B. Tech (Civil Engineering)

SEMESTER –VI

Sl No.	Course Code	Course Title	Hours Per Week			Total Credits
			Lecture	Tutorial	Practical	
1.	101602	Construction Engineering & Management	3	0	0	3
2.	101603	Design of Steel Structure	2	1	0	3
3.	101604	Engineering Economics, Estimation & Costing	2	0	0	2
4.	101605	Environmental Engineering-II	3	0	0	3
5.	101606	Geotechnical Engineering -II	3	0	0	3
6.	1016xx	Program Elective-I	3	0	0	3
7.	101604P	Engineering Economics, Estimation & Costing Lab	0	0	2	1
8.	100604P	NPTEL Courses-2	0	0	4	2
TOTAL						20

List of Program Elective Courses

SL NO.	Course Code	Course Title	Hours Per Week			Total credits
			Lecture	Tutorial	Practical	
1.	101607	Energy Science & Engineering	3	0	0	3
2.	101608	Construction Productivity	3	0	0	3
3.	101611	Environmental Systems	3	0	0	3
4.	101612	Design of Hydraulic Structures/Irrigation Engineering	3	0	0	3
5.	101614	Reliability Analysis of Structures	3	0	0	3
6.	101617	Concrete Materials	3	0	0	3
6.	101618	Structural Analysis – I	3	0	0	3
7.	101619	Soil Mechanics – I	3	0	0	3
8.	101620	Transportation Economics	3	0	0	3
9.	101621	Infrastructure Planning and Management	3	0	0	3
10.	101622	Repairs & Rehabilitation of Structures	3	0	0	3
11.	101623	Airport Planning and Design	3	0	0	3
12.	101624	High Speed Rail Engineering	3	0	0	3

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Course Code- Construction Engineering & Management 3 0 0 3

Unit 1.0- 4 hrs

Basics of Construction- Unique features of construction, construction projects- types and features, phases of a project, agencies involved and their methods of execution.

Unit 2.0- 8 hrs

Construction project planning- Stages of project planning: pre-tender planning, pre-construction planning, detailed construction planning, role of client and contractor, level of detail. Process of development of plans and schedules, work break-down structure, activity lists, assessment of work content, concept of productivities, estimating durations, sequence of activities, activity utility data; Techniques of planning- Bar charts, Gantt Charts. Networks: basic terminology, types of precedence relationships, preparation of CPM networks: activity on link and activity on node representation, computation of float values, critical and semi critical paths, calendaring networks. PERT- Assumptions underlying PERT analysis, determining three time estimates, analysis, slack computations, calculation of probability of completion.

Unit 3.0 – 5 hrs

Construction Methods basics: Types of foundations and construction methods; Basics of Formwork and Staging; Common building construction methods (conventional walls and slabs; conventional framed structure with blockwork walls; Modular construction methods for repetitive works; Precast concrete construction methods; Basics of Slip forming for tall structures; Basic construction methods for steel structures; Basics of construction methods for Bridges.

Unit 4.0- 10 hrs

Construction Equipment basics: Conventional construction methods Vs Mechanized methods and advantages of latter; Equipment for Earthmoving, Dewatering; Concrete mixing, transporting & placing; Cranes, Hoists and other equipment for lifting; Equipment for transportation of materials. Equipment Productivities.

Planning and organizing construction site and resources- Site: site layout including enabling structures, developing site organization, Documentation at site; Manpower: planning, organizing, staffing, motivation; Materials: concepts of planning, procurement and inventory control; Equipment: basic concepts of planning and organizing; Funds: cash flow, sources of funds; Histograms and S-Curves. Earned Value; Resource Scheduling- Bar chart, line of balance technique, resource constraints and conflicts; resource aggregation, allocation, smoothening and leveling. Common Good Practices in Construction.

Unit 5.0 – 8 hrs

Project Monitoring & Control- Supervision, record keeping, periodic progress reports, periodical progress meetings. Updating of plans: purpose, frequency and methods of updating. Common causes of time and cost overruns and corrective measures. Basics of Modern Project management systems such as Lean Construction; Use of Building Information Modelling (BIM) in project management; Quality control: concept of quality, quality of constructed structure, use of manuals and checklists for quality control, role of inspection, basics of statistical quality control. Safety, Health and Environment on project sites: accidents; their causes, effects and preventive measures, costs of accidents, occupational health problems in construction, organizing for safety and health.

Unit 6.0- **7 hrs**

Contracts Management basics: Importance of contracts; Types of Contracts, parties to a contract; Common contract clauses (Notice to proceed, rights and duties of various parties, notices to be given, Contract Duration and Price. Performance parameters; Delays, penalties and liquidated damages; Force Majeure, Suspension and Termination. Changes & variations, Dispute Resolution methods.

Construction Costs: Make-up of construction costs; Classification of costs, timecost trade-off in construction projects, compression and decompression.

Text/ Reference:-

1. Varghese, P.C., "Building Construction", Prentice Hall India, 2007.
2. National Building Code, Bureau of Indian Standards, New Delhi, 2017.
3. Chudley, R., Construction Technology, ELBS Publishers, 2007.
4. Peurifoy, R.L. Construction Planning, Methods and Equipment, McGraw Hill, 2011
5. Nunnally, S.W. Construction Methods and Management, Prentice Hall, 2006
6. Jha, Kumar Neeraj., Construction Project management, Theory & Practice, Pearson Education India, 2015
7. Punmia, B.C., Khandelwal, K.K., Project Planning with PERT and CPM, Laxmi Publications, 2016.

B.Tech (Civil Engineering) **Semester - VI**

Course Code- Design of Steel Structure 2 1 0 3

Unit-1.0: 6 hrs

Introduction: Steel structures, material properties, Limit states and design philosophies; analysis and design methods, Loads, partial safety factors and load combinations, analysis of roof for wind loads. Codes and standards. Section Classification: Plastic, compact, semi-compact, and slender sections.

Unit-2.0: 4 hrs

Connections: Structural fasteners - Rivets, bolts and welds, strength under combined stresses, Bolted and Welded Connections - Simple and Eccentric and Column bases.

Unit-3.0: 3 hrs

Tension members: Design based on net section including shear lag effects and block shear, lug angles. Compression members.

Unit-4.0: 6 hrs

Design for flexural and flexural-torsional buckling, Effective length factor: Sway and Non-sway frames, Local buckling, Built-up columns - Battens and lacings. Laterally Supported and Unsupported Beams.

Unit-5.0: 5 hrs

Design strength using shear-moment interaction; Built-up beams, Shear buckling strength, Plate girders and design of stiffeners, Lateral torsional buckling, Effect of restraints and effective length.

Unit-6.0: 4 hrs

Beam-Columns: Effect of axial load on flexure behaviour, P-M interaction and moment amplification, Flexural torsional buckling and Bi-axial bending.

Text/ Reference:-

1. Mc Cormac, J.C., Nelson, J.K. Jr., Structural Steel Design. 3rd edition. Prentice Hall, N.J., 2003.
2. Galambos, T.V., Lin, F.J., Johnston, B.G., Basic Steel Design with LRFD, Prentice Hall, 1996
3. Segui, W. T., LRFD Steel Design, 2nd Ed., PWS Publishing, Boston.
4. Salmon, C.G. and Johnson, J.E., Steel Structures: Design and Behavior, 3rd Edition, Harper & Row, Publishers, New York, 1990.
5. Related Codes of Practice of BIS
6. NBC, National Building Code, BIS (2017).
7. ASCE, Minimum Design Loads for Buildings and Other Structures, ASCE 7-02, American Society of Civil Engineers, Virginia, 2002.
8. Subramanian, N. (2010). Steel Structures: Design and Practice, Oxford University Press.
9. Duggal, S.K. (2014). Limit State Design of Steel Structures, McGraw Hill.

B.Tech (Civil Engineering) **Semester - VI**

Course Code- Engineering Economics, Estimation & Costing 2 0 0 2

Unit- 1.0: 6 hrs

Basic Principles and Methodology of Economics. Demand/Supply – elasticity –Government Policies and Application. Theory of the Firm and Market Structure. Basic Macro-economic Concepts (including GDP/GNP/NI/Disposable Income) and Identities for both closed and open economies. Aggregate demand and Supply (IS/LM). Price Indices (WPI/CPI), Interest rates, Direct and Indirect Taxes.

Public Sector Economics –Welfare, Externalities, Labour Market. Components of Monetary and Financial System, Central Bank –Monetary Aggregates; Commercial Banks & their functions; Capital and Debt Markets. Monetary and Fiscal Policy Tools & their impact on the economy – Inflation and Phillips Curve.

Unit- 2.0: 4 hrs

Elements of Business/Managerial Economics and forms of organizations. Cost & Cost Control –Techniques, Types of Costs, Lifecycle costs, Budgets, Break even Analysis, Capital Budgeting, Application of Linear Programming. Investment Analysis – NPV, ROI, IRR, Payback Period, Depreciation, Time value of money (present and future worth of cash flows). Business Forecasting –Elementary techniques. Statements – Cash flow, Financial. Case Study Method.

Unit- 3.0: 4 hrs

Indian economy - Brief overview of post-independence period – plans. Post reform Growth, Structure of productive activity. Issues of Inclusion – Sectors, States/Regions, Groups of people (M/F), Urbanization. Employment–Informal, Organized, Unorganized, Public, Private. Challenges and Policy Debates in Monetary, Fiscal, Social, External sectors.

Unit- 4.0: 5 hrs

Estimation / Measurements for various items- Introduction to the process of Estimation; Use of relevant Indian Standard Specifications for the same, taking out quantities from the given requirements of the work, comparison of different alternatives, Bar bending schedules, Mass haul Diagrams, Estimating Earthwork and Foundations, Estimating Concrete and Masonry, Finishes, Interiors, MEP works; BIM and quantity take-offs; adding equipment costs; labour costs; rate analysis; Material survey-Thumb rules for computation of materials requirement for different materials for buildings, percentage breakup of the cost, cost sensitive index, market survey of basic materials. Use of Computers in quantity surveying.

Unit-5.0: 4 hrs

Specifications-Types, requirements and importance, detailed specifications for buildings, roads, minor bridges and industrial structures.

Rate analysis-Purpose, importance and necessity of the same, factors affecting, task work, daily output from different equipment/ productivity.

Unit- 6.0: 5 hrs

Tender- Preparation of tender documents, importance of inviting tenders, contract types, relative merits, prequalification. general and special conditions, termination of contracts, extra work and Changes, penalty and liquidated charges, Settlement of disputes, R.A. Bill & Final Bill, Payment of advance, insurance, claims, price variation, etc. Preparing Bids- Bid Price buildup: Material, Labour, Equipment costs, Risks, Direct & Indirect Overheads, Profits; Bid conditions, alternative specifications; Alternative Bids. Bid process management.

Introduction to Acts pertaining to-Minimum wages, Workman's compensation, Contracts,

Arbitration, Easement rights.

Text/ Reference:-

1. Mankiw Gregory N. (2002), Principles of Economics, Thompson Asia.
2. V. Mote, S. Paul, G. Gupta(2004), Managerial Economics, Tata McGraw Hill.
3. Misra, S.K. and Puri (2009), Indian Economy, Himalaya.
4. Pareek Saroj (2003), Textbook of Business Economics, Sunrise Publishers.
5. M Chakravarty, Estimating, Costing Specifications & Valuation.
6. Joy P K, Handbook of Construction Management, Macmillan.
7. B.S. Patil, Building & Engineering Contracts.
8. Relevant Indian Standard Specifications.
9. World Bank Approved Contract Documents.
10. FIDIC Contract Conditions.
11. Acts Related to Minimum Wages, Workmen's Compensation, Contract, and Arbitration.
12. Typical PWD Rate Analysis documents.
13. UBS Publishers & Distributors, Estimating and Costing in Civil Engineering: Theory and Practice including Specification and Valuations,2016.
14. Dutta, B.N., Estimating and Costing in Civil Engineering (Theory & Practice), UBS Publishers, 2016.

B.Tech (Civil Engineering) **Semester - VI**

Course Code-100106 Environmental Engineering-II 3 0 0 3

Unit- 1.0 **10 hrs**

Sewage- Domestic and Storm water, Quantity of Sewage, Sewage flow variations. Conveyance of sewage- Sewers, shapes design parameters, operation and maintenance of sewers, Sewage pumping; Sewerage, Sewer appurtenances, Design of sewerage systems. Small bore systems, Storm Water- Quantification and design of Storm water; Sewage and Sullage, Pollution due to improper disposal of sewage, National River cleaning plans, Wastewater treatment, aerobic and anaerobic treatment systems, suspended and attached growth systems, recycling of sewage –quality requirements for various purposes.

Unit- 2.0 **8 hrs**

Solid waste management-Municipal solid waste, Composition and various chemical and physical parameters of MSW, MSW management: Collection, transport, treatment and disposal of MSW. Special MSW: waste from commercial establishments and other urban areas, solid waste from construction activities, biomedical wastes,

Unit- 3.0 **7 hrs**

Effects of solid waste on environment: effects on air, soil, water surface and ground health hazards. Disposal of solid waste-segregation, reduction at source, recovery and recycle. Disposal methods- Integrated solid waste management.

Unit- 4.0 **6 hrs**

Hazardous waste: Types and nature of hazardous waste as per the HW Schedules of regulating authorities.

Unit- 5.0 **5 hrs**

Government authorities and their roles in water supply, sewerage disposal.

Unit- 6.0 **6 hrs**

Solid waste management and monitoring/control of environmental pollution.

Text/ Reference:-

1. Introduction to Environmental Engineering and Science by Gilbert Masters, Prentice Hall, New Jersey.
2. Introduction to Environmental Engineering by P. Aarne Vesilind, Susan M. Morgan, Thompson /Brooks/Cole; Second Edition 2008.
3. Peavy, H.s, Rowe, D.R, Tchobanoglous, G. Environmental Engineering, Mc-Graw Hill International Editions, New York 1985.
4. MetCalf and Eddy. Wastewater Engineering, Treatment, Disposal and Reuse, Tata McGraw-Hill, New Delhi.
5. Manual on Water Supply and Treatment. Ministry of Urban Development, New Delhi.
6. Plumbing Engineering. Theory, Design and Practice, S.M. Patil, 1999
7. Integrated Solid Waste Management, Tchobanoglous, Theissen & Vigil. McGraw Hill Publication
8. Manual on Sewerage and Sewage Treatment Systems, Part A, B and C. Central Public Health and Environmental Engineering Organization, Ministry of Urban Development.

B.Tech (Civil Engineering) **Semester - VI**

Course Code-100104 Geotechnical Engineering -II 3 0 0 3

Unit- 1.0 **7 hrs**

Consolidation of Soil - Introduction, comparison between compaction and consolidation, initial, primary & secondary consolidation, spring analogy for primary consolidation, interpretation of consolidation test results, Terzaghi's theory of consolidation, final settlement of soil deposits, computation of consolidation settlement and secondary consolidation.

Unit- 2.0 **7 hrs**

Shear Strength - Mohr circle and its characteristics, principal planes, relation between major and minor principal stresses, Mohr-Coulomb theory, types of shear tests: direct shear test, merits of direct shear test, triaxial compression tests, test behaviour of UU, CU and CD tests, pore-pressure measurement, computation of effective shear strength parameters unconfined compression test, vane shear test.

Unit- 3.0 **7 hrs**

Stability of Slopes - Introduction, types of slopes and their failure mechanisms, factor of safety, analysis of finite and infinite slopes, wedge failure Swedish circle method, friction circle method, stability numbers and charts.

Unit- 4.0 **7 hrs**

Soil Exploration- Introduction, methods of site exploration and soil investigation, , geophysical and advance soil exploration methods.

Unit- 5.0 **7 hrs**

Methods of boring, soil samplers, sampling procedures, trail pits, borings, penetrometer tests, analysis of borehole logs.

Unit- 6.0 **7 hrs**

Application of soil mechanics to determine earth pressures, analysis of retaining walls, cuts & excavations and sheet piles, stability of slopes, instrumentation.

Text/ Reference:-

1. Soil Mechanics by Craig R.F., Chapman & Hall
2. Fundamentals of Soil Engineering by Taylor, John Wiley & Sons
3. An Introduction to Geotechnical Engineering, by Holtz R.D. and Kovacs, W.D., Prentice Hall, NJ
4. Principles of Geotechnical Engineering, by Braja M. Das, Cengage Learning
5. Principles of Foundation Engineering, by Braja M. Das, Cengage Learning
6. Essentials of Soil Mechanics and Foundations: Basic Geotechnics by David F. Mc Carthy
7. Soil Mechanics in Engineering Practice by Karl Terzaghi, Ralph B. Peck, and Gholamreza Mesri.
8. Geotechnical Engineering: Principles and Practices of Soil Mechanics and Foundation Engineering (Civil and Environmental Engineering) by V.N.S. Murthy.

Program Elective-I

Course Code-101607 Energy Science & Engineering 3 0 0 3

Unit-1.0 **7 hrs**

Introduction to Energy Science: Scientific principles and historical interpretation to place energy use in the context of pressing societal, environmental and climate issues; Introduction to energy systems and resources; Introduction to Energy, sustainability & the environment

Unit-2.0 **7 hrs**

Energy Sources: Overview of energy systems, sources, transformations, efficiency, and storage. Fossil fuels (coal, oil, oil-bearing shale and sands, coal gasification) - past, present & future, Remedies & alternatives for fossil fuels - biomass, wind, solar, nuclear, wave, tidal and hydrogen; Sustainability and environmental trade-offs of different energy systems; possibilities for energy storage or regeneration (Ex. Pumped storage hydro power projects, superconductor-based energy storages, high efficiency batteries)

Unit-3.0 **7 hrs**

Energy & Environment: Energy efficiency and conservation; introduction to clean energy technologies and its importance in sustainable development; Carbon footprint, energy consumption and sustainability; introduction to the economics of energy; How the economic system determines production and consumption; linkages between economic and environmental outcomes; How future energy use can be influenced by economic, environmental, trade, and research policy

Unit-4.0 **7 hrs**

Civil Engineering Projects connected with the Energy Sources: Coal mining technologies, oil exploration offshore platforms, Underground and under-sea oil pipelines, solar chimney project, wave energy caissons, coastal installations for tidal power, wind mill towers; hydro power stations above-ground and underground along with associated dams, tunnels, penstocks, etc.;

Unit-5.0 **5 hrs**

Nuclear reactor containment buildings and associated buildings, design and construction constraints and testing procedures for reactor containment buildings; Spent Nuclear fuel storage and disposal systems.

Unit-6.0 **9 hrs**

Engineering for Energy conservation: Concept of Green Building and Green Architecture; Green building concepts (Green building encompasses everything from the choice of building materials to where a building is located, how it is designed and operated); *LEED ratings;* Identification of energy related enterprises that represent the breath of the industry and prioritizing these as candidates; Embodied energy analysis and use as a tool for measuring sustainability. Energy Audit of Facilities and optimization of energy consumption.

Text/ Reference:-

1. Boyle, Godfrey (2004), Renewable Energy (2nd edition). Oxford University Press
2. Boyle, Godfrey, Bob Everett, and Janet Ramage (Eds.) (2004), Energy Systems and Sustainability: Power for a Sustainable Future. Oxford University Press
3. Schaeffer, John (2007), Real Goods Solar Living Sourcebook: The Complete Guide to Renewable Energy Technologies and Sustainable Living, Gaiam.

4. Jean-Philippe; Zaccour, Georges (Eds.), (2005), Energy and Environment Set: Mathematics of Decision Making, Loulou, Richard; Waaub, XVIII,
5. Ristinen, Robert A. Kraushaar, Jack J. AKraushaar, Jack P. Ristinen, Robert A. (2006) Energy and the Environment, 2nd Edition, John Wiley
6. UNDP (2000), Energy and the Challenge of Sustainability, World Energy assessment.
7. E H Thorndike (1976), Energy & Environment: A Primer for Scientists and Engineers, Addison-Wesley Publishing Company.

B.Tech (Civil Engineering) **Semester - VI**

Course Code- 101609 Construction Productivity **3 0 0 3**

Unit- 1.0 **5 hrs**

Definition of Productivity, Impact of productivities on construction duration and costs.

Unit- 2.0 **7 hrs**

Measuring productivities of construction equipment, Staff and Labour and typical benchmarks for the same.

Unit- 3.0 **9 hrs**

Productivity analysis from Daily Progress Reports; Lean Construction concepts of Value Adding activities, Non-Value Adding Activities and Non-Value Adding but Necessary Activities.

Unit- 4.0 **7 hrs**

Productivity measurements by special Lean Construction-oriented field methods such as Work Sampling, Takt time analysis, Foreman Delay Surveys.

Unit- 5.0 **7 hrs**

Productivity improvement measures such as Value Stream Mapping, LocationBased management Systems, 5S, good Housekeeping, etc.

Unit- 6.0 **7 hrs**

Use of specialist software such as Vico for productivity studies

Text/ Reference:-

1. Adrian, James J.; Measuring and Improving Construction Productivity, 4th edition Stipes Publishing, 2004 ISPB 1-58874-357-8.
2. Halpin, D.W. and R.W. Woodhead. 1976. Design of Construction and Process Operations. New York: John Wiley and Sons.
3. Halpin, D.W. 1990. Micro CYCLONE User's Manual. Division of Construction Engineering and Management, Purdue University, West Lafayette, Indiana.
4. Halpin, D.W. and L.S. Riggs. 1992. Planning anti Analysis of Construction Operations.

Course Code- 101611 Environmental Systems **3 0 0 3**

Unit- 1.0 **7 hrs**
Introduction to the concepts and applications of environmental systems analysis.

Unit- 2.0 **7 hrs**
Application of mathematical programming and modeling to the design, planning and management of engineered environmental systems, regional environmental systems, and environmental policy.

Unit- 3.0 **7 hrs**
Economic analysis, including benefit-cost analysis and management strategies.

Unit- 4.0 **7 hrs**
Concepts of tradeoff, non- inferior sets, single and multi-objective optimization.

Unit- 5.0 **7 hrs**
Practical application to case studies to convey an understanding of the complexity of actual design practice.

Unit- 6.0 **7 hrs**
Practical application to case studies to convey an understanding of data collection challenges of actual design practice.

Text/ Reference:-

1. Benny Joseph (2005), Environmental Studies, New Delhi, Tata McGraw Hill Publishing co. Ltd.
2. Erach Bharucha (2005), Textbook of Environmental Studies for Undergraduate Courses, Hyderabad, Universities Press.

Course Code- 101612 Design of Hydraulic Structures/Irrigation Engineering 3 0 0 3

Unit- 1.0 **8 hrs**

DESIGN & MAINTENANCE OF CANALS: Design of canal based on tractive force approach, Maintenance of unlined channels (Based on IS 4839 – 1979 part – I), Maintenance of lined channels (Based on IS 4339 – 1979 part – II).

Unit- 2.0 **8 hrs**

Design of Canal Outlets, Canal Headworks - Selection of site for storage & diversion head works - Weir or Barrages - Divide wall, Scouring sluice or under sluices, fish ladder.

Unit- 3.0 **7 hrs**

DAMS - Gravity dams, earth & rock fill dams, buttress dams & arch dams. - Spillways & outlet works

Unit- 4.0 **7 hrs**

Canal Regulation Works - Head Regulator, Distributary head regulator, Cross regulators - Necessity of channel falls, types of falls & design of vertical drop fall/Sharda type falls.

Unit- 5.0 **8 hrs**

Cross – Drainage Works - Types of C – D works: Aqueducts, siphon Aqueducts, Super passages, Siphon Super passages, level crossings, Inlet & Outlet. - Fluming of channels & design of channel transitions

Unit- 6.0 **4 hrs**

An introduction to river basis development.

Text/ Reference:-

1. Fundamental of Irrigation Engineering by Bharat Singh, Nemchand Bros., Roorkee, Uttarakhand.
2. Irrigation & Water Power Engineering by Punima B.C., Pande Lal B.B., Laxmi Publication Pvt. Ltd. New Delhi.
3. Water Resource Engineering by Garg S.K., Khanna Publishers, New Delhi.
4. Water Power Engineering by Dandekar MM/ Sharma KN, Vikash Publishing Pvt. Ltd
5. Water Resources Engineering by R.K. Linsley & J.L.H. Paulhus, McGraw Hill.
6. Hydroelectric Handbooks by W.P. Creager & J.D. Justin, John Wiley & Sons.

Course Code- 101614 Reliability Analysis of Structures 3 0 0 3

Unit- 1.0 **7 hrs**

Role of reliability in civil engineering; Historical background, random events, random variables, model uncertainty.

Unit- 2.0 **8 hrs**

Common probabilistic models; Important statistical parameters and their estimations, normal, lognormal, extreme value distribution.

Unit- 3.0 **8 hrs**

Fundamental concept of structural reliability; Derivation of stress-strength interface equation, graphical representation, Cornel reliability index, reliability and failure probability computations for simple linear functions.

Unit- 4.0 **8 hrs**

Second moment concepts, First order second moment theory, Hasofer-Lind transformation, Linear and non-linear limit state functions, Solution schemes, geometric interpretation of solution scheme, Rackwitz-Fiessler transformation.

Unit- 5.0 **6 hrs**

First order reliability method; Stochastic models for material strength and loads.

Unit- 6.0 **5 hrs**

Reliability assessment of structural component and simple civil engineering structures.

Text/ Reference:-

1. Papoulis A. Probability, Random Variables and Stochastic Processes, McGraw-Hill, New York, USA, 1991.
2. Ayyub B M, McCuen R H. Probability, Statistics and Reliability for Engineers and Scientists, Chapman & Hall, Florida, USA, 2000.
3. Ranganathan R. Structural Reliability Analysis & Design. Jaico Publishing House, Mumbai, India, 1999.
4. Melchers R E. Structural Reliability: Analysis and Prediction, John Wiley, Chichester, 1999.
5. Ang A H S & Tang W H. Probability Concepts in Engineering Planning and Design, Vol II, John Wiley, New York, 1984.
6. Madsen H O, Krenk S and Lind N C. Methods of Structural Safety, Prentice-Hall, Inc, Englewood Cliffs, USA, 1986.
7. Choi S K, Grandhi R V and Canfield R A. Reliability Based Structural Design, SpringerVerlag, London, UK, 2007.
8. Haldar A & Mahadevan S. Reliability Assessment Using Stochastic Finite Element Analysis, John-Wiely & Sons Inc., New York, USA, 2000.

Course Code- 101617 Concrete Materials **3 0 0 3**

Unit- 1.0 **8 hrs**
Examines the influence of constituent materials (cements, aggregates and admixtures) on the properties of fresh and hardened concrete.

Unit- 2.0 **7 hrs**
Recycled aggregates recovered from construction and demolition wastes; M-Sand; Light-weight aggregates.

Unit- 3.0 **7 hrs**
Use of Fly Ash in concrete; Fibre-reinforced concrete with various types of metallic and nonmetallic fibres.

Unit- 4.0 **8 hrs**
Various types of concrete such as Self Compacting Concrete, High Performance Concrete, etc.; mix design; handling and placement of concrete.

Unit- 5.0 **5 hrs**
Effect of revibration of concrete.

Unit- 6.0 **7 hrs**
Behavior of concrete under various types of loading and environment; test methods.

Text/ Reference:-

1. Advanced R.C.Design by Krishna Raju. 2005.
2. Limit State Design by A.K. Jain. 1990.
3. Reinforced Concrete Structures by Park and Pauley. 1975.
4. Reinforced Concrete Structural Elements – Behaviour Analysis and Design by Purushothaman. 1984.
5. Concrete Technology by M.S. Shetty. 2006.

B.Tech (Civil Engineering) **Semester - VI**

Course Code- 101618 Structural Analysis – I 3 0 0 3

Unit- 1.0 **7 hrs**

Basic introductory concepts: structural systems, elements, joints, stability, equilibrium, compatibility, indeterminacy, types of loading.

Unit- 2.0 **7 hrs**

Force-displacement relation, free-body diagrams; analysis of forces in statically determinate structures: trusses (including compound and complex trusses), beams and frames (including internal hinges), cables and three hinged.

Unit- 3.0 **7 hrs**

Stability of Walled Structures.

Unit- 4.0 **7 hrs**

Influence lines for beams and trusses under moving loads; Criteria for maxima.

Unit- 5.0 **7 hrs**

Work and energy principles : principle of virtual work, potential energy and Clastingliano's theorems, complementary energy theorems, reciprocal theorems and Mueller Breslau's principle with applications.

Unit- 6.0 **7 hrs**

In statically determinate structures: Unit (dummy) load and energy methods, moment area and conjugate beam methods, Williot-Mohr diagrams.
Introduction to Matrix Methods for determinate structures: Flexibility & Stiffness Methods.

Text/ Reference:-

1. Elementary Structural Analysis by Norris, Wilbur and Utku, McGraw Hill.
2. Basic Structural Analysis by C.S. Reddy, Tata McGraw Hill.
3. Intermediate Structural Analysis by C.K.Wang, McGraw Hill.
4. Theory of Structures – Volumes 1 and 2 by S. P. Gupta and G. S. Pandit, Tata McGraw Hill.
5. Structural Analysis by L.S.Negi & R.S.Jangid, Tata McGraw Hill.
6. Application of Graphics in Engg. by L.B.Roy, Standard Pub. and Dist., Delhi.
7. Structural Analysis Vol 1 by Bhavikatti Vikash ,Publishing House Pvt. Ltd.

B.Tech (Civil Engineering) **Semester - VI**

Course Code- 101619 Soil Mechanics – I 3 0 0 3

Unit- 1.0 **7 hrs**

Introduction, Origin and Classification of soils, soil weight volume relationships, Index properties of soil, soil structures and Clay Minerals.

Unit- 2.0 **7 hrs**

Effective stress principle, Surface tension and capillarity, Permeability of soils, Darcy's law, test for determination of permeability, engineering use of permeability. Factors affecting permeability.

Unit- 3.0 **7 hrs**

Seepage analysis, flow nets, flow through dams.

Unit- 4.0 **7 hrs**

Effective stress distribution in soils under hydrodynamic conditions. Quick sand, Piping, Prevention of piping failures.

Compressibility and Consolidation:- Consolidation Process- Spring analogy, Definition, measurement of consolidations- Determination of void ratio at various load increments, Terzaghi's theory of one dimensional consolidation, Determination of Coefficient of consolidation, Analysis of consolidation data

Unit- 5.0 **7 hrs**

Vertical stress below applied load in soils (Boussinesq, Westergaard, and graphical solutions), one and two- dimensional cases.

Unit- 6.0 **7 hrs**

Compaction characteristics, water content – dry unit weight relationships, OMC, max, Dry unit weight field compaction control.

Soil stabilization.

Text/ Reference:-

1. A Text Book of Soil Mechanics and Foundation Engineering by V.N.S. Murthy, Saikripa Technical consultants, Bangalore.
2. Geotechnical Engineering by S. K. Gulati et. al., TMH Publication Co. Ltd., New Delhi.
3. Basic and applied Soil Mechanics by Gopal Ranjan and A. S. R. Rao, Wiley Eastern Ltd., New Delhi.
4. Soil Mechanics and Foundation Engineering by K. R. Arora, Standard Pub. and Dist.,
5. Soil Mechanics in Engineering Practice by Terzaghi and Pech, John Wiley and Sons Inc New York.
6. Soil Mechanics by Lamb and Whitman, Wiley Eastern Pvt. Ltd., New Delhi.
7. Fundamentals of Soil Mechanics by Taylor, John Wiley and Sons Inc New Delhi.

B.Tech (Civil Engineering) **Semester - VI**

Course Code- 101620 Transportation Economics 3 0 0 3

Unit- 1.0 **7 hrs**

Introductory Concepts in Transportation Decision Making: Overall transportation project development, budgeting, financial planning, the process of transportation project development, models associated with transportation impact evaluation.

Unit- 2.0 **7 hrs**

Transportation costs - Classification of transportation costs, transportation agency costs, transportation user costs, general structure and behavior of cost functions and road pricing

Unit- 3.0 **7 hrs**

Estimating Transportation Demand and Supply - supply equilibration, dynamics of transportation demand and supply, elasticity of travel demand and supply, classification of elasticity.

Unit- 4.0 **7 hrs**

Vehicle operating costs: Fuel costs - Maintenance and spares, Depreciation - Crew costs - Value of travel time savings - Accident costs.

Unit- 5.0 **7 hrs**

Economics of traffic congestion - Pricing policy; Economic analysis of projects - Methods of evaluation - Cost-benefit ratio, first year rate of return, net present value, and internal-rate of return methods.

Unit- 6.0 **7 hrs**

Indirect costs and benefits of transport projects; Financing of road projects - methods – Private Public Partnership (PPP) - Toll collection - Economic viability of Design-Build-Operate-Transfer Schemes – Risk Analysis – Value for Money analysis - Case Studies.

Text/ Reference:-

1. Highway investment in Developing countries - Thomas Telford Ltd., Institute of Civil Engineers, 3rdEdition, 1983.
2. Winfrey R, “Economic Analysis for Highways”, International Text Book Co., Pennsylvania, 1969.
3. Dickey, J.W., “Road Project Appraisal for Developing countries”, John Wiley and Sons. 4th Edition, 1984.
4. Ian Heggie, “Transport Engineering Economics”, McGraw, 3rdEdition, 1972.
5. Road User Cost Study - Final Report - Central Road Research Institute, New Delhi.

B.Tech (Civil Engineering) **Semester - VI**

Course Code- 101621 Infrastructure Planning and Management **3 0 0 3**

Unit- 1.0
Introduction: Definition of basic terminologies, role of infrastructure in economic development, types of infrastructure, measurement of infrastructure capacity, bases for quantification of demand and supply of various types of infrastructure, Indian scenario in respect of adequacy and quality.

Unit- 1.0
Infrastructure Planning: Goals and objectives of infrastructure planning; Identification and quantification of the casual factors influence the demand for infrastructure; review and application of techniques to estimate supply and demand for infrastructure.

Unit- 1.0
Use of econometric, social and land use indicators and models to forecast the demand and level of service of infrastructure and its impact on land use; critical review of the relevant forecasting techniques; infrastructure planning to identify and prioritize preferred areas for development.

Unit- 1.0
Integration of strategic planning for infrastructure at urban, regional and national levels; case studies in infrastructure planning.

Unit- 1.0
Infrastructure Management: Concepts, Common aspects of urban and rural infrastructure management systems; pavement and bridge management systems, Integrated infrastructure management.

Unit- 1.0
Case studies; Emerging trends in infrastructure: Overview of Public-Private Sector Participation in infrastructure projects, Understanding stakeholders' concerns, regulatory framework, risk management in infrastructure projects, public policy for infrastructure Sectoral Overview: Highways, railways, waterways, airports, urban and rural infrastructure: roads, housing, water supply, sanitation – case study examples.

Text/ Reference:-

1. Goodman AS, Hastak M (2006). Infrastructure Planning Handbook: Planning, Engineering, and Economics. McGraw Hill/ ASCE Press. Chapter 1
2. World Bank (2012). Transformation through Infrastructure. Selected pages handed out in class.
3. World Bank (2006). Infrastructure at the Crossroads: Lessons from 20 Years of World Bank Experience. Land
4. ULI and Ernst & Young (2013) Infrastructure 2013: Global Priorities, Global Insights, The Urban Institute, http://www.uli.org/infrastructure- global-infrastructure-priorities/ Washington DC. Available free: initiative/infrastructure-2013-explores.
5. Lee (2009) New Delhi Water and Power. Harvard Kennedy School of Government Case Program #1891.

B.Tech (Civil Engineering) **Semester - VI**

Course Code- 101622 Repair & Rehabilitation of Structures 3 0 0 3

Unit- 1.0
Maintenance and Repair Strategies Maintenance, Repair and Rehabilitation, Facets of Maintenance, importance of Maintenance, Various aspects of Inspection.

Unit- 2.0
Assessment procedure for evaluating a damaged structure, causes of deterioration; Strength and Durability Of Concrete- Quality assurance for concrete – Strength, Durability and Thermal properties, of concrete – Cracks, different types causes – Effects due to climate, temperature, Sustained elevated temperature, Corrosion – Effects of cover thickness

Unit- 3.0
Special Concretes- Polymer concrete, Sulphur infiltrated concrete, Fibre reinforced concrete, High strength concrete, High performance concrete, Vacuum concrete, Self-compacting concrete, Geopolymer concrete, Reactive powder concrete, Concrete made with industrial wastes.

Unit- 4.0
Techniques for Repair and Protection Methods- Non-destructive Testing Techniques, Epoxy injection, Shoring, Underpinning, Corrosion protection techniques – Corrosion inhibitors, Corrosion resistant steels, Coatings to reinforcement, cathodic protection.

Unit- 5.0
Repair, Rehabilitation and Retrofitting of Structures- Evaluation of root causes; Underpinning & shoring; some simple systems of rehabilitation of structures; Guniting, shotcreting;.

Unit- 6.0
Non Destructive testing systems; Use of external plates, carbon fibre wrapping and carbon composites in repairs, Strengthening of Structural elements, Repair of structures distressed due to corrosion, fire, Leakage, earthquake – Demolition Techniques – Engineered demolition methods – Case studies.

Text/ Reference:-

1. Repair and protection of concrete structures by Noel P.Mailvaganam, CRC Press, 1991.
2. Concrete repair and maintenance Illustrated by Peter.H.Emmons, Galgotia publications Pvt. Ltd., 2001.
3. “Earthquake resistant design of structures” by Pankaj agarwal, Manish shrikande, PHI, 2006.
4. Failures and repair of concrete structures by S.Champion, John Wiley and Sons, 1961.
5. Diagnosis and treatment of structures in distress by R.N.Raikar Published by R & D Centre of Structural Designers and Consultants Pvt.Ltd, Mumbai.
6. Handbook on repair and rehabilitation of RCC buildings, CPWD, Government of India.
7. Handbook on seismic retrofit of buildings, A. Chakrabarti et.al., Narosa Publishing House, 2010.

B.Tech (Civil Engineering) **Semester - VI**

Course Code- 101623 Airport Planning and Design **3 0 0 3**

Unit- 1.0 **7 hrs**
Aircraft characteristics related to airport design.

Unit- 2.0 **7 hrs**
Airport configuration: runway configurations, relation of terminal area to runway orientation.

Unit- 3.0 **7 hrs**
Geometric Design of the airfield - ICAO and FAA design standards, runways, taxiways.

Unit- 4.0 **7 hrs**
Holding aprons and aprons: Planning and design of the terminal area- apron – gate system, size and number of gates

Unit- 5.0 **7 hrs**
Aircraft parking configurations, the passenger terminal system.

Unit- 6.0 **7 hrs**
Airport lighting and marking : air traffic control, airport planning and air travel demand forecasting; Structural design of airfield pavements.

Text/ Reference:-

1. Khanna S.K., Arora M.G., Jain S.S., "Airport Planning & Design", 1st Edition, Nem chand Bros. Roorkee, 2009.
2. Robert Horonjeff, Francis McKelvey, William Sproule and SethYoung, "Planning and Design of Airports" 5th Edition, 2010.
3. Alexander T. Wells, Ed. D & Seth, B. Young, "Airport Planning and Management', 5th Edition, 2008.
4. Heronjeff, R, McKelvey, F.X, "Planning & Design of Airports", 2nd Edition, McGraw Hill Book Co, 1994.
5. Norman J. Ashford, Saleh Mumayiz and Paul H. Wright, "Planning, Design and Development of 21st Century Airports", 4th Edition, John Wiley& Sons, 2011.
6. Subramian K.P., "Highway, Railway, Airport and Harbour Engineering", 1st Edition, Scitech Publications Private Limited, 2013.

B.Tech (Civil Engineering) **Semester - VI**

Course Code- 101624 High Speed Rail Engineering **3 0 0 3**

Unit- 1.0 **7 hrs**

Development, engineering, design and construction of high- speed rail (HSR) passenger transport systems with particular emphasis on the unique engineering elements of HSR technology.

Unit- 2.0 **7 hrs**

Key elements of HSR systems.

Unit- 3.0 **7 hrs**

Key elements of HSR subsystems including: core systems (trains, power, signal, communication and control).

Unit- 4.0 **7 hrs**

Track system and civil infrastructure (earthwork, bridges, viaducts and tunnels).

Unit- 5.0 **7 hrs**

Basic design and construction of HSR stations.

Unit- 6.0 **7 hrs**

Basic design and construction of rolling stock maintenance facilities.

Text/ Reference:-

1. Rangwala. S.C, "Railway Engineering", 27rd Edition, Charoatar Publishing House Pvt. Ltd, 2017.
2. Chandola, S.P. "Railway Engineering - A Text book of Transportation Engineering", S. Chand & Co. Ltd. 2016.
3. Satish Chandra, Agarwal M. M, "Railway Engineering", 2nd Edition, Oxford University Press, 2013.
4. Saxena S.C and Arora S.P, "Railway Engineering", Dhanpat Rai Publications, 8th Edition, 2017.
5. Mundrey J.S, "Railway Track Engineering", McGraw Hill Publications, 4th Edition, 2010. 6. RajatRastogi," Transportation Engineering-II", NPTEL Videos.

Course Code- Engineering Economics, Estimation & Costing Lab 0 0 2 1

Hands on Experiment based on the theory of Engineering Economics, Estimation & Costing.