate

8. Tests on bulking of sand
   (a) Laboratory method (b) Field method

9. Determination of fineness modulus of fine aggregate

10. Determination of fineness modulus of coarse aggregate

11. Tests on workability of concrete
    (a) Slump (b) Compaction factor

12. Tests on hardened concrete
    (a) Compressive strength (b) Flexural strength

13. Non-destructive testing of concrete structures demonstration of rebound hammer, UPV System, profometer corrosion meter and IR camera.

Suggested Reading

1. Mehta, P. K. and Paulo, J. M. M. "*Concrete Microstructure-properties and Material*." McGraw- Hill Publishers,1997.
2. Neville, A.M. and Brooks, J.J. "*Concrete Technology*" Pearson Education Ltd., India, Neww Delhi,2003.
3. Shetty, M.S. "*Concrete Technology, Theory & Practice*." S.Chand and Co. Pvt., Ltd,2004.
4. Krishna Raju, N. "*Design of concrete mix*." CBS Publishers,1985.
5. Gambhir, M.L. "*Concrete Technology*." Tata McGraw Hill, 2004.
6. Santha Kumar, A. R. (2007). "*Concrete Technology*." Oxford University press, New Delhi.
7. Remedios, A. P. (2008). "*Concrete Mix Design hand book*." Himalya Publishing House, Hyderabad.

PC 553 CE

SOIL MECHANICS LABORATORY

Instruction	*: 2 periods per week*
Duration of Semester End Examination	*: 3 hours*
CIE	*: 25 marks*
SEE	*: 50 marks*
Credits	*:1*

Objectives:

- Expose the students to different types of soils
- Experience the concepts of soil mass, soil solids, and soil structure.
- Understand the laboratory test procedures and appreciate the suitability of each test.
- Make the students to relate theoretical concepts in doing lab tests.

Outcomes:

- Competence in performing the laboratory experiments on soil specimen, analyse the results, interpret and validate the same
- Greater insight in to the soil behavior and hence enhanced understanding of soil mechanics
- Ability to model a field application in the laboratory to take up research

DETERMINATION OF INDEX PROPERTIES:

Determination of Specific Gravity of soil solids using "Density bottle" method
Determination of Specific Gravity of Soil Solids using "Pycnometer" method
Determination of water content using "Pycnometer" method
Determination of Liquid limit using Casgrande's standard LL device
Determination of Liquid limit using Cone Penetration apparatus
Determination of Plastic limit
Sieve Analysis for plotting Particle size distribution curve.
Determination of Field Density using Sand Replacement Method

DETERMINA TION OF ENGINEERING PROPERTIES:

Determination of Compaction Characteristics
Determination of Co-efficient of Permeability by "Constant Head Permeameter test"
Determination of Co-efficient of Permeability by "Variable Head Permeameter test"
Determination of shear strength, parameters by "Direct Shear Test"
Determination of shear strength Cohesive soils by "Unconfined Compression Test"
Determination of shear strength by conducting "Vane Shear Test"

DEMONSTRATION OF TEST PROCEDURE:

Consolidometer test
Tri-axial compression Test
Laboratory Plate Load Test
Reverse Osmosis Test
Quick Sand Model
Cyclic Tri-axial Test Facility

Suggested Reading :

1. IS:2720 – Relevant Parts.
2. Lambe, T.W., "*Soil Testing for Engineers*", Wiley Eastern Ltd., New Delhi, 1969.

SCHEME OF INSTRUCTION FOR B.E. (CIVIL ENGG) -VI SEMESTER

S.No.	Course Code	Course Title	Scheme of Instruction			Contact hr/week	Scheme of Examination		Credits
			L	T	P		CIE	SEE	
1	PC 601CE	Theory of Structures-II	3	1	-	4	30	70	3
2	PC 602CE	Foundation Engg	3		-	3	30	70	3
3	PC 603CE	Environmental Engg	3	-	-	3	30	70	3
4	PC 604CE	Water Resources Engg-II	3	1	-	4	30	70	3
5	PC 605CE	Transportation Engg-I	3	-	-	3	30	70	3
6		Professional Elective-I	3	-	-	3	30	70	3
7	PC 606CE	Pre-Stressed Concrete	3	-	-	3	30	70	3
8		Open Elective-I	3	-	-	3	30	70	3
8	PC 651CE	Environmental Engg lab	-	-	2	2	25	50	1
9	PC 652CE	Transportation Engg Lab	-	-	2	2	25	50	1
10	PW661CE	Survey Camp						50	2
11		Summer Internship							
			24	**02**	**04**	**30**	**290**	**710**	**28**

PROFESSIONAL ELECTIVE-I			**OPEN ELECTIVE-I**		
1	PE 601CE	Structural Dynamics	1	OE 601BM	Micro Electro Mechanical Systems (MEMS)
2	PE 602CE	Hydro Power Engineering	2	OE 602CE	Disaster Management
3	PE 603CE	Infrastructure Development	3	OE 603CE	Geo-spatial Techniques
4	PE 604CE	Soft Computing Techniques in Civil Engg	4	OE 664CS	Operating Systems
			5	OE 665CS	OOPS with JAVA
			6	OE 601EC	Embedded Systems
			7	OE 602EC	Digital System design using Verilog HDL
			8	OE 601EE	Reliability Engineering
			9	OE 601ME	Industrial Robotics
			10	OE 602ME	Material Handling
			11	OE 601LA	Intellectual Property Rights

VI – SEMESTER

DETAILED SYLLABUS

PC 601 CE

THEORY OF STRUCTURES - II

Instruction	*: 3L+1T periods per week*
Duration of Semester End Examination	*: 3 hours*
CIE	*: 30 marks*
SEE	*: 70 marks*
Credits	*: 3*

Objectives:

- Understand the analysis of structural elements subjected to moving loads & the analysis of road/railway bridges and gantry girders.
- Explain the concepts involved in the analysis of suspension cable bridges.
- Illustrate the matrix methods of structural analysis for computer applications.
- Awareness about the software package **Staad-Pro.**

Outcomes:

- Sketch ILD for bending moment and shear force, for determinate girders for different position of loading system and for different sections of girder
- Analyse cable suspension bridges along with three hinged stiffening girder for static loads.
- Calculate the bending moment and shear force and sketch the BMD and SFD for redundant members using force and displacement methods
- Analyse the redundant beams and frames by using software packages

UNIT - I

Moving loads: Influence line for support reaction, bending moment and shear force at any location for simple beams. Determination of maximum bending moment and shear force for moving load systems on simply supported girders.

Curves of maximum bending moment and shear force: for simply supported girders traversed by (l) single point load, (2) two point loads, (3) uniformly distributed-load longer/shorter than span, enveloping parabola and EUDLL.

UNIT - II

Moving loads on trusses / **girders:** Influence lines for forces in members of statically determinate plane framed structures under moving loads for Warren girder, Pratt truss, and Curved flange truss.

Suspension bridges: Stresses in suspended loaded cables, length of cable, simple suspension bridge with 3-hinged stiffening girders for static load, Influence lines for horizontal and vertical components of tension in the cable, tension in the cable, bending moment and shear force.

UNIT - III

Flexibility Matrix Method: Determination of Static and kinematic indeterminacy – Equilibrium and compatibility conditions-Principles of superposition, Application of Flexibility Matrix Method to continuous beams, plane trusses, plane frames and ortho grid structures (Static indeterminacy not exceeding three) - Effect of temperature, Lack of fit and Pre-stressing forces

UNIT - IV

Stiffness Matrix Method: Application of Stiffness Matrix Method to continuous beams, plane trusses, plane frames and ortho grid structures (Degree of freedom not exceeding three). Construction of stiffness matrix for frames - Direct Method.

UNIT - V

Direct Element Method: Development of stiffness matrices for bar, truss and beam elements.

Application of direct element method to problems of axially loaded bars, continuous beams, plane trusses and plane frames to obtain joint displacements and member end forces. Developing shear force and bending moment diagrams. Introduction to software package STAAD Pro.

Suggested Reading:

1. S.B. Junarkar and Shah*, "Mechanics of structures"*, Charotar Pub, House, 2001
2. D.S. Prakash Rao, "*Structural Analysis - a Unified Approach"*, University Press, 1991
3. B.C. Punmia and A.K. Jain, "*Theory of structures"*, Laxmi Publications, New Delhi, 2004.
4. Pandit, G .S., S. P. Gupta*, "Theory of Structures," Vol. I* , Tata McGraw Hill, New Delhi, 1999.
5. J. M. Gere & William Weaver, "*Matrix Analysis of Framed Structures"*, 2nd Ed., D Van Nostand, New Jersey, 1980.

PC 602 CE

FOUNDATION ENGINEERING

Instruction	*: 3 periods per week*
Duration of Semester End Examination	*: 3 hours*
CIE	*: 30 marks*
SEE	*: 70 marks*
Credits	*: 3*

Objectives

- Learn the definition, necessity, types and suitability of different foundation systems.
- Understand the procedures of Geotechnical design of foundations
- Understand the necessity and usage of different foundation construction related aspects
- Learn about different methods of geotechnical investigations and its role in selection and design of foundations

Outcomes:

- Enable application of soil mechanics principles learned in previous semester to the practice of foundation engineering
- Competence to plan and perform Geotechnical Investigations to characterize the ground
- Competence to decide the type and perform the Geotechnical design of foundation
- Ability to practice Foundation Engineering

UNIT - I

Stress distribution in Soils: Boussinesq's theory – Computation of increment in vertical stress due to application of a point load (its distribution on horizontal, vertical planes), uniformly distributed circular and rectangular areas –Pressure bulb – Significant depth - Construction and use of Newmark's chart – Westergaard's theory – Validity of elastic theories – Contact pressure distribution.

UNIT - II

Introduction to Foundations: Functional requirements – types – differentiation of shallow and deep foundations – suitability

Safe Bearing Capacity of Shallow foundations: Definitions - (a) Based on theories –Types of shear failures - Terazaghi's theory for safe bearing capacity of shallow foundations – Effect of type of shear failure / shape of the footing / water table – Provisions of IS : 6403-1981 (b) Based on field tests : Plate load test / Standard Penetration test

Allowable bearing Capacity of Shallow foundations: Settlement Analysis – Total settlement – Elastic settlement – Consolidation settlement (ultimate & after any given period – correction for construction period) – Permissible uniform & differential settlements – Proportioning of footings.

UNIT - III

Pile Foundations: Necessity – types based on load transfer mechanism / material / method of installation / functional use – Estimation of vertical load carrying capacity of a single pile – static formulae / Dynamic formulae / Pile load tests – Cyclic pile load test for separation of total capacity in to bearing and friction components – Pile groups – necessity – efficiency of Pile groups - estimation of group capacity – Negative Skin friction – Concept of Piled raft foundation.

UNIT – IV

Caissons: Necessity – types – Essential components of open (well) / box (floating) / Pneumatic caissons - suitability – Sinking of caissons – correction for tilt & shift.

Machine foundations: differentiation with static foundations – vibration characteristics (frequency / amplitude/ resonance) – types of machines and machine foundations – additional design requirements

Geotechnical Investigations: Necessity – Principles of exploration - objectives – Soil profile – collection of disturbed & undisturbed soil samples – samplers & quality of samples - methods – Trial pit / Bore hole method – Log of bore hole details

UNIT – V

Foundation construction related aspects :

Timbered / braced excavations: Necessity - methods – suitability – distribution of pressure – reaction of struts.

Dewatering: Necessity – methods – sumps (ditches) / well point system (single /multi-stage) / deep well system / elector-osmonsis method – merits & demerits – suitability

Coffer dams: necessity – types – suitability

Underpinning: Necessity – methods (pin / pile) - suitability

Geosynthetics: Classification – functions – applications.

Suggested Reading :

1. Bowles, E. (2012). "*Foundation analysis and Design*", McGraw-Hill Publications.
2. Das, B.M. (2012). "*Principles of Foundation Engineering*", Sengrece Publications.
3. Arora, K.R. (2012). "*Soil Mechanics & Foundation Engineering*" Standard Publications.
4. Verghese, P.C. (2012). "*Foundation Engineering*", PHI Publications.

PC 603 CE

ENVIRONMENTAL ENGINEERING

Instruction	*: 3 periods per week*
Duration of Semester End Examination	*: 3 hours*
CIE	*: 30 marks*
SEE	*: 70 marks*
Credits	*: 3*

Objectives:

- Fill the gap between general introductory environmental science and the more advanced environmental engineering
- Explain the different sequential unit operations of water and wastewater treatment processes
- Provide necessary engineering principles for analyzing the environmental issues
- Motivate the present and future generations to take suitable care of sustainability of all existing resources

Outcomes:

- Students will understand the impact of engineering solutions in a global, economic, environmental, and societal context.
- Students will have an ability to design environmental engineering systems that include considerations such as risk, uncertainty, sustainability and environmental impacts.
- Students will have the ability to speak before a group, effectively convey information to technical and non-technical audiences.

UNIT - I

Water supply: Objectives of protected water supplies, rate of demand, population forecasts, surface and ground water sources of water, analysis of water, Classification, description, and design of Coagulation, flocculation, and sedimentation processes.

UNIT - II

Classification, description, and design of filtration, disinfection, and softening processes, Methods of layout of distribution pipes, Design of distribution by Hardy Cross method for simple net works.

Municipal Solid Wastes: Characteristics, generation, collection and transportation of solid wastes, engineered systems for solid waste management (reuse/recycle, energy recovery, treatment and disposal)

UNIT - III

Wastewater engineering: Definitions, system of sewerage, shapes of sewers, hydraulic formulae for design of sewers, sewer appurtenances, traps, B.O;D. and C.O.D., self purification of stream methods of disposal of sewage.

UNIT - IV

Treatment of Sewage: Principles and l design of screens. grit chambers. detritus tanks. sedimentation tanks. Contact beds. Trickling filters. and activated sludge process. Methods of sludge disposal. sludge digestion tanks. Principles and design of septic tanks

UNIT - V

Air Pollution: Types of pollutants. their sources and impacts air pollution meteorology and control. air quality standards and limits.

Noise Pollution: Impacts of noise. permissible limits of noise pollution.Measurement of noise. and control of noise pollution.

Suggested Reading :

1. Fair. G. M. and Geyer. J. C. *'Water and Wastewater Engineering'*, vol. I and II. John Wiley & ,Sons Inc., New York
2. White. J.B .. *'Wastewater Engineering'*, Edward Arnold. London, 1978
3. Hammer. M. J. and Hammer. M. J. Jr., *'Water and Wastewater Technology'*, Prentice-Hall of India Pvt. Ltd., New Delhi, 1998
4. Metcalf & Eddy. *'Wastewater Engg; treatment, disposal reuse'*, Tata McGraw-Hill Publishing Company Limited, New Delhi,1995
5. Sasi Kumar, K. and Sanoop Gopi Krishna., *'Solid waste Management'*, Prentice-Hall of India Pvt. Ltd., New Delhi, 2009
6. Gilbert, M. Masters , *'Introduction to Environmental Engineering and Science'*, Prentice-Hall of India Pvt. Ltd., New Delhi, 1995

PC 604 CE

WATER RESOURCES ENGINEERING –II

Instruction	*: 3+1 periods per wee*
Duration of Semester End Examination	*: 3 hours*
CIE	*: 30 marks*
SEE	*: 70 marks*
Credits	*: 3*

Objectives:

- Introduction to different concepts of canal design
- Description of design aspects of different types of weirs and regulatory systems
- Imparting knowledge regarding the different types of cross drainage structures

Outcomes:

- Assimilation of the various concepts of canal design
- Application of design aspects of different types of weirs and regulatory systems
- Knowledge regarding the different types of cross drainage structures

UNIT - I

Canals: Alignment, classification of alluvium canals and their functions, Regime concept of Kennedy's and Lacey's theories, design of canals based on Kennedy's and Lacey's method, use of Garrett's diagrams for the design of canals, lining of canals, methods of lining and design of lined canals.

UNIT – II

Weirs: Components of diversion head works, types of weirs – fixation of still level of head sluice, scouring sluice and crest level of weir, afflux and top level of flood banks, design of a head regulator, design of vertical drop and sloping glacis weir, design for surface flow and sub - surface flow, length, level and thickness of downstream apron, upstream and downstream cutoffs, protection works.

UNIT - III

Seepage Forces: Causes of failure of structures on permeable foundations, piping, rupture of floor, undermining, remedial measures, computation of uplift forces by Bligh’s theory, Khoshla’s theory, analytical method, and significance of exit gradient.

UNIT - IV

Canal Falls: Definition, location, types of falls, design of trapezoidal notch fall, cylinder fall, vertical drop fall, and glacis fall.

Regulators and Modules: Head regulator and cross regulators, canal escapes, canal outlets and modules-proportionality, sensibility and flexibility.

UNIT – V

Cross Drainage Works: Definition, classification, design of aqueducts, syphon aqueducts, super passages, and canal syphons, inlets and outlets-selection of cross drainage works.

Suggested Reading:

1. Punmia, B.C., Pande B. and Lal, B., *'Irrigation and Water Power Engineering'*, Standard Book House, New Delhi, 1991
2. Garg,S.K., *'Irrigation and Hydraulic Structures'*, Khanna Publishers, New Delhi,1993.
3. Modi P.N., *'Irrigation and Water Resources and Water Power Engineering'*, Standard Book House, New Delhi, 1983
4. S. K. Sharma "*Irrigation Engineering & Hydraulic Structures*" S. Chand Publishers, New Delhi 2016

PC 605 CE

TRANSPORTATION ENGINEERING-I

Instruction	*: 3 periods per week*
Duration of Semester End Examination	*: 3 hours*
CIE	*: 30 marks*
SEE	*: 70 marks*
Credits	*: 3*

Objectives:

- Awareness about transportation engineering
- Emphasize the significance of geometric design of highways with specifications and standards
- Create the awareness of airport engineering basic things and railway engineering
- Impart knowledge on pavement engineering traffic engineering, railway engineering and airport engineering.

Outcomes:

- Assimilation of the various concepts of highway geometric design
- Application of concepts related to basic traffic engineering
- Knowledge regarding the different types of thickness design of rigid and flexible pavements
- Understand element of permanent way and application of principles of geometric design railway track
- Understand basic element of airport engineering and application of basic design concepts of runway alignment

UNIT - I

Highway Alignment and Geometric Design: History of highway engineering, factors to be considered for highway alignment, engineering surveys, obligatory points. Geometric design - Highways classification as per IRC and its standard dimensions, carriageway, shoulders, medians, right of way, footpaths, cycle tracks, service roads, frontage roads, sight distance stopping sight distance, overtaking sight distance. Chamber, horizontal curves, super - elevation, transition curve, extra widening, gradient, grade compensation and design of vertical curves.

UNIT - II

Traffic Engineering: Objectives of traffic studies, traffic characteristics, volume, speed, density, headways and relationship among them. Traffic volume studies, speed and delay studies, intersection delay studies, highway capacity and level of service concept as per HCM 2000, origin and destination studies, intersection improvement

studies at grade, need of grade separated intersection, channelization, rotary planning and design, concept of signal design, parking and accident studies.

UNIT – III

Highway Materials: Introduction.

Pavement Design: Pavement types, factors to be considered for pavement design, structural difference between flexible and rigid pavement design., Flexible pavement design - concept of layer theory, design wheel load, ESWL, EALF, vehicle damage factor, design by CBR developed by US corps of engineers, IRC cumulative standard axles method (IRC - 37: 2002). Rigid design Pavement concept, by analysis stress load wheel westergaard. Modulus of sub grade reaction and other characteristics of concrete, radius of relative stiffness, longitudinal and transverse joints. Load and temperature stress-critical wheel, dowel bars and tie bars functions, construction joints, expansion joints, contraction joints.

Unit – IV

Railway Engineering: Introduction to Railways, permanent way component parts and its functions. Rails - various types, functions, creep in rails, creep measurement, coning of wheels and rail fixations, Sleepers - various types, merits and demerits, ballast, various types and sub grade preparation, Railway alignment and geometric design - alignment, super - elevation, negative super elevation, cant deficiency, example problems .. Points and crossing, layout of left and right hand turnouts. Construction and maintenance to permanent way.

UNIT – V

Airport Engineering: Introduction to air transportation, history and international organizations role in development of airports, air craft types and its characteristics. General lay-out of an airport and its component parts. Site selection of an airport as per ICAO, orientation of runway by wind rose diagrams, basic runway length determination, corrections to basic runway length, geometric design, types of airports as per landing & take-off and dimensions.

Suggested Reading:

l. S. K. Khanna, S. K. and C.E.G Justo, *Highway Engineering*, Nemchand & Bros, New Delhi. India, 1994
2. Highway Capacity Manual, Transportation Research Board, National Research Council; Washington, D.C., 2000.
3. R. Srinivasa Kumar, *Transportation Engineering (Railways, Airport, Docks& Harbour)*, Universities Press, 2014.
4. Chandra, S. and Agarwal, M.M. *Railway Engineering*, Oxford Higher Education", University Press New Delhi, 2007
5. Relevant IRC and IS codes

PC 606 CE

PRESTRESSED CONCRETE

Instruction	*: 3 periods per week*
Duration of Semester End Examination	*: 3 hours*
CIE	*: 30 marks*
SEE	*: 70 marks*
Credits	*: 3*

Objectives:

- Understand the basic concept of prestressed concrete and materials used
- Learn the analysis prestress and load balancing concept
- Study the flexural and shear design of prestressed concrete beam sections
- Know the concepts of deflections and end blocks of prestressed concrete sections

Outcomes:

- Apply the concept of prestressing and determine the losses of prestress
- Analyze the prestressed concrete beam and suggest the cable profile for beam
- Design the prestressed concrete beam for flexure and shear
- Analyze the prestressed continuous beam and determine the concordant cable profile
- Estimate the deflection of a prestressed concrete beam and design the end block

UNIT - I

Introduction to prestressed concrete: Historical development, principles of prestressed concrete. Definition, classification and systems of prestressing. Materials for prestressed concrete.

Loss of prestress: Losses of prestress in pre-tensioned and post-tensioned members.

UNIT - II

Analysis of prestress: Basic assumptions, analysis of prestress, resultant stress, pressure line, kern points, cable profiles, load balancing concept, stress diagrams for prestress, dead load and live load.

UNIT - III

Simply supported continuous beams: concordant cable profile, analysis of continuous prestressed concrete beams.

Design of sections: Flexural strength design of rectangular, I and T sections using IS code provisions.

UNIT - IV

Design for shear: Basic concept of shear design, shear failure, flexural shear failure, shear compression failure, shear tension failure, shear strength of beams (a) unfrocked in flexure and (b) cracked in flexure.

UNIT - V

Deflections: Necessity of deflection estimation, limitations of deflections. Deflections of pre- stressed concrete beams with uniformly distributed and point loads.
End Block: Types of end blocks and Importance of end block, Analysis and design of end block by Guyon method and IS method for not more than two cables.

Suggested Reading:

1. T.Y. Lin and N.H. Burns, *Design of prestressed concrete structure*, Jon Wildy and sons, 1982.
2. A.H. Nilson, *Design of prestressed concrete*, John Wiley and Sons, 1982.
3. N. Krishna Raju, *Design of prestressed concrete structure*, Tata McGraw Hill Book Co., 1996.
4. G.S. Pandit and S.P. Gupta, *Prestressed Concrete*, CBS Publishers, 1995.

PC 651 CE

ENVIRONMENTAL ENGINEERING LABORATORY

Instruction	*: 2 periods per week*
Duration of Semester End Examination	*: 2 hours*
CIE	*: 25marks*
SEE	*: 50 marks*
Credits	*: 1*

Objective:

- Characterization of water and wastewater to ensure security and well being of humanity
- Verify the suitability of certain water treatment processes

Outcome:

- Locate, compile and use environmental information
- Design and perform experiments to satisfy specific requirements
- Critically analyze for interpreting data and present results.

1. a) Determination of total dissolved solids
   b) Determination of total suspended solids
   c) Determination of fluorides
2. Determination of total hardness
3. Determination of alkalinity
4. Determination of chlorides
5. Determination of sulphates
6. Determination of MPN
7. Determination of residual chlorine
8. Determination of optimum alum dosage
9. Determination of BOD
10. Determination of COD

Suggested Reading :

1. Fair. G. M. and Geyer. J. C. *'Water and Wastewater Engineering'*, vol. I and II. John Wiley & ,Sons Inc., New York
2. White. J.B .. *'Wastewater Engineering'*, Edward Arnold. London, 1978

3. Hammer. M. J. and Hammer. M. J. Jr., *'Water and Wastewater Technology'*, Prentice-Hall of India Pvt. Ltd., New Delhi, 1998
4. Metcalf & Eddy. *'Wastewater Engg; treatment, disposal reuse'*, Tata McGraw-Hill Publishing Company Limited, New Delhi,1995
5. Sasi Kumar, K. and Sanoop Gopi Krishna., *'Solid waste Management'*, Prentice-Hall of India Pvt. Ltd., New Delhi, 2009
6. Gilbert, M. Masters , *'Introduction to Environmental Engineering and Science'*, Prentice-Hall of India Pvt. Ltd., New Delhi, 1995

PC 652 CE

TRANSPORTATION ENGINEERING LABORATORY

Instruction	*: 2 periods per week*
Duration of Semester End Examination	*: 2 hours*
CIE	*: 25marks*
SEE	*: 50 marks*
Credits	*: 1*

Objectives:

- Know the properties of various road materials
- Create the awareness about various traffic studies in the field
- Impart knowledge on mix design of bitumen and CBR test etc.,

Outcomes:

- Characterise the pavement materials.
- Perform quality control tests on pavement material and pavements.
- Conduct traffic studies for estimation of traffic flow characteristics.

A) Tests on bitumen

1. Penetration Test.
2. Ductility Test
3. Softening point test
4. Specific gravity test
5. Viscosity test
6. Flash and fire point test

B) Tests on road aggregate

7. Aggregate crushing value test
8. Los Angeles abrasion test
9. Aggregate impact value test
10. Aggregate shape test (flakiness & elongation)
11. Specific aggregate
12. Water Absorption
13. Soundness

C) Experiments on Traffic

14. Traffic Volume study (a) at mid section (b) at intersection
15. Spot speed stu.
16. Speed and delay study

17. Origin and Destination Study

D) Miscellaneous Tests (demonstration only)

18. Marshal stability test
19. Determination of C.B.R.
20. Preparation f representative sample by coning and quartering.
21. Benkelman beam test
22. Bitumen extraction test
23. Stripping value test
24. Stone polishing value test

Suggested Reading :

1. Relevant IS and IRC Codes of Practice.
2. Relevant ASTM and AASHTO Codes of Practice
3. Khanna, S. K. and Justo, C.E.G., Highway material Testing (laboratory manual). Nem Chand and Bros, Roorkee (2000).

PROFESSIONAL ELECTIVE COURSES

PE 601 CE

STRUCTURAL DYNAMICS

Instruction	*: 3 periods per week*
Duration of Semester End Examination	*: 3 hours*
CIE	*: 30 marks*
SEE	*: 70 marks*
Credits	*: 3*

Objectives:

- Elastic analysis of structures subjected to dynamic loads is introduced.
- To learn. response of Un-damped/Damped vibrations of SDOF systems
- The estimate response of Multi Degree Freedom Systems:
- The estimate response of Multi Degree Freedom Systems: by approximate methods
- To learn the concepts earthquake resistant design of RCC Structures.

Outcomes:

- Formulate the equation of motion for given conditions using different approaches
- Determine the response of single degree freedom system for free and forced vibrations
- Determine the mode shapes of multi degree freedom system by normalisation and other procedures
- Solve the response of multi degree freedom system by mathematical and approximate methods
- Determine the displacement of a structure due to earthquake load

UNIT - I

Objectives of dynamic analysis: Types of prescribed dynamic loading – Characteristics of a dynamic problem – Methods of dicretization: Lumped mass Procedure / Consistent mass procedure/generalized displacements – Single Degree Freedom Systems – Formulation of Equation of Motion: d'Alemberts's Principle / Method of Virtual Work / Hamilton's Principle – Influence of Gravity Forces and Ground Motion on equation of motion – Generalized SDOF systems: Rigid Body Assemblage/Distributed Flexibility.

UNIT - II

Response of Un-damped/Damped free vibrations of SDOF systems: Un-damped/Damped vibrations of SDOF systems subjected to Harmonic loading: Dynamic equilibrium /Accelero-Meters / Displacement Meters / Resonant Response / Vibration Isolation – Un-damped / Damped vibrations of SDOF systems subjected Periodic loading – Response of SDOF systems subjected Impulse loads: Half-sine pulse/Rectangular pulse/Triangular Pulse/ Shock spectra / Approximate method of impulse load analysis – Un-damped / Damped vibrations of SDOF systems subjected General dynamic loading / Duhamel Integral.

UNIT - III

Multi Degree Freedom Systems:

Formulation of Equations of Motion / Evaluation of Lumped Mass Matrix / Evaluation of Stiffness Matrix

Un-damped Free Vibrations: Analysis of frequency matrix and mode shape matrices using determinental equation/Flexibility Formulation/Orthogonality Conditions/ Normalizing Mode shapes/Analysis of Dynamic Response/Normal Coordinates/ Uncoupled Equations of Motion for un-damped systems/Conditions for damping orthogonality – Mode super position procedure for damped forced vibrations – Time History Analysis.

UNIT - IV

Practical Vibration Analysis: Stodola Method, Holtzer Method – Fundamental mode only, Reduction of degrees of freedom, basic concepts in matrix iteration.

Variation Formulation of Equations of Motion: Generalised coordinates, Lagrange's Equations of Motion, Application to simple un-damped problems of 2-DOF systems.

UNIT - V

Distributed Parameter Systems: Partial Differential Equation of Motion – Beam Flexure (Elementary case) – Undamped free vibrations (Elementary case) – Analysis of dynamic response – normal coordinates.

Earthquake Resistant Design: Brief exposure to relevant IS Codes of Practice, Method of construction of Response Spectra.

Suggested Reading :

1. Walter C. Hurty & Moshe F. Rubinstein, (1964)." *Dynamics of Structures*", Prentice Hall India.
2. Clough, Ray. W, and Penzien, Joseph (1982). "*Dynamics of Structures"*, McGraw Hill Company Limited, New Delhi.
3. Mario Paz, (1987). *"Structural Dynamics",* CBS Publishers.
4. Chopra, A. K, (1996*)." Dynamics of Structures",* Prentice Hall India

PE 602 CE

HYDRO POWER ENGINEERING

Instruction	*: 3 periods per week*
Duration of Semester End Examination	*: 3 hours*
CIE	*: 30 marks*
SEE	*: 70 marks*
Credits	*: 3*

Objectives:

An overview of hydro power development
Exposure to the principles involved in the design of surge tanks and penstocks
Description regarding the concepts of speed and pressure regulation

Outcomes:

Planning for hydro power development projects
Application of principles involved in the design of surge tanks and penstocks

UNIT – I

General: Comparison with other methods of power generation, Site investigation and location of water power plant, Study of stream flow data for power estimation - Pondage and storage, and load prediction.
Development of power: Different types of layout, component parts of waterpower schemes.

UNIT – II

Water Conductor System: Intake – Various types, Hydraulics of Intakes, gates and their operations.
Powerhouse: General arrangements and criteria for fixing power house dimensions, including mechanical & electrical equipment details.

UNIT – III

Pipe networks : Analysis by Hardy Cross Method, and Newton Raphson Method, Joining and laying of pipes and pipe specials (Cast Iron, Ductile Iron, Pre stressed Concrete, and HDPE).
Penstocks and Pressure Shafts: Classification, Hydraulic design, Economical diameter of Steel Penstocks

UNIT – IV

Hydraulic transients and Surge Tanks: Introduction, effect of rapid valve closure, unsteady compressible flow, surge protection, and method of characteristics to water hammer.

Water Hammer theory – Joukowsky's method, and Allieve's method.

UNIT – V

Anchor Blocks: Various types and design of simple anchor blocks, Design of simple surge tanks, and method of characteristics to the design of surge tanks.

Pressure Regulation: General features, auxiliary devices, automatic and remote control devices, governor improvement methods, performance characteristics and speed regulation of different turbines.

Suggested reading:

1. Modi, P.N., *'Irrigation Water Resources and Water Power Engineering'*, Standard Book House, New Delhi, 1988
2. Bhave, P.R., Gupta, R., *'Analysis of flow in water distribution networks'*, Narosa Publishing House, New Delhi,2006
3. Creager W. P., and Justin J.D., *'Hydroelectric Hand Book'*, John Wiley and Sons Inc., New York,1959
4. Barrows, H.K., *'Water Power Engineering'*, Tata McGraw-Hill Publishing Company, New Delhi,1980
5. EI-Wakil, M.M., *'Power Plant Technology'*, McGraw-Hill Book Company, New York, 1984

PE 603 CE

INFRASTRUCTRE DEVELOPMENT

Instruction	*: 3 periods per week*
Duration of Semester End Examination	*: 3 hours*
CIE	*: 30 marks*
SEE	*: 70 marks*
Credits	*: 3*

Objectives:

- Description of the design aspects of different types spillways
- Knowledge regarding the design of energy dissipation arrangements
- Awareness about urban storm drainage and concepts of dam safety

Outcomes:

- Assimilation of the various concepts in power development
- Understanding of the various transport systems for development
- Knowledge regarding the different types of infrastructure contract systems

UNIT - I

Introduction - Infrastructure management, concepts, definitions, importance of infrastructure, management in infrastructure, role of civil engineers, concept of management, need for management in infrastructure projects.

Power Sector - Generation, types of generation, infrastructure requirements for power generation, hydroelectric, thermal and nuclear energy, non-conventional energy, critical infrastructure requirements for the projects, maintenance issue in power generation, transmission, technology involved, tower foundations, distribution, transmission cables and poles, distribution boxes, demand scenario in India, issues of importance, infrastructure shortcomings, Government policies on electric power, case studies in power industry.

UNIT - II

Transport (People and Cargo)

Roads - Existing infrastructure in India, importance of the economy, National Highway Development Program (NHDP), road planning and construction, bridges, Government policies on road construction.

Rail - Overview of situation in India, elements of railway infrastructure, platform, rails, communication, infrastructure maintenance issues, Government policies.

Water Transport - Shipping industry overview, ship building infrastructure needs, basic components of port and harbor; infrastructure needs, machinery needs, and Government policies.
Air Transport **-** Overview, types of air cargo transport, basic components of an airport, infrastructure requirements, runway, airport security, communication towers, aircraft building, and issues of importance, Government policies, and cases in transportation industry.

UNIT - III
Communication - Telecommunication, overview of industry, wired and wireless services, infrastructure requirements, exchanges, wires, towers, junction boxes, software needs, Government regulations, issues in telecommunication.
Postal Services: Extent of networks in India, other services provided, need for other infrastructure facilities, appraisal of postal infrastructure, cases in communication industry.

UNIT - IV
Housing and Commercial Construction - Commercial construction need, overview in India, infrastructure essentials, planning, special parks, domestic construction, overview of Indian scene, town planning and development, Government policies, regulations and schemes.

Privatisation - Need for privatisation, scheme for privatisation, Need of Public Private Participation (PPP), Built Operate Transfer (BOT), Build Own Operate Transfer (BOOT), Build Transfer Lease Operate (BTLO), Develop Build Operate (DBO), application of each type of scheme in specific projects, Incentives to the private participants and challenges of PPP mode of projects impementation.

UNIT - V
Financing and Pricing - Project cost estimation, feasibility analysis, social cost benefit analysis, sources of finance, evaluation of various sources of financial institutions, types of sourcing used for each type of infrastructure project, pricing issues in infrastructure investment recovery, Government regulations in infrastructure pricing and identification of sources of pricing of individual sector.
Infrastructure Appraisal - Type of Engineering Surveys: A case study, issues in grading roads, communication, waterways, bridges, energy and construction, cases in infrastructure appraisal.

References:

1. L. N. Dash, Infrastructure Development and the Indian Economy, Regal Publications, 2008.
2. Rajarshi Majumder **,** Infrastructure and development in India**,** Inter linkages and Policy Issues, Rawath Publications.
3. The Contributions of Infrastructure to Economic Development: A Review of Experience and Policy, World Bank Publications, 01-Jan-1993.
4. Economic Survey by Government of India, 1999-2000, New Delhi.
5. Infrastructure, CMIE, Bulletins, Mumbai.
6. Planning Commission website.: http://planningcommission.gov.in/

PE 604 CE

SOFT COMPUTING TECHNIQUES IN CIVIL ENGINEERING

Instruction	*: 3 periods per week*
Duration of Semester End Examination	*: 3 hours*
CIE	*: 30 marks*
SEE	*: 70 marks*
Credits	*: 3*

Objectives:

- Impart the knowledge of various soft computing techniques
- Understand programming concept and optimization Techniques
- Know the applications of soft computing techniques in Water Resources Engineering

Outcomes:

- Competence in understanding the optimization principles.
- Able to solve simple numerical problems and applications using L.P., D.P.
- The students will be able to understand some of the soft computing techniques like Neural Network, Fuzzy Logic techniques in water Resources

UNIT - I

Optimization Techniques: Introduction, one dimensional Un-constrained minimization , Linear Programming, Generalized formation for simple problems, Solution to Linear Programming by Simplex method, Big M method, two-phase linear programming. Formulation of Linear Programming problems for simple case studies in water resources.

UNIT - II

Dynamic Programming: Introduction to dynamic programming. Bellman's p1inciple, General principles of recursive optimization. Method of forward dynamic programming and back ward dynamic programming. Formulation of recursive relationship for water resources problems (allocation problem, capacity expansion and net works).

UNIT- III

Artificial Neural Networks: Fundamental concepts, Biological Neural networks, Basic Models in Neural Networks, Comparison of Biological Neuron and artificial neuron, terminology of Neural networks. Supervised Learning networks and calculation of error. Back propagation networks (algorithm and architectures).

UNIT - IV

Fuzzy sets: Introduction to fuzzy sets and classical sets, fuzzy set operations and properties. Fuzzy relations, fuzzy membership functions, Fuzzy logic, fuzzy quantifiers and fuzzy inferences. fuzzy rule based methods and defuzzification methods. Application of fuzzy methods in water resources.

UNIT - V

Genetic Algorithms: Fundamentals of genetic algorithms, basic concepts, binary coding, fitness function, Reproduction, (Roulett wheel selection, Tournament selection). Cross over and mutation operations, convergence of algorithm. Simple applications in water resources.

Suggested Reading :

1. Raja Sekharan , S. and Vijaya Laxmi Pai, G.A. (2003). "Neural Networks, Fuzzy Logic, and Genetic Algorithm." M/s. Prentice Hall, New Delhi.
2. Jang,J.S.R, Tsai Sun, C.H. and Eiji Mizutsanil. (2004). "Neuro-Fuzzy and Soft Computing." M/s.Pearson Education New Delhi.
3. Ashok. D. Belegundu and Chandraputala, T.R. (2002). "Optimization concepts and Applications in Engineering." M/s. Pearson Education New Delhi.
4. Vedula, S., Mujumdar, P.P. (2005). "Water resources Systems." M/S. McGraw-Hill publishers. New Delhi.

OPEN ELECTIVE COURSES

MICRO ELECTRO MECHANICAL SYSTEMS

Instruction	:	3 Periods per week
Duration of University Examination	:	3 Hours
University Examination	:	70 Marks
Sessional	:	30 Marks
Credits	:	3

OBJECTIVES:

- ✓ To provide knowledge of semiconductors and solid mechanics to fabricate MEMS devices.
- ✓ To introduce various sensors and actuators
- ✓ To introduce different materials used for MEMS
- ✓ To educate on the applications of MEMS to various disciplines.

UNIT -I INTRODUCTION

Intrinsic Characteristics of MEMS – Energy Domains and Transducers- Sensors and Actuators –Introduction to Micro fabrication - Silicon based MEMS processes – New Materials – Review of Electrical and Mechanical concepts in MEMS – Semiconductor devices – Stress and strain analysis –Flexural beam bending- Torsional deflection.

UNIT- II SENSORS AND ACTUATORS-I

Electrostatic sensors – Parallel plate capacitors – Applications – Interdigitated Finger capacitor –Comb drive devices – Micro Grippers – Micro Motors - Thermal Sensing and Actuation – Thermal expansion – Thermal couples – Thermal resistors – Thermal Bimorph - Applications – Magnetic Actuators –Micromagnetic components – Case studies of MEMS in magnetic actuators- Actuation using Shape Memory Alloys.

UNIT-III SENSORS AND ACTUATORS-II

Piezoresistive sensors – Piezoresistive sensor materials - Stress analysis of mechanical elements –Applications to Inertia, Pressure, Tactile and Flow sensors – Piezoelectric sensors and actuators –piezoelectric effects – piezoelectric materials – Applications to Inertia , Acoustic, Tactile and Flow sensors.

UNIT- IV MICROMACHINING

Silicon Anisotropic Etching – Anisotrophic Wet Etching – Dry Etching of Silicon – Plasma Etching –Deep Reaction Ion Etching (DRIE) – Isotropic Wet Etching – Gas Phase Etchants – Case studies -Basic surface micro machining processes – Structural and Sacrificial Materials – Acceleration of sacrificial Etch -Striction and Antistriction methods – LIGA Process - Assembly of 3D MEMS –Foundry process.

UNIT-V POLYMER AND OPTICAL MEMS

Polymers in MEMS– Polimide - SU-8 - Liquid Crystal Polymer (LCP) – PDMS – PMMA – Parylene –Fluorocarbon - Application to Acceleration, Pressure, Flow and Tactile sensors- Optical MEMS –Lenses and Mirrors – Actuators for Active Optical MEMS.

TEXT BOOKS:

1. Tai Ran Hsu, "*MEMS & Micro systems Design and Manufacture*" Tata McGraw Hill, New Delhi, 2002.
2. Chang Liu, '*Foundations of MEMS*', Pearson Education Inc., 2012.
3. Stephen D Senturia, '*Microsystem Design'*, Springer Publication, 2000.
4. Mohamed Gad-el-Hak, editor, "*The MEMS Handbook*", CRC press Baco Raton, 2001.

OE 602 CE

DISASTER MANAGEMENT

Instruction	*: 3 periods per week*
Duration of Semester End Examination	*: 3 hours*
CIE	*: 30 marks*
SEE	*: 70 marks*
Credits	*: 3*

Objectives:

- To provide students an exposure to disasters, their significance and types.
- To ensure that students begin to understand the relationship between vulnerability, disasters, disaster prevention and risk reduction
- To gain a preliminary understanding of approaches of Disaster Risk Reduction (DRR)
- To enhance awareness of institutional processes in the country and
- To develop rudimentary ability to respond to their surroundings with potential disaster response in areas where they live, with due sensitivity

Outcomes:

- The students will be able to understand impact on Natural and manmade disasters.
- Able to classify disasters and destructions due to cyclones
- Able to understand disaster management applied in India

UNIT-I

Introduction to Disasters: Concepts and definitions of Disaster, Hazard, Vulnerability, Resilience, Risks.

Natural and Manmade disasters, impact of drought, review of past disasters and drought in India, its classification and characteristics. Classification of drought, causes, Impacts (including social, economic. political, environmental, health, psychosocial, etc.).

UNIT-II

Disaster: Classifications, Causes, Impacts including social, economic, political, environmental, health, psychosocial etc.

Differential Impacts - in terms of caste, class, gender, age, location, disability Global trends in disasters, urban disasters, pandemics, complex emergencies, climate change.

Cyclones and Floods: Tropical cyclones & Local storms, Destruction by tropical cyclones and local storms, Cumulative atmospheric hazards/ disasters, Cold waves, Heat waves, Causes of floods, Rood hazards in India.

UNIT-III

Approaches to Disaster Risk Reduction: Disaster cycle - its analysis, Phases, Culture of safety, prevention, mitigation and preparedness community based DRR, Structural-nonstructural sources, roles and responsibilities of community, Panchayati Raj Institutions/Urban Local Bodies (PRis/ULBs), states, Centre, and other stake-holders.

UNIT-IV

Inter-relationship between Disasters and Development: Factors affecting Vulnerabilities, differential impacts, impact of development projects such as darns, embankments, changes in Land-use etc. Climate Change Adaptation, Relevance of indigenous knowledge, appropriate technology and local resources.

UNIT-V

Disaster Risk Management in India: Hazard and Vulnerability profile of India Components of Disaster Relief: Water, Food, Sanitation, Shelter, Health, Waste Management Institutional arrangements (Mitigation, Response and Preparedness, OM Act and Policy, other related policies, plans, programmes and legislation)

Field Work and Case Studies: The field work is meant for students to understand vulnerabilities and to work on reducing disaster risks and to build a culture of safety. Projects must be conceived creatively based on the geographic location and hazard profile of the region where the college is located.

Suggested Reading :

1. Sharma V. K. (1999). *Disaster Management, National Centre for Disaster Management*, IIPE, Delhi.
2. Gupta Anil K, and Sreeja S. Nair. (2011). *Environmental Knowledge for Disaster Risk Management,* NIDM, New Delhi.
3. Nick. (1991). *Disaster Management*: A Disaster Manager's Handbook. Asian Development Bank, Manila Philippines.
4. Kapur, et al. (2005). *Disasters in India Studies of grim reality*, Rawat Publishers, Jaipur.
5. Pelling Mark, (2003). *The Vulnerability of Cities*: Natural Disaster and Social Resilience Earthscan publishers, London.

OE 603 CE

GEOSPATIAL TECHNIQUES

Instruction	*: 3 periods per week*
Duration of Semester End Examination	*: 3 hours*
CIE	*: 30 marks*
SEE	*: 70 marks*
Credits	*: 3*

Objectives:

- Description about various spatial and non-spatial data types, and data base management techniques
- Development of the concepts and professional skills in utility of geospatial techniques
- Enhancement of knowledge of geospatial techniques to field problems

Outcomes:

- The students will be able to understand and apply GIS tools
- Will be able to analyse and process data to apply to the GIS tools.
- Will be able assimilate knowledge on field problems using remote sensing

UNIT- I

Introduction: Basic concepts, socioeconomic challenges, fundamentals of geographical information systems (GIS), history of geographical information system, components of geographical information systems.

Projections and Coordinate Systems: Map definitions, representations of point, line, polygon, common coordinate system, geographic coordinate system, map projections, transformations, map analysis.

UNIT- II

Data Acquisition and Data Management*:* data types, spatial, non spatial (attribute) data, data structure and database management, data format, vector and raster data representation, object structural model filters and files data in computer, key board entry, manual digitizing, scanner, aerial photographic data, remotely sensed data, digital data, cartographic database, digital elevation data, data compression, data storage and maintenance, data quality and standards, precision, accuracy, error and data uncertainty.

Data Processing: Geometric errors and corrections, types of systematic and non systematic errors, radiometric errors and corrections, internal and external errors.

UNIT- III

Data Modeling: Spatial data analysis, data retrieval query, simple analysis, recode overlay, vector data model, raster data model, digital elevation model, cost and path analysis, knowledge based system.

GIS Analysis and Functions: Organizing data for analysis, analysis function, maintenance and analysis of spatial data, buffer analysis, overlay analysis, transformations, conflation, edge matching and editing, maintenance and analysis of spatial and non spatial data

UNIT -IV

Applications of GIS: Environmental and natural resource management, soil and water resources, agriculture, land use planning, geology and municipal applications, urban planning and project management, GIS for decision making under uncertainty, software scenario functions, standard GIS packages, introduction to Global Positioning Systems (GPS) and its applications.

UNIT- V

Introduction to Remote Sensing: General background of remote sensing technology, objectives and limitations of remote sensing, electro-magnetic radiation, characteristics, interaction with earth surface and atmosphere, remote sensing platforms and sensors, satellite characteristics, digital image processing, IRS series and high resolution satellites, software scenario functions, remote sensing applications to watershed modeling, environmental modeling, urban planning and management.

Suggested Reading:

1. Burrough, P. A., and McDonnell R. A. (1998), '*Principles of Geographical Information Systems*', Oxford University Press, New York
2. Choudhury S., Chakrabarti, D., and Choudhury S. (2009), '*An Introduction to Geographic Information Technology*', I.K. International Publishing House (P) Ltd, New Delhi
3. Kang-tsung Chang. (2006), '*Introduction to Geographical information Systems', Tata McGraw-Hill Publishing Company Ltd*., Third Edition, New Delhi
4. Lilysand T.M., and Kiefer R.W. (2002), '*Remote Sensing and Image Interpretation'*, John Wiley and Sons, Fourth Edition, New York
5. Sabins F.F. Jr. (1978), '*Remote Sensing Principles and Interpretations'*, W.H. Freeman and Company, San Francisco
6. Tor Bernhardsen. (2002), *'Geographical Information System'*, Wiley India (P) Ltd., Third Edition, New Delhi
7. Hoffman-Wellenhof, B, et al. (1997), '*GPS Theory and Practice'*, Fourth Edition, Springer Wein, New York.

OE 664 CS *With effect from the Academic year 2017-2018*

OPERATING SYSTEMS

Instruction	*: (3L) hrs per week*
Duration of SEE	*: 3 hours*
CIE	*: 30 Marks*
Credits	*:3*

Course Objectives:

- *To understand CPU, Memory, File and Device management*
- *To learn about concurrency control, protection and security*
- *To gain knowledge of Linux and Windows NT internals*

Course Outcomes:

Student will be able to

- *Explain the components and functions of operating systems.*
- *Analyze various Scheduling algorithms.*
- *Apply the principles of concurrency*
- *Compare and contrast various memory management schemes*
- *Perform administrative tasks on Linux Windows Systems*

UNIT-I

Introduction to Operating Systems: OS structure and strategies, Process concepts, Threads, Inter process communication. CPU scheduling algorithms, Process synchronization, Critical section problem, Semaphores, Monitors.

UNIT-II

Memory management, Swapping, Contiguous allocation, Paging, Static and Dynamic partitions, Demand paging, Page replacement algorithms, Thrashing, Segmentation, Segmentation with paging. File system interface: File concepts, Access methods and protection. File system implementation: File system structure, Allocation methods, Directory implementation.

UNIT-III

Deadlocks: Necessary conditions, Resource allocation graph, Methods for handling deadlocks, Prevention, Avoidance, Detection and Recovery. Protection: Goals, Domain of protection, Access matrix. Security: Authentication, Threat monitoring, Encryption.

UNIT-IV

Device Management: Disk scheduling methods, Disk management, Device drivers and interfaces, CPU- Device interactions, I/O optimization.

UNIT-V

Case Studies:

The Linux System–Design principles, Kernel modules, Process management, Scheduling, Memory management, File systems, Input and Output, Inter process communication

Windows NT – General Architecture, The NT kernel, The NT executive

Suggested Reading:

1. Abraham Silberschatz, Peter B Galvin, *Operating System Concepts,* Addison Wesley, 2006
2. William Stallings, *Operating Systems-Internals and Design Principles,* 8th edition, Pearson, 2014
3. Andrew S Tanenbaum, *Modern Operating Systems,* 4th edition, Pearson, 2016.

With effect from the Academic year 2017-2018

OE 665 CS

OOP USING JAVA

Instruction	*: (3L) hrs per week*
Duration of SEE	*: 3 hours*
CIE	*: 30 Marks*
SEE	*: 70 Marks*
Credits	*:3*

Course Objectives:

- *To introduce fundamental object oriented concepts of Java programming Language -such as classes, inheritance packages and interfaces.*
- *To introduce concepts of exception handling and multi threading.*
- *To use various classes and interfaces in java collection framework and utility classes.*
- *To understand the concepts of GUI programming using AWT controls.*
- *To introduce Java I/O streams and serialization*

Course Outcomes

Student will be

- *Able to develop java applications using OO concepts and packages.*
- *Able to write multi threaded programs with synchronization*
- *Able to implement real world applications using java collection frame work and I/O classes*
- *Able to write Event driven GUI programs using AWT/Swing*

UNIT – I

Object Oriented System Development: understanding object oriented development, understanding object oriented concepts, benefits of object oriented development.

Java Programming Fundamentals: Introduction, overview of Java, data types, variables and arrays, operators, control statements

UNIT – II

Java Programming OO concepts: classes, methods, inheritance, packages and interfaces.

Exceptional Handling, Multithreaded Programming

UNIT – III

I/O Basics, Reading Console Input and Output, Reading and Writing Files, Print Writer Class, String Handling Exploring Java. Lang, Collections Overview, Collection Interfaces, Collection Classes, Iterators, Random Access Interface, Maps, Comparators, Arrays, Legacy Classes and Interfaces, String Tokenizer

UNIT – IV

Introducing AWT working With Graphics: AWT Classes, Working with Graphics.
Event Handling: Two Event Handling Mechanisms, The Delegation Event Model, Event Classes, Source of Events, Event Listener Interfaces.
AWT Controls: Control Fundamentals, Labels, Using Buttons, Applying Check Boxes, Checkbox Group, Choice Controls, Using Lists, Managing Scroll Bars, Using Text Field, Using Text Area, Understanding Layout Managers, Menu bars and Menus, Dialog Boxes, File Dialog, Handling events by Extending AWT Components, Exploring the controls, Menus and Layout
Managers.

UNIT – V

Java I/O Classes and Interfaces, Files, Stream and Byte Classes, Character Streams, Serialization.

Suggested Readings:

1. Herbert Schildt, The Complete Reference JAVA, Tata McGraw Hill, 7thEdition, 2005
2. James M Slack, Programming and Problem Solving with JAVA, Thomson learning, 2002
3. C.Thomas Wu, An Introduction to Object-Oriented Programming with Java, Tata McGraw Hill, 5thEdition, 2005.

With effect from the Academic year 2017-2018

OE 601 EC

EMBEDDED SYSTEMS

Instruction	*: (3L) hrs per week*
Duration of SEE	*: 3 hours*
CIE	*: 30 Marks*
SEE	*: 70 Marks*
Credits	*: 3*

Course Objectives:

- *To understand the fundamentals of embedded systems*
- *To study the block diagram and advanced hardware fundamentals*
- *To study the software architecture of embedded systems*
- *To learn the tool chain of embedded systems*
- *To understand the tools and debugging process of embedded systems.*

Course Outcomes:

Student will be

- *Able to acquire an overview of what an embedded system implies*
- *Able to understand the architecture of a microprocessor and microcontroller to enable to design embedded applications using them.*
- *Able to apply theoretical learning to practical real time problems for automation.*
- *Able to understand how to build and debug an embedded system application.*
- *Able to analyze and design real world applications and interface peripheral devices to the microprocessor.*

UNIT – I

Fundamentals of embedded systems: Definition of Embedded system, Examples of Embedded Systems, Typical Hardware, Terminology, Gates, A few other basic considerations, Timing Diagrams, Memory

UNIT – II

Advanced hardware fundamentals: Microprocessors, Buses, Direct Memory Access, Interrupts, Other Common Parts, Built-Ins on the Microprocessor, Conventions used in Schematics, Microprocessor Architecture, Interrupts Basics, Shared Data Problem, Interrupt Latency.

UNIT – III

Software architecture of embedded systems: Round- Robin, Round-Robin with Interrupts, Function- Queue- Scheduling Architecture, Real- Time Operating System Architecture, Selecting an Architecture.

UNIT – IV

Embedded software development tools: Host and Target Machines, Cross compilers, Cross Assemblers and Tool Chains, Linkers /Locaters for Embedded Software, Getting Embedded Software into Target System: PROM programmers, ROM Emulators, In-Circuit Emulators.

UNIT – V

Debugging techniques: Testing on your host machine, Instruction Set Simulators, The assert Macro, Using Laboratory Tools

Suggested Readings:

1. David. E. Simon, "*An Embedded Software Primer*", Low price edition, Pearson Education, New Delhi, 2006.
2. Frank Vahid and Tony Givargis "*Embedded System Design: A Unified Hardware/Software. Approach*". John Wiley & Sons, October 2001.
3. Rajkamal, "*Embedded systems: Programming, architecture and Design*", second edition, McGraw-Hill Education (India), March 2009.

OE 602 EC

DIGITAL SYSTEM DESIGN USING VERILOG HDL

Instruction	*: (3L) hrs per week*
Duration of SEE	*: 3 hours*
CIE	*: 30 Marks*
SEE	*: 70 Marks*
Credits	*: 3*

Course Objectives:

- *To familiarize with various modeling styles: structural, dataflow and behavioral of Verilog HDL.*
- *To develop combinational and sequential circuits using various modeling styles of Verilog HDL*
- *To design and develop Verilog HDL models of data path and control units of Central Processing Unit (CPU)*
- *To learn Synthesis and FPGA design flow.*
- *To design and develop real time applications: Booth's multiplier, Divider, hardwired control for basic CPU and FIR filter.*

Course Outcomes:

Student will be

- *Able to implement and distinguish different Verilog HDL modeling styles*
- *Able to construct and analyze Verilog HDL models of combinational and sequential circuits*
- *Able to design and develop Verilog HDL modeling and test bench for digital systems for the given specifications*
- *Able to outline FPGA design flow and timing analysis*

UNIT – I

Structural modeling: Overview of Digital Design with Verilog HDL, Basic concepts, modules and ports, gate-level modeling, hazards and design examples

UNIT – II

Dataflow and Switch level modeling: dataflow modeling, operands and operators. Switch Level Modeling: CMOS switches and bidirectional switches and design examples

Unit III

Behavioral Modeling: Structured Procedures, Procedural Assignments, Timing Controls, Conditional Statements, multi-way branching, Loops, Sequential and Parallel blocks, Generate blocks. Combinational, sequential logic modules and design examples.

Unit IV

Synthesis and Verification: Tasks and Functions: Differences between Tasks and Functions. Verilog HDL synthesis, Application Specific IC (ASIC) and Field Programmable Gate Array (FPGA) design flow. Verification: Timing analysis and Test bench design. Design examples.

Unit V

Real time implementations: Fixed-Point Arithmetic modules: Addition, Multiplication, Division, Arithmetic and Logic Unit (ALU), Timer, Universal Asynchronous Receiver and Transmitter (UART), DSP modules: FIR and IIR filters, CPU design: Data path and control units.

Suggested Readings:

1. Samir Palnitkar, "*Verilog HDL A Guide to Digital Design and Synthesis*," 2nd Edition, Pearson Education, 2006.
2. Ming-Bo Lin, *Digital System Designs and Practices: Using Verilog HDL and FPGA,"* Wiley India Edition, 2008.
3. J. Bhasker, "*A Verilog HDL Primer*," 2nd Edition, BS Publications, 2001.

OE 601 EE *With effect from the Academic year 2017-2018*

RELEABILITY ENGINEERING (OPEN ELECTIVE-I)

Instruction	3 Periods per week
University Examination	75 Marks
Duration of University Examination	3 Hours
Sessional	25 Marks
Credits	4

Course Objectives:

- *To understand the concepts of different types of probability distributions. importance of reliability evaluation of networks.*
- *To make the students understand about Reliability, availability model of Power Systems and markov modeling of Power Plants. with identical and nonidentical units.*

Outcomes

The students will be able to

- Understand the meaning of discrete and continuous random variables and their significance, causes of failures of a system.
- Acquire the knowledge of different distribution functions and their applications.
- Able to develop reliability block diagrams and evaluation of reliability of different systems.

UNIT- I

Discrete and continuous random variables. Probability density function and Cumulative distribution function. Mean and variance. Binomial, Poisson, Exponential and WeibulI distributions.

UNIT - II

Failure and causes of failure. Failure rate and failure density. Reliability function and MTTF. Bath tub curve for different systems. Parametric methods for above distributions. Non - Parametric methods from field data.

UNIT- III

Reliability block diagram. Series and parallel systems. Network reduction technique, Examples. Evaluation of failure rate, MTTF and reliability, Active and Standby Redundancy, r out of n configuration. Non-series - parallel systems. Path based and cut set methods.

UNIT- IV

Availability, MTTR and MTBF, Markov models and State transition matrices. Reliability models for single component. two components, Load sharing and standby systems. Reliability and availability models of two unit parallel systern with repair and standby systems with repair.

UNIT-V

Repairable Systems. maintainability. Preventive maintenance, Evaluation of reliability and J1TTF. Overhauling and replacement. Optimum maintenance policy. Markov model of a power plant with identical units and non-identical units. Capacity outage probability table. Frequency of failures and Cumulative frequency.

Suggested Reading:

1. Charles E. Ebeling. *Reliability and Maintainability Engineering,* McGraw Hill International Edition, 1997.
2. Balaguruswamy, Reliability *Engineering,* Tata McGraw Hill Publishing Company Ltd, 1984.
3. R.N. Allan. *Reliability Evaluation of Engineering Systems,* Pitman Publishing, 1996.
4. Endrenyi. *Reliability Modeling in Electric Power Systems.* John Wiley & Sons, 1978.

With effect from the Academic year 2017-2018

OE 601 ME

INDUSTRIAL ROBOTICS

Instruction	*: (3L) hrs per week*
Duration of SEE	*: 3 hours*
CIE	*: 30 Marks*
SEE	*: 70 Marks*
Credits	*: 3*

Course Objectives:

- *To familiarize the student with the anatomy of robot and their applications*
- *To provide knowledge about various kinds of end effectors usage*
- *To equip the students with information about various sensors used in industrial robots*
- *To make the student understand the importance of spatial transformation of robots using forward and inverse kinematics*
- *To specify and provide the knowledge of techniques involved in robot vision in industry*
- *To equip students with latest robot languages implemented in industrial manipulators.*

Course Outcomes:

Student will be

- *Able to demonstrate knowledge of the relationship between mechanical structures of industrial robots and their operational workspace characteristics and Have an understanding of the functionality and limitations of robot actuators and sensors*
- *Able to demonstrate an ability to apply spatial transformation to obtain forward/Inverse kinematics equation of robot manipulators using analytical/numerical/simulation tools*
- *Able to apply knowledge and choose the best & economically suitable sensors/end effectors required for specific applications*
- *Able to understand the importance of robot vision and apply the learnt techniques to get the required information from input images*

- *Able to design and develop a industrial robot for a given purpose economically*
- *Appreciate the current state and potential for robotics in new application areas.*

UNIT – I

Introduction to Robotics: Basic structure of Robots. Degree of freedom of Robots. Work envelope. Classification of Robots based on Drive Technology, Work-Envelope and motion control methods. Application of Robots in Industry, Repeatability, Precision and Accuracy as applied to Robots, Specifications of robots used for various applications.

End effectors – Grippers: Mechanical grippers, pneumatic and hydraulic grippers, magnetic grippers, vacuum grippers, RCC grippers – Two fingered and three fingered grippers – Internal grippers and external grippers – Selection and design considerations.

UNIT – II

Requirements of a sensor, principles and applications of the following types of sensors – Position of sensors (Piezo electric sensor, LVDT, Resolvers, Optical encoders, Pneumatic position sensors) – Range sensors (Triangulation principle, Structured, Lighting approach, Time of flight range finders, Laser range meters) – Proximity sensors (Inductive, Hall effect, Capacitive, Ultrasonic and Optical proximity sensors) – Touch sensors (Binary sensors, Analog sensors) – Wrist Sensors – Compliance Sensors – Slip Sensors.

Unit III

Kinematic Analysis of robots: Rotation matrix. Homogeneous transformation matrix, Denavit & Hartenberg representation, Euler and RPY angles representation. Representation of absolute position and orientation in terms of joint parameters, Direct Kinematics of manipulators, Inverse kinematics of Robot arm for position and orientation. Redundancy in Robots. Static force analysis

Unit IV

Introduction to techniques used in Robot vision. Image acquisition, illumination techniques, imaging geometry, basic relationship pixels, preprocessing, segmentation & description of 3 dimensional structures, their recognition and interpretation

Types of Camera, frame grabbing , sensing and digitizing image data – Signal conversion – Image Storage – Lighting techniques – Image processing and analysis – Data reduction – Segmentation – Feature extraction – Object recognition – and various algorithms – Applications – Inspection, identification, visual serving and navigation.

Unit V

Robot programming languages: Characteristics of robot level languages, task level languages Teach pendant programming – Lead through programming – Robot programming languages – VAL programming – Motion commands – Sensor commands – End effecter commands – Simple programs.

RGV – AGV – Implementation of robots in industries – Various steps - Safety considerations for robot operations. Economic analysis of robots – Pay back method, EUAC method and Rate of return method.

Suggested Readings:

1. Groover M P, "*Industrial Robotics*", McGraw Hill Publications, 1999.
2. Fu. K.S., Gon Zalez R.C., Lee C.S.G. "*Robotics, Control-sensing vision and Intelligence*", McGraw Hill, Int. Ed., 1987.
3. Spong and Vidyasagar, "*Robot Dynamics & Control*", John Wiley and Sons, Ed.,1990
4. Mittal and Nagrath, "*Industrial Robotics",* Tata McGraw Hill Publications, 2004.
5 Saha & Subir kumar saha, *'robotics',* tmh, india.

With effect from the Academic year 2017-2018

OE 602 ME

MATERIAL HANDLING

Instruction	*: (3L) hrs per week*
Duration of SEE	*: 3 hours*
CIE	*: 30 Marks*
SEE	*: 70 Marks*
Credits	*: 3*

Course Objectives:

- To know about the working principle of various material handling equipments
- To understand the Material handling relates to the loading, unloading and movement of all types of materials
- To understand the estimation of storage space and maintenance of material handling equipments

Course Outcomes:

Student will be

- Able to understand various conveying systems that available in industry
- Able to understand various bulk solids handling systems and their design features
- Able to understand and various modern material handling systems and their integration.
- Able to calculate number of MH systems required, storage space, cost and maintenance.

UNIT – I

Mechanical Handling Systems: Belt Conveyors and Desing, Bucket Elevators, Package conveyors, Chain and Flight Conveyors, Screw Conveyors, Vibratory Conveyors, Cranes and Hoists.

UNIT – II

Pneumatic and Hydraulic Conveying Systems: Modes of Conveying and High pressure conveying systems,Low Velocity Conveying System. Components of Pneumatic Conveying Systems: General Requirements, Fans and Blowers, Boots-Type Blowers, Sliding-Vane Rotary Compressors, Screw Compressors, Reciprocating Compressors, Vacuum Pumps.

Unit III

Bulk Solids Handling: Particle and Bulk Properties. Adhesion, Cohesion and Moisture Content. Gravity Flow of Bulk Solids: Static and Dynamic Pressure Distribution in Bulk Solids. Modes of Flow: Mass Flow, Funnel Flow and Expanded Flow from Hoppers, Bins and Silos.

Unit IV

Modern Material Handling Systems: Constructional features of (i) AGV (ii) Automated storage and retrieval systems. Sensors used in AGVs and ASRS. Bar code systems and RFID systems: Fundamentals and their integration with computer-based information systems.

Unit V

Total MH Throughput: Calculation for no. of MH systems; storage space estimation based on no of aisles. Maintenance of MH equipment, spare parts management, cost of materials handling, cost per unit load computations.

Suggested Readings:

1. Dr. Mahesh Varma, "*Construction Equipment and its Planning & Application*", Metropolitan Book Co.(P) Ltd., New Delhi, India 1997.
2. James M. Apple, "*Material Handling Systems Design*", The Ronald Press Company, New York, USA, 1972.
3. Woodcock CR. and Mason J.S., "*Bulk Solids Handling: An Introduction to Practice Technology",* Leonard Hill USA, Chapman and Hall, New York.
4. M P Groover etal, "*Industrial Robotics*", Me Graw Hill, 1999.

OE 601 LA *With effect from the Academic year 2017-2018*

INTELLECTUAL PROPERTY RIGHTS

(Elective – I)

Instruction	*: 3 hrs per week*
Duration of SEE	*: 3 hours*
CIE	*: 30 marks*
SEE	*: 70 marks*

Course Objectives:-

1. To create awareness on Engineering Ethics providing basic knowledge about ethics, moral issues & moral dilemmas and professional ideals.
2. To understanding, define and differentiate different types of intellectual properties (IPs) and their roles in contributing to organizational competitiveness.
3. To expose to the Legal management of IP and understanding of real life practice of Intellectual Property Management.

Course Outcomes:-

At the end of the course, students will be able to,

1. Identify different types of Intellectual Properties (IPs), the right of ownership, scope of protection as well as the ways to create and to extract value from IP
2. Recognize the crucial role of IP in organizations of different industrial sectors for the purposes of product and technology development
3. Identify activities and constitute IP infringements and the remedies available to the IP owner and describe the precautious steps to be taken to prevent infringement of proprietary rights and duties in products and technology development.

Unit-I:

Meaning, Nature, Classification and protection of Intellectual Property — The main forms of Intellectual Property — Copyright, Trademarks, Patents, Designs (Industrial and Layout) -- Geographical Indications - Plant Varieties Protection and Biotechnology – Traditional Knowledge – Indigenous Knowledge --etc

Unit-II:

Introduction to the leading International instruments concerning Intellectual Property Rights — The Berne Convention — Universal Copyright Convention — The Paris

Union — Patent Co-operation Treaty -- The World Intellectual Property Organization (WIPO) and the UNEESCO, International Trade Agreements concerning IPR — WTO — TRIPS.

Unit-III :
Select aspects of the Law of Copyright in India — The Copy Right Act, 1957 - Historical evolution — Meaning of copyright — Copyright in literary, dramatic and musical works, computer programmes and cinematograph films — Neighbouring rights — Rights of performers and broadcasters, etc. — Ownership and Assignment of copyright — Author's special rights — Notion of infringement — Criteria of infringement — Infringement of copyright in films, literary and dramatic works — Authorities under the Act — Remedies for infringement of copyright.

Unit-IV:
Intellectual Property in Trademarks and the rationale of their protection - The Trade Marks Act, 1999 — Definition of Trademarks — Distinction between Trademark and Property Mark - Registration — Passing off —Infringement of Trademark — Criteria of Infringement — Remedies. The Designs Act, 2000 — Definition and characteristics of Design — Law in India — Protection and rights of design holders — Copyright in design — Registration — Remedies for infringement.

Unit-V:
Patents — Concept of Patent — Historical overview of the Patents Law in India — Patentable Inventions — Kinds of Patents — Procedure for obtaining patent — The Patents Act, 1970 — Rights and obligations of a patentee — Term of patent protection — Use and exercise of rights — Exclusive Marketing Rights — Right to Secrecy — The notion of 'abuse' of patent rights — Infringement of patent rights and remedies available.

Suggested Readings:

1. P. Narayanan: *Patent Law*, Eastern Law House, 1995.
2. Roy Chowdhary, S.K. & Other: *Law of Trademark, Copyrights, Patents and Designs,* Kamal Law House, 1999.
3. John Holyoak and Paul Torremans: *Intellectual Property Law.*
4. B.L. Wadhera: *Intellectual Property Law*, Universal Publishers, 2nd Ed. 2000.
5. W.R. Cornish: *Intellectual Property Law*, Universal Publishers, 3rd Ed. 2001.
6. Cornish, W. R. "Intellectual Property Law" Eastern Law House, Second Edition, 1997.
7. Jacob, R and Alexander, D. "A guide book to intellectual property, Patents, trademarks. Copy rights and designs. Sweet & Maxwell, 1993.