SEM VII- COURSE CONTENTS
AY 19-20

PC-BTC 701 **Limit State Method of Reinforced Concrete Structures**
(AY 2019-20)

Prerequisites: ES-BTC302, PC-BTC402, PC-BTC501

Course Objectives:

1. To develop Civil Engineering graduates having clear understanding of concepts of reinforced concrete design using Limit state approach.
2. Application of LSM to design different RCC members.
3. To familiarize students to use of IS 456 and relevant IS codes, its importance in RCC design.
4. To deal with environmental and economic issues.
5. To develop Civil Engineering graduates having clear understanding of concepts of reinforced concrete design using Limit state approach.
6. Application of LSM to design different RCC members.
7. To familiarize students to use of IS 456 and relevant IS codes, its importance in RCC design.
8. To deal with environmental and economic issues.

Course Outcomes:
At the end of the course the students shall be able to develop collaborative skills to work in a team/group and design skills to:

1. Deign RCC members like beam, slab, column, footings using LSM method for safety stability and economy.
2. Use IS 456 for design of RCC members

Course Content

Module No	Details	Hrs
1	Ultimate Load Method: Brief introduction to fundamentals of ultimate strength theory: curved stress distribution, compressive stress block, simplified rectangular stress block as per Self Learning:Whitney's approach, ultimate moment of resistance of singly reinforced section and doubly reinforced sections.	03
2	Limit State Method: Introduction to limit state method of design as per IS 456 (latest edition): concepts of probability and reliability, introduction to various limit states Self Learning :characteristic loads, characteristic strength, partial safety factors for loads and materials,.	02
3	Limit State of Collapse - Flexure: Limit state of collapse in flexure, shear and design of singly reinforced rectangular sections. Limit state of serviceability in deflection and cracking	04
4	Design and analysis of doubly reinforced rectangular sections, T sections for flexure, Design of members in shear and bond, design of beam subjected to bending and torsion. Requirements governing reinforcement detailing.	07
5	Design of Slabs: Design of one way slab, two way slab and flat slabs	05

6	Limit State of Collapse - Compression: Limit state of collapse compression for short and slender column. Column Members subjected to combined axial and uni-axial as well as biaxial bending. Development of interactive curves. Use of interactive curves in column design.	07
7	Design of Foundations: Isolated square and rectangular footings subjected to axial load and moments. Design of combined rectangular pad footings, slab beam type footing and strap footing	08

Text Books:-

1. Ashok K. Jain(1993), "Reinforced Concrete: Limit State Design" , Nem Chand & Brothers, ISBN 8185240531, 844 pages
2. Dr. H. J .Shah,(2008),"Reinforced Concrete, Volume 2", Charotar Publishing House Pvt. Limited, ISBN 8185594732, 424 pages
3. S N Sinha, (2002),"Reinforced Concrete Design, Second Revised Edition", Tata McGraw-Hill Education, ISBN 0070473323, 705 pages
4. Karve& Shah, (2011), "Illustrated Design of Reinforced concrete Buildings", mihail-koprivchin-3758, 502 pages
5. Relevant I.S. codes and design aids
6. P.C. Vargese (2007) Advance reinforced concrete design, PHI Learning.
7. B.C. Punmia, Ashokumar Jain and Arunkumar Jain (2009), Limit State Design of Reinforce Concrete.

Reference books:-

1. B.P. Hughes (1976), "Limit State Theory for Reinforced Concrete Design", Pitman, ISBN 0273010239.
2. Phil Moss Ferguson, J.E. Breen & J.O. Jirsa (1988), "Reinforced Concrete Fundamentals", John Wiley and Sons (WIE), ISBN 0471803782, 592 pages.

PC-BTC 702 Construction Engineering
(AY 2019-20)

Prerequisites:

Course Outcomes:

On completion of the course, the students will be able to:

1. Select appropriate equipment for various construction activities, determine its optimal use and estimate cost & its efficiency.
2. Describe various methods of tunneling in soil and in hard rock, choose suitable equipment and explain various factors related to the planning and execution during construction of tunnels.
3. Evaluate and analyze the requirements of a given construction site and propose a suitable ground improvement technique.

Syllabus

Module	Topic	Lectures (hours)
1	**CONSTRUCTION EQUIPMENT** Study of equipments, with reference to available types -- standard and special types, and their capacities, operations and factors affecting their performance, production rate - earthmoving and hauling equipment, drilling and blasting equipment, mining, quarrying & crushing equipments, pile driving equipments, cranes.	**16**
2	**EQUIPMENT COST** Cost of owning and operating an equipment, depreciation costs, equipment life – economic life and useful life, scrap and salvage value, accessing equipment production for a construction activity.	**03**
3	**TUNNELLING** Geotechnical investigations, selection of alignment, methods of tunnelling in soil, soft rock and in hard rock, sequence of operations for drilling and blasting method, mechanical moles, boomers, tunnel boring machines, mucking, fore-polling, ventilation of tunnels, construction of cross passage, dust control, types of tunnel supports, sequence of lining operation, precast liner, lining with pneumatic placers, and by pump concrete method.	**05**
4	**GOUND IMPROVEMENT TECHNIQUES** Soil stabilization techniques - use of geotextiles and chemicals, sand drains, stone columns, diaphragm wall, rock anchors, foundation grouting, Tunnel grouting, ground settlement improvement.	**03**
5	**ADVANCED CONCRETE CONSTRUCTION** Mass concreting, vacuum concrete, forms for concrete construction: slip forms, Jump forms, collapsible forms, forms for cantilevers, concrete mixers.	**03**
6	**DEWATERING** Well point system, deep well, selection of pumps, types of pumps, numerical based on HP & selection of pump.	**03**
7	**BRIDGE CONSTRUCTION** Geotechnical investigation, Site selection, launching of Precast Prestressed Girder / Structural Girders by incremental launching, using false work, balanced cantilever construction method, coffer dams types and applications.	**03**

Term work: -
At least one site visit should be arranged to give an exposure to various construction equipment and techniques discussed in the above syllabus. A report on site visit and at least 10 assignments shall besubmitted as term work.

Textbooks:

1. Navalkar, C. B. (2005); "Textbook on Explosive Engineering – Blasting Technology & Explosive Applications, Basics, State of the Art & Instrumentation" SEMCONS Consultants. 108p
2. Peurifoy, Schexnayder, and Shapira (2013); "Construction Planning, Equipment and Method" McGraw Hill Education (India) Private Limited, ISBN-13 9780070706996.
3. Purushothama Raj, P. (2005); "Ground Improvement Techniques", Firewall Media, ISBN-13 – 9788170088370. 266p
4. Raina, V.K. "Concrete Bridge Practice", Tata McGraw Hill Publications, 2nd edition.
5. Srinivasan, R. (2009); "Harbour, Dock and Tunnel Engineering", Charotar Publishing House Pvt. Limited, ISBN-13 – 9788185594897. 424p
6. P Guha thakurtha, Handbook, concrete technology

Reference books:

1. Bowels J E (1997); "Foundation Analysis and Design", McGraw Hill Education (India)
2. Mahesh Varma (1975); "Constrution Equipment and Its Planning and Management" Metropolitan Book Company. ASIN: B0007AK5JY. 531p
3. Private Limited. ISBN-13 9780071188449. 1175p.
4. S C Sharma (2002); "Constrution Equipment and Its Management" Khanna Publications. ISBN-13 978-8174091376. 982p.
5. S. Seetharaman (2000); "Construction Engineering & Management", Umesh, S Chand, New Delhi ISBN-13 – 9788188114061. 487p.
6. USBR, Concrete Manual
7. USBR, Earth Manual

PC-BTC 703 Water Resources Engineering
(AY 2019-20)

Prerequisites: PC-BTC 306, PC-BTC353, PC-BTC504, PC-BTC603, PC-BTC501

Course Objectives:

The main objectives of the course are

1.To summarize the fundamentals of water resources systems and to compute the various parameters required for the design of hydraulic structures as per Codal provisions.
2.To acquire the knowledge of hydrological parameters for the discharge calculations.
3.To appraise the various parameters for the design of hydraulic structure, cross drainage work, groundwater and well water system.
4.To discuss different methods of irrigation, water distribution systems and their suitability.

Course Outcomes:
At the end of the course the students shall be able to

1.Describe various methods of irrigations
2.Measure and analyse rainfall and runoff.
3.Compute the water requirements of crops
4.Design various hydraulic structures and irrigation systems**.**

Course Content

Module	Details	Hrs
1	Introduction water resources in India, Hydrologic cycle, Irrigation, need of irrigation in India, development of irrigation in India, impact of irrigation on human environment, irrigation systems, minor and major command area development,	02
2	Water requirement of crops: Crops and crop seasons in India, cropping pattern, duty and delta. Quality of irrigation water. Soil water relationship: soil characteristics significant from irrigation considerations, root zone soil water, infiltration, consumptive use, irrigation requirement, frequency of irrigation. Methods of applying water to the fields: surface, sub-surface, sprinkler and drip irrigation. Bandhara Irrigation, Water logging: causes, effects and remedial measures.	06
3	Hydrology: Rainfall and its measurement, stream flow measurement runoff process, factors affecting runoff, runoff hydrograph, runoff computations, flood discharge calculations, unit hydrograph, S -hydrograph.	06

4	Ground water and well hydraulics: Ground water resources, occurrence of ground water, methods of ground water exploration, well irrigation. Well hydraulics: steady state flow in wells, equilibrium equations for confined and unconfined aquifer, aquifer tests, design of water wells.	05
5	Reservoir planning: Investigations, selection of site, zones of storage, storage capacity and yield, reservoir sedimentation. Economic height of dam, Flood routing.	04
6	Dams Introduction, classification. Gravity dams: forces acting on gravity dam, modes of failure, stability analysis, design, galleries, joints, keys, water seals. Earth and rockfill dams: types, causes of failure, seepage analysis, stability analysis, design, rockfill dams. Arch and buttress dams: types. Spillways and other energy dissipating devices: types	09
7	Distribution systems: Canal systems, alignment of canals, canal losses, estimation of design discharge.Design of Canal: Kennedy's and Lacey's Theory. Canal outlets: non-modular, semi-modular and modular outlets Lining of canals: economics of lining. Drainage of irrigated land: necessity, methods. Canal regulation works. Cross drainage works.	04

Term work: -

At least seven assignments covering the entire syllabus shall be submitted as term work.

Recommended Books: -

1. Dr. B.C. Punmia and Dr. Pande B.B.Lal (2009); "Irrigation and Water Power Engineering", Laxmi Publications Pvt. Ltd. New Delhi. ISBN-13 – 9788131807637. 964p.
2. Dr. P.N. Modi (2008); "Irrigation Water Resources and Water Power Engineering" Standard Book House. Delhi. ISBN-13 – 9788189401290. 1070p.
3. S. K. Garg (2009); "Irrigation Engineering and Hydraulics Structures", Khanna Publishers. Delhi. ISBN-13 – 9788174090478. 1594p
4. Challa Satya Murthy (2002);"Water Resources Engineering: Principles and Practice" ISBN-13 – 9788122413823. 306p.
5. S. K. Sharma; "Design of Irrigation Structures", S. Chand and Co. ISBN-13 – 9788121903295
6. R. S. Varshney and R. C. Gupta (1988); "Theory and Design of Irrigation Structures: Canal and storage works" Nem Chand & Bros. ISBN-13 – 9788185240022
7. G.L.Asawa (2006); "Irrigation and Water Resources Engineering", New Age International Publishers. ISBN-13 9788122416732. 624p

PC-BTC704 Course: - Environmental Engineering – II (AY 2019-20)

Prerequisites: BTC330, BTC379

Course Objectives:

The students will learn to –

1. Design various units of sewerage system and wastewater treatment processes
2. Quantify and analyse the sewage generated by various sources
3. Evaluate sources of air and noise pollution in detail and devise methods for controlling them
4. Utilize environmental laws and environmental management system as a key towards a better society

Course Outcomes:

The students will be able to

1. Design all units of sewerage network and wastewater treatment plant such as grit chamber, screens, biological treatment and sedimentation tanks
2. Analyze the pollution parameters for the wastewater
3. Develop a mitigation plan for noise, soil and air pollution
4. Undertake and hypothesize the environmental audit plan

Course Content

Module No.	Topics	No of Lectures
1	Air Pollution: i. Definition of air pollution, major episodes, classification of air pollutants, units of quantification, sources of air pollution, natural & man made effects of air pollution on human health, animals. plants, properties. Global atmospheric change, green house effect, ozone depletion, carbon cycle. Effects of carbon dioxide, chlorofluorocarbons, green house gases, effects of temperature increase, emission control.	06
2	Soil/Land Pollution i. Definition, Causes of soil pollution, Effects: Health and ecosystem, Remediation of soil pollution	02
3	Sewage: Conveyance and pumping i. Conveyance of Sewage: Sewers- shapes and materials of sewers, sanitary, storm and combined sewers, capacities and designs, appurtenances, maintenance of sewers. ii. Sewage pumping: Consideration of the selection of pump and location of pumping stations.	04
4	Sewage: Characterization and disposal i. Characteristics of sewage: Composition, chemistry of sanitary sewage, B.O.D., C.O.D., aerobic and anaerobic decomposition. ii. Sewage Disposal: discharge of raw and treated sewage on land and water, standards for disposal, raw and treated sewage on land and water, limits of dilution. iii. Self purification of streams: oxygen economy, sewage farming.	06
5	Sewage treatment: Basic flow sheets and Unit Operations Aims, methods of treatments and various flow-sheets for preliminary, primary, secondary and, tertiary treatment, screens, grit chambers, primary and secondary clarifiers, disposal of screenings and grit.	06

6	Biological treatment methods, principles, trickling filter operation, recirculation, activated sludge process and its modifications, hydraulic design of trickling filter and activated sludge process, sludge volume index, operational problems in activated sludge process and trickling filters, stabilization ponds Sludge digestion: Principles of anaerobic digestion, quantity and characterization of sludge, design of sludge digestion tanks, disposal of digested sludge, drying bed Low cost sanitation: Septic tanks and Imhoff tanks – principles, operation and suitability, design values, disposal of treated effluent	17
7	Environment Auditing, Legislation and Laws Environmental Management System (EMS) ISO 19000 series Legislation and Laws i) Water Act, 1974 ii) Air Act, 1981 iii) Environment protection act (EPA- 1986)	08

Theory Examination:-

1. Question paper will consist of total seven questions carrying 20 marks each.
2. Only five questions need to be attempted.
3. In question paper, weightage of each module may be proportional to the number of respective lecture hours as mentioned in the syllabus.

Practical Examination:-

Practical examination will be based on the experiments conducted

Term work:

Report on experiments performed as detailed above, assignments including 10 problems based on the above syllabus (preferably 2 problems on each topic) shall be submitted as term work.

Recommended Books:-

1. E.W.Steel (1947); “Water Supply & Sewage”, McGraw Hill, New York. ASIN: B001SL037A
2. T.J.McGhee (1991); “Water Supply & Sewage” McGraw Hill, New York. ISBN-13-9780071008235. 602p.
3. Dr. P.N.Modi (2008); “Sewage Treatment & Disposal & waste water engineering” Standard Book House. ISBN 13 9788190089326. 988p.
4. Garg S. K (2008); “Sewage Disposal & Air Pollution Engineering”. Khanna Publication. ISBN 13 978-8174092304. 200p
5. M.N.Rao (1989); “Air Pollution:” Tata McGraw Hill, New Delhi. ISBN 13 9780074518717.339p
6. Nathanson J.A (2014) “Basic Environmental Technology: Water Supply, Waste Management and Pollution Control”. Prentice Hall. ISBN-13: 978-0132840149. 456p.
7. J.W. Clark, W.Veisman, M.J.Hammer (2008); “Water Supply and Pollution Control” Prentice Hall. ISBN-13: 978-0132337175. 864p.
8. Gilbert Masters (2013); “Introduction to Environmental Engineering and Science” Pearson Education. ISBN 13 9781292025759. 700p.
9. Manual on Water Supply and Treatment, (latest Ed.): Ministry of & Housing. New Delhi
10. Relevant Indian Standard Specifications, BIS Publications
11. CPHEEO Manual on Water Supply & Treatment

PC-BTC751 Course: - Environmental Engineering II (Laboratory)

(AY 2019-20)

Prerequisites:

Course Objectives:

The students will learn to

1. To find various parameters of wastewater
2. To analyse and interpret the usability of wastewater for reuse purposes and to check the standards with relation to disposal of wastewater
3. To analyse and interpret the treatment technologies to be use for waste reuse or disposal

Course Outcomes:

The course will enable the students to

1. Analyse and interpret the data related to wastewater parameters.

Experiment No.	Details
1	Determination of pH, Temperature and Color
2	Determination of Turbidity
3	Determination of Hardness
4	Determination of Alkalinity
5	Determination of Solids(Total solids, Suspended Solids, volatile solids)
6	Determination of Chlorides
7	Determination of Dissolved Oxygen
8	Determination of Biological Oxygen Demand
9	Determination of Chemical Oxygen Demand
10	Determination of Sulphates
11	Determination of ammoniacal Nitrogen and Nitrate Nitrogen (Kjeldahl Nitrogen)

Reports of experiment performed shall be submitted as part of practical work along with assignments related to experimental work. The assessment will be based on practical performance, attendance and experimental work during semester.

Recommended Books: -

[1] Eaton, A. D., Clesceri, L. S., Greenberg, A. E., Franson, M. A. H., American Public Health Association, AmericanWater Works Association., &Water Environment Federation. (2000). Standard methods for the examination of water and wastewater.Washington, DC: American Public Health Association (APHA).

[2] Relevant Indian standards, CPCB standard method (available online)

PE-BTC711 Course: -Elective-I: Advanced Structural Analysis (AY 2019-20)

Prerequisites -Structural Analysis I & II

Course Objectives:

1. To impart clear understanding of concepts & practical knowledge of advanced and conventional methods of analysis required to design various types of civil engineering structures.
2. To apply stiffness matrix method to analyze various real life structures required to design of safe &economical structures.
3. To understand development of commercial software using stiffness matrix method

Course Outcomes:

After completing the course, student will be able to develop collaborative skills to work in a team/group and analytical skills to

1. Analyze various types of structures, using stiffness matrix method.
2. Analyze pin jointed/rigid jointed plane frames (including frames with inclined members) subjected to different loadings including settlement of supports, temperature changes and elastic supports by flexibility method.
3. Analyze framed structures using conventional methods for preliminary design of structure.
4. Construct the ILD for indeterminate beams
5. Use computer software (SAP/ETAB) for analysis of various real life structures

Course Content

Module No	Details	No of Lectures
1	**Introduction to Stiffness Method in Matrix Form:** Basic concepts of stiffness coefficients, member stiffness matrix for member of plane truss, member of rigid jointed plane frame, member of plane grid and member of space frame. Properties of stiffness matrix, co-ordinate transformation matrix, stiffness matrix in local and global co-ordinate axes system, assemblage of structural stiffness matrix and application of boundary conditions.	6
2	**Stiffness Matrix Method contd…** Joint loads, Equivalent joint loads, method of solution for displacements and computation of internal forces in members. Application of stiffness method to beams, pin jointed trusses, rigid jointed plane frames and simple plane grid structures.	4
3	**Conventional Form of Stiffness Method, Modified Moment Distribution Method**: Symmetric structure, Symmetric and anti-symmetric loads, Modification of stiffness and carryover factors for symmetric and anti-symmetric loads both for sway and non-sway cases for frames with different support conditions. Application to frames (without inclined members) with and without side sways.	06
4	**Flexibility Method:** Review of concepts of flexibility coefficients, Selection of primary structure, concept of structure flexibility matrix, compatibility equations, solution for redundant forces, computation of internal forces, and joint displacements. Application to pin jointed trusses and rigid jointed plane frames for different loading including the effect of settlement of support, temperature changes and elastic supports. **Conventional Form of Flexibility Method:** Elastic Center Method and its application to rectangular box, rigid jointed portal	03 06

	frames and fixed arches. Column Analogy Method and its application to analysis of non prismatic beams, simple rectangular frames, determination of stiffness coefficients and carry over factors for non prismatic beam members. Self Learning: Application of Elastic Center Method to fixed arches.	
5	**Influence Line Diagrams for Indeterminate Structures:** Muller Breslau's Principle for drawing influence line diagrams for statically indeterminate structures. Influence Lines Diagrams for propped cantilevers, fixed beams and continuous beams. Self Learning: ILD for indeterminate beams.	05
6	**Approximate Methods for Analysis of Building Frames:** Approximate methods for gravity loads: Substitute frame and equivalent frames. Approximate methods for lateral loads: Portal and cantilever method.	03
7	**Plastic Analysis of Steel Structures:** Application to single bay single storey rectangular frames.	03

Term work:-

At least 20 (twenty) solved problems based on the above syllabus shall be submitted as term work. Exposure to computer aided analysis using available software.

Text Books:-

1. Basic Structural Analysis: Reddy C.S., Tata McGraw hill.
2. Intermediate Structural Analysis: Wang C.K., Tata McGraw hill.

Reference Books:-

1. Matrix Method in Structural Analysis: Livesley R. K., Pergamon Press, London.
2. Analysis of Framed Structures: Gere and Weaver, East-West Press.
3. Elementary Structural Analysis: Wilber, McGraw Hill, New York.
4. Analytical Method in Structural Analysis: S.A. Raz, New Age Int Publishers
5. Modern Methods in Structural Analysis: Dr. B.N. Thadani and Dr. J. P.Desai,Weinall Book Corporation.
3. Plastic Methods of Structural Analysis: B.G.Neal, Chapman & Hall, London.
4. Structural Analysis Vol.I and Vol. II: Pandit and Gupta, Tata McGraw hill.
5. Matrix Method in Structural Analysis: Pandit and Gupta, Tata McGraw hill.
6. Matrix Methods of Structural Analysis: Dr. A. S. Meghre, S. K. Deshmukh, Charotar Publishing House.
7. Structural Analysis: In Theory & Practice: Alan Williams, Butterworth-Heinemann, 2009
8. Fundamentals of Structural Analysis: Kenneth M Leet, Chia-Ming Uang & Anne M Gilbert, Tata McGraw hill.
9. Matrix Structural Analysis: Ronald L Sack, Waveland Press, 1994
10. Plastic Thoery of Structures: Michael R Horne, Elsevier, 2014
11. Advanced Methods of Structural Analysis: Igor A Karnovsky, Olga Lebed, Springer Science & Business Media, 2010
12. Structural Analysis: A Unified Classical & Matrix Approach: Amin Ghali, Adam Neville & T G Brown, CRC Press, 2013
13. Statically Indeterminate Structures: Approximate Analysis by Deflected Structures & Lateral Load Analysis: Jack R Benjamin, Literary Licensing, 2012

PE- BTC712 Course: - Elective-I: Advanced Computational Techniques (AY 2019-20)

Prerequisites: BS-BTC301, BS-BTC401

Course Objectives:

1. To discuss different methods of statistics, probability theory and its application in construction Industry.
2. To outline different methods of data collections for civil engineering problems, its use in statics and Hypothesis.
3. To explain the application of linear programming problem and transportation problem in construction industry.

Course Outcomes:
Student will be able:

1. To identify the method of data collection for statistical analysis and testing of hypothesis.
2. To implement the concept of probability theory in civil engineering projects.
3. Toformulate a linear Programming Problem and Transportation Problem for optimization of civil engineering projects.

Course Content

Module No	Topics	No of Lectures
1	Review of basic statistics and probability : Probability Distributions, Theoretical : binomial, poisson, normal, exponential, hypergeometric, uniform	06
2	Sampling and Sampling Distributions Probability and non-probability samples, sampling and non-sampling errors Sample size, sampling distributions : t, F and c^2 distributions	06
3	Hypothesis Testing Type I and II error, testing of mean, proportion, tests for equality of mean and variances of two populations, confidence interval, c^2 test for goodness of fit, ANOVA (one way classification), Non parametric tests : sign test, U test	06
4	Correlation and Regression	04

	Karl Pearson's and Rank Correlation coefficient, simple linear regression : least squares method	
5	Management Decision Making, System approach, decision making under uncertainty and risk: decision tables and decision tree.	04
6	Linear Programming Graphical solution, simplex method, dual, sensitivity analysis, transportation and assignment problems	06
7	Intoduction to Genetic Algorithms	04

Term work:-
Minimum eight assignments shall be submitted as term work.

Recommended Books:-

1. Quantitative Techniques for Managerial Decisions: Shrivastava, Shenoy& Sharma, Wiley
2. Research Methodology: Kothari C R, Wiley Eastern
3. Methods in Social Research: Goode W J &Hatt P K, McGraw Hill
4. Handbook of Genetic Algorithms (1991): L. D. Davis, Melanie Mitchell. Van NostrandReinham
5. An Introduction to Genetic Algorithms (1998): Melanie Mitchell, Van NostrandReinham

PE-BTC 713- : Applied Hydrology and Flood Control
(AY 2019-20)

Prerequisites: BS-BTC301, BS-BTC401

Course Objectives:
The objective of this course is:
1. To discuss scope of hydrology and hydrologic parameters and introduce the basic components of the hydrological cycle and discuss the water balance model.
2. Give an account of the different components evapotranspiration, precipitation, interception, run off, stream flow.
3. To summarize hydrographs along with estimation and design flood control methods.
4. to describe reservoir and channel routing techniques and its applications.

Course Outcomes:
At the end of this course, students will be able:
1. To estimate precipitation, runoff and water losses along with stream flow measurements by various techniques.
2.To carry out the flood estimation, its routing techniques along with importance of flood frequency studies and
3.To apply probabilistic as well as stochastic methods in flood estimation.

Module No	Topics
1	Introduction: Hydrological cycle, scope of hydrology, water budget equation, sources of data, Introduction to climate change.
2	Precipitation and Water Losses: Measurement, rainfall records, missing data, mass curve analysis, station year method, depth - area - duration relationship, intensity - duration - frequency relationship. Water losses: Evaporation, evapotranspiration, interception, initial loss, infiltration. Determination of water losses.
3	Streamflow's and Runoff: Stream gauging techniques, latest methods of measuring depths, current meter-types-calibration, mid-section and mean section methods, rating curves. Runoff: Factors affecting runoff, rainfall-runoff relationship, runoff estimation.
4	Hydrograph analysis: Characteristics, base flow separation, unit hydrograph, S-hydrograph, complex hydrograph, synthetic hydrograph, dimensionless unit hydrograph, instantaneous unit hydrograph.
5	Floods and Flood routing: Estimation, envelope curves, flood frequency studies, probability and stochastic methods, estimation of design flood, flood plains, flood hazards, flood control methods, limitations, risk-reliability and safety factor. Reservoir routing, channel routing.
6	Hydrological forecasting: Introduction, General operation of flood forecasting, forecasting by unit hydrograph method.

Recommended Books:-

1. Engineering Hydrology: K. Subramanya, Tata McGraw Hill Publishing Co. Ltd.. New Delhi.
2. Hydrology: H. M. Raghunath, New Age International Publishers, New Delhi
3. Elementary Hydrology: V. P. Singh, Prentice Hall
4. Engineering Hydrology: Principles and practice: V. M. Ponce, Prentice Hall
5. Hydrology and Water Resources Engineering: K. C. Patra, Narosa Publishing House, New Delhi.
6. A Text Book of Hydrology: Dr. P. Jayarami Reddi, Laxmi Publications Pvt. Ltd. New Delhi.

PE-BTC 715: GEO-INFORMATICS TECHNOLOGIES
(AY 2019-20)

Course Outcomes:
On completion of the course, the student will be able to:

1. Provide a basic understanding on geospatial data, technologies and its process.
2. Apply the knowledge of geo-informatics technologies for data acquisition, data analysis, data interpretation and application for any spatial problems.

Proposed Syllabus

Module	Topic	Lectures (hours)
1	**INTRODUCTION** Basic or conventional geodesy – shape and size of the earth, geoid models, time system, coordinate system, ellipsoids, datums, Indian geodetic system and transformation, satellite geodesy –history and applications	04
2	**CARTOGRAPHY** Introduction, cartography and map types, map projections, map scales, data characteristics and map symbols, map design – georefrencing	03
3	**GLOBAL POSITIONING SYSTEM** Introduction –History - Transit, Timation, NAVSTAR GPS,GLONASS, GALILEO, GPS design objectives and details ofsegmentsspace, control and user, blocks ofGPS- Block I, II/IIA, IIR Satellites, IIF, advantages and current limitations of GPS, Status of GPS Surveying, GPS signal structure, GPS orbits, GPS errors and accuracy, GPS observables, GPS survey methods, GPS applications, future developments in GPS – GLONASS and GALILEO systems	08
4	**REMOTE SENSING TECHNOLOGY** Definition and overview, history and evolution, physics of remote sensing – MER, EM spectrum, Sources of EMR, interaction between MER and atmosphere, atmospheric windows, remote sensing system - platforms, active and passive system, imaging and non-imaging systems, resolution – spectral, spatial, radiometric, temporal, ground truth data collection – radiometers, spectrophotometers, spectral reflectance, spectral signatures, Earth observation satellites and their characteristics – LANDASAT, SPOT, IRS, IKONOS, sensors, image interpretation, image processing – data enhancement, data classification, data compression	12
5	**GEOGRAPHIC INFORMATION SYSTEM** Spatial information, hardware and software requirements, data models – conceptual model for spatial and non- spatial databases, data creation and organisation, data quality, errors in GIS, spatial data analysis – vector based and raster based, network analysis, digital elevation models (DEM), interpolation methods, spatial data infrastructure, recent trends in GIS, GIS applications	09

Total: 36 Lectures

Textbooks:

1. Hoffmann-Wellenhof, B. (1994). GPS Theory and Practice. Springer-Verlag, New York (2nd edition).
2. Lillesand Thomas M. & Kiefer Ralph: Remote Sensing and Image Interpretation Third Edition John Wiley.
3. Longley,P.A., Goodchild, M. F., Maguire, D. J., and Rhind,D. W. (2005). Geographic Information Systems and Science, 2nd Edition, John Wiley and Sons.

Reference books:

1. Burrough,P.A., and McDonnell, R.A. (1998) Principles ofGeographical Information Systems, 2nd Edition, OxfordUniversity Press, 1998.
2. Campbell John B. Introduction to Remote Sensing, Taylor & Francis, London.
3. Ormsby, T., E. Napoleon, R. Burke, C. Groessl, and L. Bowden (2010). Getting toKnow ArcGIS Desktop: for ArcGIS 10, 2nd Edition, ESRI Press, Redlands, CA, ISBN:978-1-58948-260-9.
4. Parkinson,B. W., Spilker, J. J. (Jr.)(1996).Global Positioning System: Theory & Applications (Volume-I). AIAA, USA.

PE-BTC 716-Advanced Repair and Rehabilitation of Structures (AY 2019-20)

Prerequisites: BS-BTC302, BS-BTC403

Course Objectives:

1.To understand need for repair and rehabilitation.
2. To develop clear understanding of concepts, and practical knowledge of modern Civil Engineering techniques.
3. To encourage students and faculty to interact with industry, alumni and other reputed institutes for purpose of better understanding of industry requirements and different materials used.
4. To deal with social, environmental and economic issues when applying various techniques.

Course Outcomes:

1. Application of various repair techniques as per the requirement of the problem.
2. To act as catalyst in transferring the Civil Engineering knowledge to field usage for the socio-economic development of the society.
3. To provide a platform to students, scientists, engineers and working professionals to come together and implement the academic outcome to the field.

Proposed Syllabus

Module	Topic	Lectures (hours)
1	Introduction: Need for strengthening due to various reasons such as ageing, natural calamities, increase of load, change of function and design, construction errors	4
2	Structural Strengthening: Strengthening and retrofitting of columns, beams, walls, footings and slabs, piers of concrete structures by jacketing, external post-tensioning, replacing or adding reinforcement, plate bonding, textile reinforced concrete	3
3	Specialized Repairs: Electro chemical repair using re-alkalization and chloride extraction techniques, Specialized repairs for chemical disruption, fire, marine exposure etc, Repair of damaged structures of water retaining structures	8
4	Hydraulic structures, Pavements and Runways, Tunnels, Bridges, Piers andFlyovers, Parking Garages, Underwater repair, Masonary Repair, Repair and Restoration of Heritage Structures	5

Term work:-
At least 8 assignments shall be submitted as term work.

Recommended Books:-
1. Concrete Repair and Maintenance: Peter H .Emmons and Gajanan M. Sabnis, Galgotia Publication.
2. Repairs and Rehabilitation-Compilation from Indian Concrete Journal-ACC Publication.
3. Guide to Concrete Repair and Protection, HB84-2006, A joint publication of Australia Concrete Repair Association, CSIRO and Standards Australia.
4. CPWD hand book on Repairs and Rehabilitation of RCC buildings published by DG(Works), CPWD, Government of India (NirmanBhawan), http://www.cpwd.gov.in/handbook.pdf
5. Guide to Concrete Repair, Glenn Smoak, US Department of the Interior Bureau of Reclamation, Technical Service Center , http://books.google.co.in
6. Management of Deteriorating Concrete Structures: George Somerville, Taylor and Francis Publication
7. Concrete Building Pathology: Susan Macdonald, Blackwell Publishing.
8. Testing of Concrete in Structures: John H. Bungey, Stephen G. Millard & Michael G. Grantham, Taylor & Francis Publication.
9. Durability of concrete and cement composites: C.L.Page& M.M. Page,Woodhead Publishing
10. Concrete Repair, Rehabilitation and Retrofitting: M. Alexander, H. D. Beushausen, F. Dehn& P. Moyo, Taylor & Francis Publication
11. Concrete Repair Manual, Volume I & II, Published jointly by ACI, BRE, Concrete Society, ICRI

Sr. No.	Examination	Module
1	T-1	Module 1 and 2
2	T-2	Module 3 and 4
3	Final Examination	Module 1 to 7

PE-BTC 717-Systems Approach in Civil Engineering
(AY 2019-20)

Prerequisites: BS-BTC301, BS-BTC401

Course Objectives:

1. Student should be able to develop the skill for problem formulation and should be able to understand various components for formulating a problem
2. To develop decision making Specially under uncertain Scenario
3. Students should be able to formulate LPP, Distribution and queuning models and should able to analyse them.

Course Outcomes:

Graduate students should be able to develop capability in solving various civil engineering activites related to infrastructural projects by formulating problems and modules related to LPP, Distribution quening. They should be able to analyse and come to appropriate decision making.

Course Content

Module No	Topics	No of Lectures
1	Concept of systems approach: system, boundaries of system, goals and objectives, optimality, mathematical models, objective function and constraints, problem solving mechanism, types of problems, modeling / problem formulation, sub-optimization, solution techniques, sensitivity analysis	06
2	Decision theory: classification of decision situations, decision tables and decision tree, criteria for decision making under certain, uncertain and risk conditions, utility theory	05
3	Time series analysis: variations in time series, trend analysis: method of moving averages, method of least squares	05
4	Index numbers: basic requirements of index numbers, constructing index numbers: using relatives, using aggregates	04
5	Linear programming: general nature of problem, formulation of problems, graphical method of solution, simplex method, dual, sensitivity analysis	07
6	Distribution models: transportation and assignment problems and their solutions	06
7	Queuing models: various situations, queue discipline and customer behavior, single server model	

Term work:- At least two assignments and 3 problems on each of the topic shall be submitted as term work.

Recommended Books:-

1. Systems Analysis for Civil Engineers: Ossenbruggen P J
2. Quantitative Techniques for Managerial Decisions: Shrivastava, Shenoy& Sharma, Wiley Eastern

PE-BTC 719 -Structural Dynamics
(AY 2019-20)

Prerequisites: BTC302, BTC331, BTC228,BTC203

Course Objectives:

1 To develop civil engineering graduates having clear understanding of concept of dynamic loads, dynamic analysis of structures.
2 To apply knowledge of structural dynamics to understand the behavior & to find the response of various structures subjected to dynamic loads.
3 To apply knowledge of Random Vibration analysis to study the behavior of structures.

Course Outcomes:

After completing the course students will be able to develop collaborative skills to work in a team/group and analytical skills to

1. Distinguish between static and dynamic loads.
2. Carry out the dynamic analysis of various types of single and multiple degrees of freedom structures (Damped and undamped) for different types of dynamic loads including ground motion in time domain.
3. Carry out Frequency Domain analysis of single and multiple degrees of freedom structures

Course Content

Module No	Topics	No of Lectures
1	**Introduction:** Introduction to structural dynamics, definition of basic problem in Dynamics, static v/s dynamic loads, different types of dynamic loads.	02
2	**Single degree of Freedom (SDOF) systems:** Un-damped free vibration of SDOF system, natural frequency and period ofvibration, damping in structures, Viscous damping and Coulomb damping,effect of damping on frequency of vibration and amplitude of vibration, logarithmic decrement, computation of damping. Forced vibration, response to harmonic forces, periodic loading, dynamicload factors, and response of structure subjected to general dynamic load, Duhamel's integral, numerical evaluation of dynamic response of SDOF systems subjected to different types of dynamic loads. Distributed mass system idealized as SDOF system, use of Rayleigh'smethod, response of SDOF system subjected to ground motion.	10
3	Use of Fourier Series for periodic forces, introduction to vibration isolation. Concept of Transmissibility. **Introduction to frequency domain analysis**, response of structure in frequency domain subjected to general periodic and non-periodic /impulsive forces of short duration, use of complex frequency response function, Fourier Response Integral, Discrete Fourier Transforms, Fast Fourier Transforms.	03
4	**Generalized Single-Degree of Freedom System:** Generalized properties, assemblages of rigid bodies, systems with distributed mass and elasticity, expressions for generalized system properties. Application to single span beams.	07

5	**Free vibration of Lumped mass multi degree of freedom (MDOF) system:** Coupled and uncoupled systems, direct determination of frequencies of vibration and mode shapes, orthogonality principle, vibration of MDOFsystems with initial conditions, approximate methods of determination ofnatural frequencies of vibration and mode shapes-vector iteration methods, energy methods and use of Lagrange's method in writing equations of motion.	04
6	**Force vibration of Lumped mass multi degree of freedom (MDOF) system:** Decoupling of equations of motion, modal equation of motion, concept of modal mass and modal stiffness, forced vibration of MDOF system, modal analysis, and application to beams and multi storey frames with rigid girders subjected to lateral dynamic loads.	07
7	**Structure with distributed mass system:** Use of partial differential equation, free vibration analysis of single span beams with various boundary conditions, determination of frequencies of vibration and mode shapes, forced vibration of single span beams subjected to the action of specified dynamic loads.	03

Text Books: -

1. Dynamics of Structures by Clough &Penzien, McGraw-Hill, Computers & Structures, CBS Publishers, 2015
2. Dynamics of Structures: Theory & Applications to Earthquake Engineering by Anil K Chopra, Prentice Hall of India

Reference Books: -

1. Structural Dynamics by Mario Paz, Springer India, CBS Publishers, 2004
2. Introduction to Structural Dynamics by John M Biggs, CBS Publishers,2014
3. Basic Structural Dynamics by James C Anderson &FarzadNaeim, John Wiley & Sons
4. Fundamentals of Structural Dynamics by Roy R Craig & Andrew J Kurdia, Wiley
5. Mechanical Vibrations by Den P Hartog, McGraw-Hill
6. Dynamics of Structures by Jagmohan L Humar, 3rd Edition, CRC Press,
7. Wind Effects on Structures by Simiu E &Scanlan R H, Wiley
8. Wing Loading of Structures by John D Holmes, Spon Press
9. Structural Vibration: Analysis & Damping by Beards C F, Arnold
10. Vibrations & Control System by Beards C F, Ellis Horwood
11. Passive Energy Dissipation Systems in Structural Engineering by Soong T T&Dargush G F, Wiley
12. Introduction to Structural Motion Control by Connor J J, Prentice Hall, NJ
13. Active Structural Control by Soong T T, Wiley, NY & Longman Scientific & Technical, England
14. Liquid Sloshing Dynamics by Ibrahim, Cambridge University Press
15. Structural Damping: Applications in Seismic Response Modification by Zach Liang, George C Lee, Gary F Dargush&Jianwei Song, CRC Press
16. MATLAB: An Introduction with Applications by Amos Gilat, Wiley India

PE-BTC 718 Risk and Value Management
(AY 2019-20)

Prerequisites: BTC401

Course Objectives:
1. To discuss the basics of risk and value management.
2. To explain various mathematical tools used in risk assessment process.
3. To describe value engineering job, plan.
4. To outline the process of life cycle costing.

Course Outcome:
1. To carry out risk analysis and development of mitigation measures.
2. To implement value management process.
3. To execute the life cycle cost analysis.

Course Content

Module No	Topics	No of Lectures
1	Basic concept of Risk & Value Management, Definition of Risk, Types of risk, Risk & Uncertainty, Failure Mode Effect analysis, Performance Measures, Scope of risk control during project life cycle. Risk Registers	04
2	Risk analysis in construction projects, Risk priority number, Risk identification, analysis & response measures, Probabilistic Risk Assessment, Sensitivity analysis, Break even analysis, Scenario analysis, Decision trees, Monte-Carlo simulation	06
3	Risk Mitigation – by elimination, reducing, transferring, avoiding, absorbing or pooling. Residual risk, mitigation of unqualified risk. Coverage of risk through CIDC's MOU with the Actuarial Society of India through risk premium such as(BIP) – Bidding Indemnity Policy (DIMO) – Delay in meeting obligation by client policy, (SOC) – Settlement of claims policy (LOP)- Loss of profit policy(TI).	06
4	Value : Meaning of value, basic and secondary functions, factor contributing to value such as aesthetic, ergonomic, technical, economic : identifying reasons or unnecessary costs	04
5	Value Analysis: value analysis team; principles of value analysis, elements of a job plan viz. orientation, Information, presentation. Implementation, follow up action, benefits of value analysis, various applications; assessing effectiveness of value analysis	06
6	Value management, Energy resources, consumption patterns, energy cost escalation and its impact, key factors affecting energy consumption in the building and other construction works	04
7	Life cycle costing – Forecasting of Capital as well as operating & maintenance costs. Time value, present worth analysis, DCF methods, ROR Analysis	06

Term work:-
Assignments consisting of minimum twenty problems covering entire syllabus shall be submitted as term work

Recommended Books:-

1. Risk & Decision Analysis in projects, John Schuyler,PMI.
2. Risk Management & Construction, Roger Flangan& George Norman, Blackwell science
3. Risk Management for Design & Construction, OvidiuCretu, Robert B. Stewart and Terry Berends
4. Value Engineering Manual

PE-BTC 720Advanced Structural Mechanics
(AY 2019-20)

Prerequisites: ES-BT104, ES-BT204, ES-BTC302, PC-BTC402, PC-BTC502

Course Objectives:

The main objectives of the course:
1. To Introduced to the advanced topics of structural mechanics

Course Outcomes

At the end of the course the students shall be able to develop collaborative skills to work in a team/group and analytical skills to

1. Determine Shear Centre of thin walled open sections and analyse beams/members with large initial curvature
2. Analyse beams on elastic foundation and beams curved in plan
3. Use suitable failure theory to find the failure stress
4. Analyse deep beams and non-circular solid sections subjected to torsion

Course Content

Module No	Topics	No of Lectures
1	Shear Centre for symmetrical and non-symmetrical (about both axis) thin walled open sections	06
2	Bending of beams with large initial curvature loaded in their plane of curvature. Application to analysis of hooks, circular closed rings, chain links with straight length and semi-circular ends.	06
3	Beams on elastic foundation: Analysis of beams of infinite length Course ed to concentrated force/moment and semi infinite length subjected to concentrated load/moment at one end. Semi infinite beam hinged at one end (origin)& subjected to UDL throughout.	06
4	Beams curved in plan: Analysis of beams loaded perpendicular to their own plane, simply supported, fixed and continuous beams.	06
5	Theories of Failure: Maximum principal stress theory, Maximum principal strain theory, Maximum shear stress theory, maximum total strain energy theory..	04
6	Analysis of deep beams: Determination of deflection. Determination of shear correction factor for various sections rectangular solid and hollow section and circular solid and hollow section and I-section	04
7	Torsion in non circular solid section rectangle, triangular and hexagon section	04

Term work: -At least 20 solved problems based on the above syllabus shall be submitted as term work.-

Text Books: -

1. Mechanics of Materials: E.P. Popov, Prentice Hall of India Pvt. Ltd.
2. Mechanics of Materials: James M. Gere, Thomson Brooks.
3. Mechanics of Materials: F.P. Beer, E. Russell Jhonston and John T. DeWolf, TMH, New Delhi.
4. Advanced Mechanics of Materials: Arthur p. Boresi and Omar M. Sidebottom, Wiley & Sons.
5. Advanced Mechanics of Materials: Arthur p. Boresi and Richard Schmidt, John Wiley & Sons.
6. Strength of Material Part I and Part II: Timoshenko, McGraw Hill, New York.
7. Mechanics of Solids: Shames I & J.M. Pitarresi, Preentice Hall, New Delhi.
8. Beams on Elastic Foundation: Heteny M.
9. Strength of Materials: Subramanian, Oxford University Press.

PE-BTC 721Advanced Foundation Engineering
(AY 2019-20)

Prerequisites: BS-BTC305, PC-BTC501, PC-BTC601

In this course, students are taught about the higher level applications of the topics learnt during GE-I and GE-II. They will be exposed to the field applications in the form of completion and submission of mini projects.

Course Objectives

1. Highlight the importance of site exploration and characterization, purpose, scope and methods.
2. Apply the consolidation theory, use appropriate laboratory tests and field curves, introduce concept of quasi-consolidation
3. Predict the stress-strain behaviour of soil and estimate stresses in soil using various theories
4. Analyse and estimate bearing capacity and settlement of shallow foundations and estimate pile capacity by various methods
5. Explain methods of ground improvement

Course Outcome:

The students will be able to

1. Apply the basics explained in earlier semester to complex and practical problems in design and construction of foundations.
2. Plan and handle simple site projects based on the fielddata provided to them.

Course Content

Module No	Topics	No of Lectures
1	**Site Exploration and Characterization** Purpose and scope, influence of soil conditions and type of foundation on exploratory programme, project assessment, phasing of site exploration, excavation and boring methods of exploration, types of samplers and their design features, subsurface soundings – static and dynamic methods, planning of subsurface investigations, type and sequence of operations, lateral extent and depth of exploration, interpretation of field and laboratory data.	6
2	**Consolidation** Terzaghi's theory of one-d consolidation – derivation of equation(solution in detail need not be covered), estimation of C_C and C_V from laboratory tests, estimation of P_C by various methods, field consolidation curves, Quasi- preconsolidation and secondary consolidation, practical applications	6
3	**Stress and Strain Behaviour of Soils** Triaxial test - drained and	6

	undrained behaviour of sands and clays, failure criteria in soils - only Mohr - Coulomb's criteria, ideal, plastic and real soil behaviour, shear strength of sands and clays.	
4	**Estimation of Stresses** -Boussinesq's theory, vertical stress due to concentrated load, horizontal and shear stress due to concentrated load, Isobar diagram, vertical stress distribution on horizontal plane, influence diagram, vertical stress distribution on vertical plane, vertical stress due to line load, vertical stress under strip load, maximum shear stress at points under strip loads, vertical stresses under a circular area, vertical stress under a corner of a rectangular area, Newmark's influence charts, Westergard's theory.	6
5	**Bearing Capacity and Settlement Analysis of Shallow Foundations** Modes of failure, failure criteria, – Terzaghi solutions, Vesic's solutions, IS Code recommendations, assumptions in estimates of ultimate loads, effect of shape, embedment of footing, eccentricity in loading,compressibility (including critical rigidity index), choice of factor safety, settlement of foundations on sand – Schmertmann method, Plate load test, evaluation of bearing capacity using standard penetration test, Housel Method	6
6	**Pile Foundations** Use of load tests, Estimation of single pile capacity by static and dynamic methods, Group capacity in sand and clay deposits, Separation of skin friction and end-bearing capacity. Settlement of single and group of piles,	3
7	**Ground Improvement** Improvement of deep cohesionless soils and cohesive soils (including stone columns / band drains), instrumentation – mainly pore pressure gauges and settlement gauges and their applications.	3

Term work: -

A project report covering the selection of soil parameters and design of shallow / pile foundations and ground improvements, using stone columns and sand drains shall be submitted as term work.

Text Books: -

1. Soil Mechanics and Foundation Engineering, Volume I and II: V. N. S. Murthy, Saitech Publication.
2. Soil Mechanics in Engineering Practice: K. Terzaghi and R. B. Peck – Second Edition, Wiley International Edition.
3. Foundation Engineering Handbook: Winterkorn and Fang, Galgotia Publications.
4. Foundation Design Manual: N. V. Nayak - Dhanpat Rai Publications (P) Ltd.
5. Principles of Foundation Engineering: Braja M. Das – PWS Publishing
6. Relevant IS Codes, BIS Publications

PE-BTC 722 Ground Water Hydrology
(AY 2019-20)

Prerequisites: PC-BTC304,PC-BTC353, PCBTC328PCBTC377

Course objectives:

1. To describe principles of ground water flow, steady and unsteady flow into a well along with methods of construction.
2. To explain ground water modelling techniques for flow analysis.
3. To summarize environmental influences and pollution of ground water.
4. To summarize concept of ground water basin management.

Course outcomes:

At the end of this course, students will be able:

1. To use principles of ground water flow.
2. To utilize methods of well construction and development of wells.
3. To formulate model of ground water flow with various techniques.
4. To check time variation of ground water levels, its fluctuations and effects of urbanization, earthquake and tsunami.
5. To monitor conjunctive use of ground water.

Course Content

Module No	Topics	No of Lectures
1	**Principles of ground water flow:** Ground water occurrence, Darcy's Law, aquifers, estimation of aquifer parameters, steady and unsteady flow equations, steady one dimensional flow in confined and unconfined aquifers, drainage using tiles, flow through leaky aquifer, flow into infiltration galleries.	06
2	**Well Hydraulics:** Steady and Unsteady flow into a well, spacing of wells, well loss, ground water quality, sea water intrusion, Surface and subsurface investigations of ground water, ground water recharge estimation, ground water budgeting, water logging, flow net analysis, methods of well construction, well completion, development of wells.	06
3	**Ground water modelling techniques:** Porous media models, analog and electric analog models, digital computer models,	04
4	**Numerical modelling of ground water flow:**	06

	Finite difference methods, one dimensional flow model, Explicit approximation , Implicit approximation for 1-D flow domain and 2-D flow domain, Boundary conditions	
5	**Ground water levels and Environmental influences:** Time variation of levels, ground water fluctuations, urbanization, earthquakes and tsunami, land subsidence and ground water	04
6	**Pollution of ground water:** Pollution in relation to water use, sources and causes-municipal, agricultural, industrial, miscellaneous, attenuation of pollution , evaluation of pollution potential, monitoring ground water quality	04
7	**Management of Groundwater:** Concept of basin management, Ground water basin investigations, basin management and conjunctive use, basin yields	06

Term work:-

Assignments consisting of minimum 30 problems covering entire syllabus shall be submitted as term work.

Text Books:-

1. Numerical Ground Water Hydrology: A.K. Rastogi, Penram International Publishing, Mumbai, 2007
2. Ground Water Hydrology: D.K.Todd, John Wiley &Sons, New York, USA, 1980
3. Engineering Hydrology: C.S.P.Ojha, R.Berndtsson, &P.Bhunya:, Oxford University Press
4. Hydrology- Principles, Analysis, Design: H.M.Raghunath, New Age International Publishers.

PE-BTC 723 Pavement Subgrade and Materials
(AY 2019-20)

Prerequisites:

Course Objectives:

1. To describe the different layers of flexible and rigid pavement.
2. To explain the function of subgrade, properties of subgrade material and its determination.
3. To discuss the importance of drainage system, its design and ground improvement techniques.

Course Outcomes:

At the end of course students will be able

1. Identify the quality of material to be used in subgrades and other pavement layers and demonstrate laboratory and field test.
2. Utilize the knowledge gained for the analysis and design of surface and subsurface drainage system.
3. Appraise different ground improvement technique, use of different stabilizer like, lime, fly ash, fibres in highway subgrade.

Course Content

Module No.	Topics	No. of Lectures
1	Subgrade: Functions, Importance of subgrade soil properties on pavement performance, subgrade soil classification for highway engineering purpose soils as per PRA system, revised PRA system, Burmister system,Compaction system.	4
2	Grading requirements for aggregate, selection of bases and subbase material (including stabilized materials), selection of different grade of bitumen, types of bituminous surfaces, skid qualities, bituminous mix design, Marshall stability test, design aspect of paving concrete. Experimental characteristics of road aggregate.	6
3	Soil Survey: Soil Survey Procedure for Highway and Ground Water Investigation. Identification and Significance of soil Characteristics, effect of water in soil Swelling/shrinkage, cohesion, plasticity in soil. Soil Moisture movement-ground water, gravitational water, held water, soil suction.	4
4	Storm water Drainage: General principles subsoil Drainage. Compaction of soils, field and laboratory method of soil compaction, equipment's used in field compaction. Design of surface and subsurface drainage system, pumping system, water body, holding ponds.	6
5	Stress in soil: Theories of elastic and plastic behaviour of soils, Methods of reducing settlement, estimation of rate of settlement due to consolidation in foundation of road embankment,	4

6	Test on subgrade soils: Static and cyclic triaxial test on subgrade soils, resilient deformation, Resilient strain, resilient modulus. CBR test, effect of lateral confinement on CBR and E – value of Subgrade soil. Static and cyclic plate load test, estimation of modulus of subgrade reaction, correction for plate size, correction for worst moisture content.	6
7	Ground Improvement Technique: Different method of soil stabilization, use of geo-textile, geogrid and fibres, lime, fly ash in highway subgrade. Vertical sand drain: design criteria, construction and uses	6

Term work: -
At least 10 assignments covering entire syllabus shall be submitted as term work.

Text Books: -

1. Principles of Pavement Design, Second edition, 1975: Yoder, E. J., John Wiley & Sons, Inc., New York
2. Concrete Roads: HMSO, Road Research Laboratory, London.
3. Highway Engineering: Khanna & Justo, New Chand & Brothers, Roorkee.
4. Principles and Practices of Highway Engineering: Dr. L. R. Kadiyali and Dr. N. B. Lal, Khanna Publication, New Delhi.

PE-BTC723: Pavement Design and Construction

(AY 2019-20)

Course Objectives:

1. To acquire the knowledge about distribution of stress within the pavement
2. To discuss the methods available for design of pavements and utilize the knowledge for implementation.
3. To summarize the importance of strengthening existing pavements and implementation of knowledge for its application.

Course Outcome:

At the end of course the students will be able

1. To acquire the knowledge about distribution of stress within the pavement
2. To summarize the methods available for design of pavements and utilize the knowledge for implementation.
3. To understand the importance of strengthening of pavements and implementation of knowledge for its application.

Course Content

Module No	Topics	No. of Lectures
1	Pavement structure and functional attributes, factor affecting pavement design, types of wheel loads for highways, Classification of Pavement Design Methods. Stresses in flexible pavements, 1-layer, 2-layer, 3-layers theories, EWLF, ESWL, Stresses in Rigid pavement: wheel load and temperature stresses, combined stresses.	06
2	**Flexible Pavement Design:** i. Testing of subgrade soils. ii. Empirical methods using no soil strength criteria, GI method, iii. Empirical method based on soil strength criteria: CBR method as specified by IRC: 37: 2001 & IRC: 37: 2012, Fatigue and rutting as a failure criterion, Analysis of flexible Pavement using IITPAVE software.	08
3	**Rigid Pavement Design:** Comparison of Flexible and rigid pavements, Design of Rigid Pavement using IRC: 58:2002, IRC: 58:2011, axle load survey.	07
4	**Road Construction:** Construction of different layers of Flexible Pavements, size and gradation of aggregate, material selection, Economics in construction. Mix design, concrete strength, size of aggregates, and gradation, and workability, preparation of base form work, mixing, transporting, placing, compaction, finishing and curing, classification of joints.	05

	Construction of Roller Compacted concrete pavements, Cell filled Concrete Flexible Pavements.	
5	**Distress Evaluation maintenance and strengthening:** Flexible and rigid pavement distresses, condition and evaluation surveys, present serviceability index, roughness measurement, Benkaleman beam deflections & design of overlays using IRC: 81:1997,	04
6	**Highway Drainage:** Surface & Subsurface Drainage, Surface Drainage for Hilly Roads, Design of surface and subsurface drainage system.	03
7	**Quality Control:** Quality control test prior to construction and during construction on different pavement layer materials and pavement layers. frequency of tests,	03

Term work:-
At least 10 assignments shall be submitted as term work.

Recommended Books:-
1. Yoder, E. J., John (1975); **"Principles of Pavement Design"** Wiley & Sons, Inc., New York. ISBN -13: 9780471977803.
2. S. K. Khanna, C. E. G. Justo & A. Veeraragavan (2014); **"Highway Engineering",** Xth Edition New Chand & Brothers, Roorkee.
3. Dr. L. R. Kadiyali and Dr. N. B. Lal (2005); **"Principles and Practices of Highway Engineering",** Khanna Publication, New Delhi. ISBN-13: 9788174091659.
4. **Guide lines for the Design of Flexible Pavements**, IRC:37 -2001, IRC:37-2012,
5. **Guide lines for the Design of Rigid Pavements**, IRC: 58:2002, IRC: 58:2011.
6. **Guide lines for Strengthening of Flexible Road Pavements using Benkelman Beam Deflection Technique.** IRC: 81:1997.
7. Concrete Roads: HMSO, Road Research Laboratory, London.
8. **Specification for Rural Roads – 2014**, Ministry of Rural Development.

PE-BTC 724: Air Pollution
(AY 2019-20)

Prerequisites: PC-BTC330, PC-BTC379, PC-BTC404, PC-BTC451

Course Objectives:
The students will learn to –

1. Quantify Composition of air and quantification of pollution gases and particulates
2. Understand effects of air and noise pollution
3. Understand the plume behaviour
4. Various incidences related to air pollution
5. Design of control devices such as fabric filters, cyclones, electrostatic precipitators

Course Outcomes:
The students will be able to

1. Design the various devices based on quantification and efficiency required
2. Quantify and analyse the data for air pollutants using stack sampling and ambient air sampling
3. Design a stack structure and zoning of nearby areas
4. Understand the various Government laws related to air pollution

Course Content

Module No	Topics	No. of Lectures
1	Composition of dry ambient air Properties of air. Function of air, Definition of pollution. Classification of air pollutants. Units for Qualification of air pollution History of air pollution, Global and national scope of the problem-general, urban, rural, specific.	6
2	Sources of air pollution natural and man made Major pollutants from different sources in Greater Bombay area (or any metropolis of Maharashtra), Emission factors.	4
3	Effects of air and noise pollution on human health, plants, animals, properties and visibility, indoor air pollution and personal exposure to air pollution, simple numerical problems based on COH, CoHb	4
4	Meteorological aspects of air pollution Large scale wind circulation geotropic wind, gradient wind, cyclone, anticyclone, planetary boundary layer. Lapse rate, stability conditions, wind velocity profile, maximum mixing depth, topographic effects.	6
5	Plum patterns, plum dispersion, Gaussian model for predicting concentration, downwind from a single source, diffusion coefficients, Turner's stability categories and graphs for dispersion estimates. Maximum ground level concentration, inversion effects, distance touching ground modification of Gaussian model to predict particulate dispersion, plume rise, modified Holland equation for small source. ASME equation for large source, Brigg's equation for buoyant plum rise, Bragg's equation for momentum plum rise.	6

6	Methods and instruments for sampling and analysis of air for stack and ambient air monitoring. Government of India: air pollution laws. Indian standards- emission and air quality standards.	4
7	Control Devices Principles, operations and types, simple hoods and ducts. Settling chambers, cyclones, electrostatic precipitators (ESP), Filters, scrubbers, absorption towers and incinerators. Collection efficiencies for laminar and turbulent flows for settling chambers, particle cut size for cyclone, ESP Concept of frictional and overall efficiencies. Design criteria for filters, scrubbers, absorption towers and incinerators.	6

Term work:-
Each student shall prepare a report on at least one of the following:

1) A stack monitoring report of at least one stacks describing the methods of sampling and analysis used.

2) An ambient air quality survey of a particular location.
At least 07 assignments, report as mentioned above shall be submitted as term work.

Text Books: -

1. Air Pollution: Henry Capeskins, McGraw Hill publication.
2. Air Pollution: Part A- Analysis and part B-Prevention and control: J.O. Ledbetter, Make Dekker Inc., New York.
3. Air Pollution: Wark and Warner, Harper & Row, New York.
4. Air Pollution Control Guidebook for Management: Edited by A.T. Rossano, Environ Science Service Division. ERA Inc., USA
5. Air Pollution Control Theory: Martin Crawford, Mc Graw hill publication.
6. Government of India's Publication of laws related to air pollution, Maharashtra Pollution Control Board's (MPCB) Publication of standards. Indian standards relevant to air pollution monitoring, definitions, standards.
7. Air Pollution: Rao M N & Rao H V N, Tata McGraw Hill Pub., New Delhi.
8. Air Pollution Vol.1: Tripathi A.K (editor) Ashish Publication House, New Delhi.
9. Air Pollution (Bio-pollutants in air): Srivastava A.K., Ashish Publication House, New Delhi.
10. Environmental Engineers Handbook Vol. II, Air pollution: B,GLiptak (ed) . Chilton Book Co USA.
11. Air Pollution Handbook: PL Magill et al., Mc Graw Hill publication.
12. Industrial Air Pollution Handbook: A Parker Tata McGraw Hills Publication.
13. Journal of Air and Water Management Association (formerly known as journal of air pollution control association) Published from USA.
Air pollution, M N Rao, H V N Rao, Tata McGraw Hill

PE-BTC 725-Design of Prestressed Concrete Structures
(AY 2019-20)

Prerequisites: ES-BTC302, PC-BTC402, PC-BTC502, PC-BTC606

Course Contents

Module No.	Topic	No. of Lectures
1	Introduction to prestressed concrete: Basic concept and general principles, materials used and their properties, methods, techniques and systems of prestressing.	04
2	Analysis of prestressed concrete sections: Loading stages and computation of section properties, critical section under working load for pre tensioned and post tensioned members, stress method, load balancing method and internal resisting couple method, kern points, choice and efficiency of sections, cable profiles.	06
3	Loss of prestress: Loss of stresses doe to elastic deformation of concrete, creep in concrete, creep in steel, shrinkage in concrete, relaxation in steel, anchorage slip and friction.	06
4	Deflections of prestressed concrete members: Short time and long-time deflection, deflection of uncracked sections, uni-linear and bi-linear methods for cracked sections.	04
5	Design of prestressed concrete sections for flexure in working stress and limit state method: General philosophy of design, permissible stresses in concrete and steel, suitability of section, safe cable zone, design of simply supported pretension and post tension slabs and beams using limit state method	06
6	Design for shear: Calculation of principle tension under working load, permissible principle tension, shear strength calculation under limit state of collapse for both sections cracked and uncracked in flexure.	04
7	End zone stresses in prestressed concrete members: Pretension transfer bond, transmission length, end block of post-tensioned members. Introduction to application of prestressing to continuous beams and slabs, linear transformation and concordancy of cables	06

Term work:-

At least 10 solved problems based on the above syllabus, one design report along with one half imperial size drawing sheet on design of a post-tensioned prestressed concrete beam (as a project) shall be submitted as term work.

Text Books:-

1. Prestressed Concrete: N. Krishna Raju, McGraw Hill, New York.
2. Prestressed Concrete: N. Rajgopalan, Narosa Publishing House.
3. Fundamentals of Prestressed Concrete: Sinha N.C & S.K. Roy, S.C. Chand & Company.
4. Prestressed Concrete Structures: Dayaratnam P, Oxford &mH
5. Design of Prestressed Concrete Structures: T.Y.Lin& N.H. Burns, John Willey, New York.
6. Design of Prestressed Concrete: Nilson Arthur, McGraw Hill Book Company.
7. Prestressed Concrete Vol-I: IY.Guyon, Contractors Record, London.
8. Prestressed Concrete: S. Ramamurtham, Dhanpat Rai & Son's
9. Relevant latest IS codes.

Sr. No.	Examination	Module
1	T – I	1, 2
2	T – II	3, 4
3	Final Examination	1 to 7

PE-BTC 726-Traffic Engineering and Control
(AY 2019-20)

Prerequisites: PC-BTC305, PC-BTC604, PCBTC406

Course Objectives:

1. To discuss different types of traffic surveys with conventional and latest techniques for data collection and summaries the application of statistical techniques for the traffic related problems.
2. To develop skills for planning, design and operations of traffic regulatory and control devices with due application of statistical techniques.

Course Outcomes:

Graduate students will be able

1. To collect required traffic data independently and analyses to plan and design traffic regulatory and control devices with due consideration to road safety issues.
2. To design traffic regulatory and control devices with due application of statistical techniques.

Course Content

Module No	Topics	No. of Lectures
1	**Traffic Engineering and control:** Importance of traffic engineering, power performance of vehicles, running speed, journey speed, spot speed studies, Various traffic surveys and traffic studies: vehicle volume counts classification and occupancy, Origin – Destination surveys, Trip generation and trip distribution.	07
2	**Statistical methods for traffic engineering and their applications:** probability and its application, std. deviation, Distributions, Sampling theory and Significance testing, Regression and Correlation, Hypothesis.	07
3	**Transportation and Assignment problems:** Balanced and Unbalanced Transportation Problem, N-W Corner Method, Least Cost Method, Vogel's Approximation method.	06
4	**Intersection Design:** at grade and grade separate intersection, rotary inter section its advantages and disadvantages, design rotary inter section, mini round about.	05
	Traffic signals: types of traffic signals, advantages, determination of optimal cycle time and signal setting for an intersection with fixed time signals, co-ordination of signals, types, area traffic control, delay at signalized intersection.	05
5	**Economic Evaluation of Transportation Plan:** cost and benefits of transportation project, different methods available for economic evaluation.	04
6	**Traffic signs and Markings**: General principal of traffic signing, Types of traffic signs, Location and maintenance of signs, Different types of road markings, marking design, marking maintenance.	04

Term work:-
Project based on traffic studies - data collection and analysis, proposals for new facilities or improvement to existing facility / Application of traffic engineering software, at least 10 assignments covering entire syllabus shall be submitted as term work. Alternately a mini-project can be done involving data collection. Analysis and design.

Recommended Books:-

1. Traffic Engineering and Transport Planning: L.R. Kadiyali, Khanna publishers Delhi
2. Principles of Traffic Engineering: G.J. Pingnataro, Mc Graw-Hill, 1970.
3. Traffic System Analysis for Engineering and Planners: Wohl and Martin, Mc Graw Hill, 1983.
4. Principles of Transportation Engineering: Partha Chakroborty and Animesh Das, Prentice hall (India)
5. Traffic Flow Theory and Control: Drew D.R., McGraw – Hill , New York, 1964
6. Highway Capacity Manual, Transportation Research Board, National Research Council, Washington D.C.

PE-BTC 727 Reinforced Concrete Repairs and Maintenance (AY 2019-20)

Prerequisites: ES-BTC302, PC-BTC403

Course Content

Sr. No.	Topics	No. of Lectures
1	Introduction: Causes of deterioration of concrete structures. Effects of climate, moisture, temperature, chemicals, wear, erosion and loading on serviceability and durability. Design and construction errors. Causes of seepage and leakage in concrete structures. Formation of cracks including those due to corrosion.	**6**
2	Condition Survey, Evaluation and Assessment of Damage: Diagnostic methods and analysis. Destructive, Semi destructive and Non-Destructive methods including Core test, Carbonation test , Chloride test, Petrography, Corrosion Analysis, Cover meter test, Rebound Hammer test, Ultrasonic Pulse Velocity test, Crack measurement techniques, Concrete Endoscopy and Thermal imaging, Pull-off test and Pull-out test etc.	**6**
3	Materials and Methodology of Repairs: Repair analysis and design. Repair materials and their properties. Methodologies of crack and patch repair used of Polymer modified mortar, Polymer modified concrete, Polymer concrete. Injection grouting. Shortcreting. Joints and sealants. Rebar corrosion crack repair.	**6**
4	Protection of Concrete Structures: Protective materials and their properties for moisture barrier systems, Above-grade and below grade waterproofing of concrete structures. Systems like integral, crystalline, coatings, membranes etc,. Thermal protection coatings.	**6**
5	Rebar Corrosion Protection: Methods of Corrosion protection. Corrosion inhibitors, Corrosion resistant steels, Cathodic Protection, Pre-packaged zinc sacrificial anode, Snap-on zinc mesh anode CP system	**6**

List of Practical:-(Minimum six experiments out of Sr. No 2 to 10)

1. Condition survey of any damaged structures by visual observation, crack measurement and preparing a report
2. Rapid chloride penetration test
3. Carbonation test by spraying phenolphthalein
4. Non-destructive testing of concrete structures by Rebound hammer, UPV meter etc.
5. Corrosion analyser by half-cell potential meter
6. Tests on polymer modified mortar/concrete and coating for adhesion by Pull-off test method
7. Outdoor exposure test to measure weathering of coating
8. Test for flexibility of coating by applying on a tin sheet

9. Test for effectiveness by measuring temperature difference of a thermal protection coating and concrete substrate on terrace
10. Test for effectiveness by measuring water absorption of coating applied on a card board

Term work:-

Report on condition survey and minimum six experiments performed shall be submitted as term work.

Text Books: -

1. Concrete Repair and Maintenance: Peter H. Emmons and Gajanan M. Sabnis, Galgotia Publication.
2. Repairs and Rehabilitation-Compilation from Indian Concrete Journal-ACC Publication.
3. Guide to Concrete Repair and Protection, HB84-2006, A joint publication of Australia Concrete Repair Association, CSIRO and Standards Australia.
4. CPWD hand book on Repairs and Rehabilitation of RCC buildings published by DG(Works), CPWD, Government of India (Nirman Bhawan), http://www.cpwd.gov.in/handbook.pdf
5. Guide to Concrete Repair, Glenn Smoak, US Department of the Interior Bureau of Reclamation, Technical Service Center , http://books.google.co.in
6. Management of Deteriorating Concrete Structures: George Somerville, Taylor and Francis Publication
7. Concrete Building Pathology: Susan Macdonald, Blackwell Publishing.
8. Testing of Concrete in Structures: John H. Bungey, Stephen G. Millard & Michael G. Grantham, Taylor & Francis Publication.
9. Durability of concrete and cement composites: C.L.Page& M.M. Page,Woodhead Publishing

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Class:-B E (Civil)			**Semester VII**
CODE: PEC-BTC-728	**Subject:-Elective-V : Pavement Construction and Management**		
Periods per week (each of 60 minutes)	Lecture	03	
	Practical	---	
	Tutorial	---	
		Hours	Marks
Evaluation System	In Semester	01	20*2
	End Semester	03	100
	Practical	-	--
	Oral	-	--
	Term Work	-	--
	Total		**100**

*60% Weightage for end semester

Flexible Pavement Construction: Earthwork, compaction and construction of embankments, specifications of materials, construction methods and field control checks for various types of flexible pavement materials in subbase, base, binder and surface course layers and their choice; Cement Concrete Pavement Layers: Specifications and method of cement concrete pavement construction; Quality control tests; Construction of various types of joints;

Soil Stabilized Pavement Layers: Principles of gradation/proportioning of soil aggregate mixes and compaction; Design factors, mix design, construction control and quality control checks for mechanical, soil-Cement, soil-bitumen and soil-lime stabilization methods. Use of additives, Numerical problems on mix design and applications;

Pavement Evaluation - Pavement Distress - Functional and structural condition of pavements, Pavement distress survey, Functional condition evaluation of pavements- Roughness, Skid Resistance.

Structural evaluation of pavements – non-destructive testing, Benkelman beam and Falling Weight Deflectometer, Pavement strengthening based on deflection as per IRC, Maintenance and rehabilitation techniques;

Pavement Management Systems - Pavement Management Systems- Components, structure, data requirements, Project level and Network level needs, Pavement performance prediction – concepts, modelling techniques– AASTHO, CRRI and HDM models, Budget forecasting for maintenance and rehabilitation, Ranking and optimization methodologies, life cycle costing,

Value Added Courses

Sardar Patel College of Engineering Andheri (West), Mumbai 400 058
Academic Year: 2019-20

VC-BTC 772Environmental Impact Assessment
(AY 2019-20)

Course Objective:

1. Enable graduates to identify attributes for EIA
2. Enable graduates to prepare EIA reports
3. Enable graduates to formulate Environmental Management Plans

Course Outcomes:

1. Identify environmental attributes for the EIA study
2. Identify methodology and prepare EIA reports
3. Specify methods for prediction of the impacts
4. Formulate environmental management plans

Detailed Syllabus

MODULES	TOPICS	No. of Lectures
1	Introduction: The Need for EIA, Indian Policies Requiring EIA, The EIA Cycle and Procedures, Screening, Scoping, Baseline Data, Impact Prediction, Assessment of Alternatives, Delineation of Mitigation, Measure and EIA Report, Public Hearing, Decision Making, Monitoring the Clearance Conditions, Components of EIA, Roles in the EIA Process. Government of India Ministry of Environment and Forest Notification (2000), List of projects requiring Environmental clearance, Application form, Composition of Expert Committee, Ecological sensitive places, International agreements.	4

2	Identifying The Key Issues: Key Elements of an Initial Project Description and Scoping, Project Location(s), Land Use Impacts, Consideration of Alternatives, Process selection: Construction Phase, Input Requirements, Wastes and Emissions, Air Emissions, Liquid Effluents, Solid Wastes, Risks to Environment and Human, Health, Socio-Economic Impacts, Ecological Impacts, Global Environmental Issues.	4
3	EIA Methodologies: Criteria for the selection of EIA methodology, impact identification, impact measurement, impact interpretation & Evaluation, impact communication, Methods-Adhoc methods, Checklists methods, Matrices methods, Networks methods, Overlays methods, Environmental index using factor analysis, Cost/benefit analysis, Predictive or Simulation methods. Rapid assessment of Pollution sources method, predictive models for impact assessment, Applications for RS and GIS.	4
4	Reviewing The EIA Report: Scope, Baseline Conditions, Site and Process alternatives, Public hearing. Construction Stage Impacts, Project Resource Requirements and Related Impacts, Prediction of Environmental Media Quality, Socio-economic Impacts, Ecological Impacts, Occupational Health Impact, Major Hazard/ Risk Assessment, Impact on Transport System, Integrated Impact Assessment.	4
5	Review of EMP and Monitoring: Environmental Management Plan, Identification of Significant or Unacceptable Impacts Requiring Mitigation, Mitigation Plans and Relief &Rehabilitation, Stipulating the Conditions, what should be monitored? Monitoring Methods, who should monitor? Pre-Appraisal and Appraisal.	4
6	Case Studies: Preparation of EIA for developmental projects- Factors to be considered in making assessment decisions, Water Resources Project, Pharmaceutical industry, thermal plant, Nuclear fuel complex, Highway project, Sewage treatment plant, Municipal Solid waste processing plant, Tannery industry.	8
7	ISO 14001	6

Term Work

Report on assignments including problems based on the above syllabus shall be submitted as term work. One assignment on each module is to be submitted.

Audit will be granted on submitting the assignments and case studies

References

1.Canter, L.W., Environmental Impact Assessment, McGraw Hill Pub. Co., 1997
2. David P. Lawrence, Environmental Impact Assessment: Practical Solutions to Recurrent Problems, John Wiley & Sons, 2003
3. Hosetti, B. B., Kumar A, Eds, Environmental Impact Assessment & Management, Daya Publishing House, 1998
4.UNESCO, Methodological Guidelines for the Integrated Environmental Evaluation of Water Resources Development, UNESCO/UNEP, Paris, 1987
5.Anjaneyulu.Y., and Manickam. V., Environmental Impact Assessment Methodologies, B.S. Publications, Hyderabad, 2007
6.Wathern.P., Environmental Impact Assessment- Theory and Practice, Routledge Publishers, London, 2004

Sardar Patel College of Engineering Andheri (West), Mumbai 400 058
Academic Year: 2019-20

VA-BTC 773 Conventional & Nonconventional Materials in Highway Subgrade (AY 2019-20)

Course Objectives:

1. To Explain the Laboratory & Field Procedure for Testing of Subgrade,
2. To discuss use conventional & Nonconventional Materials in Subgrade.

Course Outcome:

1 Learn how to conduct static and cyclic triaxial test & how to use these data in pavement design. How to conduct static & cyclic plate bearing test, CBR test in field & lab.

2 Learn about different ground improvement technique, use of different stabilizers like, lime, fly ash, fibres in highway subgrade

Detailed Syllabus

Module No	Topics	No. of Lecture
1	Subgrade: Functions, importance of subgrade soil properties on pavement performance, subgrade soil classification for highway engineering purpose soils as per PRA system, revised PRA system, Burmister system, Compaction System.	10
2	Test on subgrade soils: Static and cyclic triaxial test on subgrade soils, resilient deformation, Resilient strain, resilient modulus. CBR test, effect of lateral confinement on CBR and E – value of Subgrade soil. Static and cyclic plate load test, estimation of modulus of subgrade reaction, correction for plate size, correction for worst moisture content.	06
3	Ground Improvement Technique: Different method of soil stabilization, use of geo- textile, geogrid and fibres, lime, fly ash in highway subgrade. Vertical sand drain: design criteria, construction and uses.	08

Recommended Books:

1. Principles of Pavement Design, Second edition, 1975: Yoder, E. J., John Wiley & Sons, Inc., New York.
2. Concrete Roads: HMSO, Road Research Laboratory, London.
3. Highway Engineering: Khanna & Justo, New Chand & Brothers, Roorkee.

Principles and Practices of Highway Engineering: Dr. L. R. Kadiyali and Dr. N. B. Lal, Khanna Publication, New Delhi

SEM VIII-COURSE CONTENTS

AY 19-20

Sardar Patel College of Engineering Andheri (West), Mumbai 400 058
Academic Year: 2019-20

PC-BTC801 Course:-Design & Drawing of Reinforced Concrete Structure (AY 2019-20)

Prerequisites: PC-BTC 331, PC-BTC 401

Course Objectives:

1. To develop Civil Engineering graduates having clear understanding of concepts, and practical knowledge of modern Civil Engineering techniques
2. To apply the structural analysis knowledge to design real life RCC structures for safety serviceability and economy.
3. To achieve effective communication, inculcate leadership and ethics to deal with social, environmental and economic issues.

Course Outcomes:

After completing the course student will be able to

1. To design buildings, water tanks, retaining wall for safety, stability and economy.
2. To prepare detailed drawings ready for construction.
3. To comply with regulations and requirements of RCC design as per relevant IS codes
4. To act as catalyst in transferring the Civil Engineering knowledge to field usage for the socio-economic development of the society.

Module No	Details	Hrs
1	Design of staircases: (limit state method of design) Design of Dog legged, Open well type staircase.	05
2	Design of Flat Slabs: (limit state method of design)	06
3	Complete design of residential, commercial or Industrial building including staircase and foundations. (Limit state method of design).	05
4	Complete design of residential, commercial or Industrial building including staircase and foundations. (Limit state method of design). Overview of ductile detailing for Earthquake resistant structures.	05
5	Design of retaining walls: (limit state method of design) Design of Cantilever, Counter fort type retaining wall.	05
6	Design of water tanks: Circular and rectangular, at ground level, underground and	05

	overhead water tanks	
7	Design of water tanks: Circular and rectangular, at ground level, underground and overhead water tanks both by IS coefficient and - approximate methods, including supporting structure for overhead water tanks Self Learning: Design of underground water tank	05
	TOTAL	**36**

Note: Relevant and latest IS codes of practice shall be followed for all the topics

Term work: -

Design report and at least four A3 size drawings sheets for three projects covering the above syllabus shall be submitted as term work. All drawing work to be done in AUTOCAD. Exposure to design by available software for design is also to be considered.

The above mentioned work shall be submitted as term work.

Text Books: -

8. Ashok K. Jain(1993), "Reinforced Concrete: Limit State Design" , Nem Chand & Brothers, ISBN 8185240531, 844 pages
9. Dr. H. J .Shah,(2008),"Reinforced Concrete, Volume 2", Charotar Publishing House Pvt. Limited, ISBN 8185594732, 424 pages
10. S N Sinha, (2002),"Reinforced Concrete Design, Second Revised Edition", Tata McGraw-Hill Education, ISBN 0070473323, 705 pages
11. Karve & Shah, (2011), "Illustrated Design of Reinforced concrete Buildings", mihail-koprivchin-3758, 502 pages
12. Relevant I.S. codes and design aids
13. P.C. Vargese (2007) Advance reinforced concrete design, PHI Learning.
14. B.C. Punmia, Ashokumar Jain and Arunkumar Jain (2009), Limit State Design of Reinforce Concrete.

Reference books:-

3. B.P. Hughes (1976), "Limit State Theory for Reinforced Concrete Design", Pitman, ISBN 0273010239.
4. Phil Moss Ferguson, J.E. Breen & J.O. Jirsa (1988), "Reinforced Concrete Fundamentals", John Wiley and Sons (WIE), ISBN 0471803782, 592 pages.

Sardar Patel College of Engineering Andheri (West), Mumbai 400 058
Academic Year: 2019-20

PC-BTC802 Course: -QUANTITY SURVEY ESTIMATION AND VALUATION

(AY 2019-20)

Quantity Survey:
A quantity survey involves the measurement and calculation of various quantities of material and labour required for a construction project. A quantity survey is typically done when all details, design, plans and drawings for the project are ready.

Estimation:
This deals with the estimation of quantities of material and labour along with the estimate for the cost of a project in the stages of its infancy. At this stage, no details are available or even if available; they are subject to major changes and revisions.

Valuation:
It is the art of evaluating the worth or utility of an asset. This is particularly of great interest in the real estate industry.

Course Objectives:

1. Explain various methods of detailed and approximate estimates.
2. Emphasize the importance of relevant IS codes and relevant Indian Standard Specifications, taking out quantities from the given requirements of the work, drafting specifications, conduct a material and labour survey and perform rate analysis for various items
3. Describe the process of tendering and its various stages
4. Assess the value of a property

Course Outcomes:
At the end of this course, the students will be able to

1. Prepare approximate and detailed estimates based on the quantity survey of the available general and detailed drawings,
2. Draft specifications, make bar bending schedules, draw mass haul diagrams,
3. Draft tenders and prepare valid contract documents,
4. Assess the value of a property using the appropriate method using standard tables..

Module No	Topics	No. of Lectures
1	Estimates: Various types, complete set of estimate. Different methods of approximate estimates. Use of CBRI Equations. Methods of preparation of estimates for projects such as i) Building R.C.C., Load bearing ii) Road iii) Sanitary works	8
2	Measurements for various items: 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	8

3	Material survey: Approximate estimates of requirement of various materials for building works, percentage breakup of the cost, market survey of basic materials	4
4	Specifications: types, requirements and importance, detailing of specifications for various items	4
5	Rate analysis: purpose, importance and necessity of the same, factors affecting, task work.	3
6	Tender: preparation of tender documents, importance of inviting tenders, contract types, relative merits, prequalification. General and special conditions, termination of contracts, extra work and items, penalty and liquidated charges, Settlement of disputes, etc.	3
7	Valuation: different terms used, the role of a valuer, purpose and necessity of the same. Capitalised Value, Years purchase,sinking fund, depreciation, types of values, Purpose of valuation. Different methods of valuation for i. open plots. ii. open plots with existing residential & commercial structures iii. lease hold properties Use of valuation tables and formulae	6

Term work:-

The term work shall consist of the following:

i. To find out the approximate estimate of a multistoried building by approximate method.
ii. Detailed estimate of any TWO of the following with the required material survey for the same.
   a. a ground plus three storied building (RCC)
   b. a bridge with minimum 2 spans
   c. a road work
   d. a cross drainage work
   e. a load bearing structure
iii. Preparation of valuation report in standard Government form.
iv. Assignments on rate analysis, market survey, specifications and simple estimates.
v. Bar bending schedule

Use of quantity survey software and for some of the above assignments is desirable.
Total of minimum ten assignments including all of the above.

Text Books:-

1. M Chakraborty (2006); "Estimating, Costing Specifications & Valuation" M Chakraborty Kolkata. ISBN-13: 978-8185304366.
2. B.N. Dutta. "Estimating and Costing in Civil Engineering: Theory and Practice Including Specifications and Valuation" Sangam Books. ISBN -13 9788174763839. 917p
3. B.S. Patil (2006); "Building & Engineering Contracts", Universities Press (India) Pvt. Limited, ISBN 13 :9788173715594. 516p.
4. A.K. Upadhyay (2013); "Civil Estimating & Costing: Including Quality Surveying, Tendering and Valuation" S K Kataria and Sons. ISBN-13: 978-8185749983. 474p
5. Relevant Indian Standard Specifications, BIS Publications
6. World Bank approved contract documents

PC-BTC803 Course:-Construction Management (AY 2019-20)

Prerequisites : ES-BTC304

Construction Management

Construction management is the branch of engineering which provides information regarding management of Civil Engineering Projects in addition to safety, quality etc.

Course Objectives:

1. To describe to the students about the unique features of construction project and subsequent legal aspects for labours.
2. To summarize the students about various techniques of construction planning, resource scheduling, project monitoring quality control and safety of personnel involved.

Course Outcomes:

1. Plan the project right from initial stage up to completion stage.
2. Use quality and safety tools to all personnel for smooth completion of construction work.
3. Carry out dispute free construction work

Module No	Details	Hrs
1	Construction : Unique features of construction, construction project, types and features, phases of a project, agencies involved and their methods of execution	04
2	Construction project planning : Stages of project planning: pre-tender planning, pre-construction planning detailed construction planning, role of client and contractor, level of detail project of development of plans and schedules, work break-down structure activity lists, assessment of work content, estimating durations sequence of activities, activity utility data	06
3	Techniques of planning : Bar charts, Networks: basic terminology, single and overlapping, relationship preparation of CPM networks: activity on link and activity on node representation, analysis of single relationship (finish to start) networks computation of float values, critical and semi-critical paths calculating networks	06

	PERT: Assumptions underlying PERT analysis, determining three time estimates, analysis, slack computations, calculation of probability of completion	
4	Resource scheduling : Line of balance technique, resource constraints and conflicts, resource aggregation allocation smoothening and levelling	04
5	Planning and organizing construction site and resources: Site : site layout, developing site organization, record keeping 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 Construction cost : Classification of costs, time cost trade-off in construction projects compression and decompression	06
6	Monitoring & control : Supervision, record keeping, periodic progress reports, periodical progress meetings Updating of plans: purpose, frequency and methods of updating Common causes of time andcost overruns and corrective measures cost overruns and corrective measures quality of constructed structure use of manuals and checklists for quality control, role of inspection, basics of statistical quality control Safety and health on project sites: accidents; their causes and effects costs of accidents, occupational health problems in construction organizing for safety and health	06
7	Purpose and brief provisions in brief of following acts : Minimum wages act, The building and other construction workers (regulation of employment and conditions of service) Act, The building and other construction workers welfare cess Act, Contract Act, Alternative disputes resolution methods	04
	TOTAL	**38**

Term work:-

At least 10 assignments including numerical problems shall be submitted as term work.

Text Books:-

1. Barrie D.S. & Paulson B C (2013); "Professional Construction Management" McGraw Hill Education (India) Private Limited. ISBN-13: 978-1259098420. 672p.
2. Chitkara K K (2010); "Construction Project Management" McGraw Hill Education (India) Private Limited. ISBN-13: 978-0070680753. 772p.

3. P K Joy (1991); "Handbook of Construction Management", Macmillan, India. ISBN-13-9780333926932. 484p

4. King & Hudson (1985); "Construction Hazard and Safety Handbook", Butterworths.
ISBN-13: 978-0408013475. 477p.

5. Antill J M & Woodhead R W, (1990); "Critical Path Methods in Construction Practice:"
John Wiley & Sons. ISBN-13: 978-0471620570. 448p

6. S.Seetaraman (2000); "Construction Engineering and Management". Umesh pub. ISBN-13 9788188114061. 487p

7. L.S.Shreenath (2001); "CPM and PERT" Affiliated East-West Press (Pvt.) Ltd. ISBN-13:978-8185336206

Sardar Patel College of Engineering Andheri (West), Mumbai 400 058
Academic Year: 2019-20

HSM-BTC805 Course:-Entrepreneurship & Management

(AY 2019 – 20)

ENTREPRENEURSHIP AND MANAGEMENT

An engineer applies mathematics, science, and systems-integrative approaches to conceive, design, build, and operate useful objects or processes; whereas an entrepreneur assumes the tasks of organization and management as well as the risks of new-project creation or new-venture startup. In today's advanced world, there's a need of engineers as entrepreneurs.

Course Objectives:

1. To understand concepts of entrepreneurship and management, entrepreneurial culture & various types, and entrepreneurial motivation.
2. To complete a new product development, including definition and design or elaboration of new idea, strategic planning, business plan, funding analysis, appraisal and various tools of analysis with project accounting.
3. To understand the application of management theories & various principles in business.

Course Outcomes:

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

1. Analyze the business environment in order to identify business opportunities.
2. Identify the elements such as technical, legal and financial conditions for starting a business venture,Evaluate the effectiveness of different entrepreneurial strategies & management principles

Module No	Details	Hrs
1	Concept of entrepreneurship, characteristics of entrepreneur and entrepreneurship, aspects of entrepreneurship, environment for entrepreneurship, socio-economic origins & barriers to entrepreneurship	04
2	The entrepreneurial culture : elements of culture, business culture and culture of society, entrepreneurial culture, cultural change, Classification depending on type of business, technology, motivation, growth, stages of development. Entrepreneurial traits and motivation: initiative, entrepreneurial skills, entrepreneurship: sources of supply & motivation, Growth of entrepreneurs, entrepreneurial functions	04
3	Project development Project: stages of project, project development cycle, life	06

	cycle of project, ISO certification & its importance, search for an idea, preliminary screening, project identification, project Formulation, SWOT analysis, and project report. Project appraisal: market, technical, financial, economical, social, ecological, organizational. Tools of analysis: time value of money, compounding & discounting, breakeven analysis, payback period, net present value, social cost-benefit analysis Sources & types of finance.	
4	Project accounting: generally accepted accounting principles, book keeping, double entry system and ledger, preparation of income statement and balance sheet	04
5	Present scenario of Indian industry and entrepreneurs, government policies promoting entrepreneurship, institutions in aid of entrepreneurs, finance for entrepreneurs, sources and types of finance, small scale industries related to civil engineering, steps for starting a small scale industry, safety rules & regulations for construction industries	06
6	Principles of organization, forms of organization: line, line & staff, functional and matrix, , selection of type of own organization, ownership types: sole proprietorship, partnership, private company, public limited company	06
7	Management: concept of management, objectives, basic functions of management, emergence of management thought, brief description of contributions by Fredrick Taylor, Henry Fayol, Elton Mayo and Gilbreth	06
	TOTAL	**38**

Recommended Books

1. Peter drucker, 'Innovations and Entrepreneurship', HarperBusiness; Reprint edition.
2. Dr.S.S.Khanna, 'Entrepreneurial development' S.CHAND, revised edition.
3. Vasant desai, ' Entrepreneurial development' Himalaya Publishing house.
4. A.K.Singh, ' Entrepreneurial development & management' Lakshmi publication, second edition

Sardar Patel College of Engineering Andheri (West), Mumbai 400 058
Academic Year: 2019-20

VA -BTC873 Course:-Elective-II : Low Cost Roads

(AY 2019 – 20)

Course Objectives:

1. To acquire the knowledge about the selection of materials for construction and maintenance of Rural Roads.
2. To discuss the Geometric standard of rural roads and utilize the knowledge for implementation.
3. To identify and Implement the suitable technique for construction of rural roads.

Course Outcome:

At the end of course the students will be able

1. To produce the knowledge for deciding the geometric standards for rural roads.
2. To acquire the knowledge about the selection of materials for construction and maintenance of Rural Roads.
3. To identify and Implement the suitable technique for construction of rural roads.

Module No	Details	Hrs
1	**Rural Road Planning**: classification of low cost roads, reason of low connectivity, Road alignments survey, factor affecting alignments, collection of data, preparation of project reports and drawing, PMGSY Approach for priority of construction and upgradation of roads.	06
2	**Geometric Design standards:** Classification of rural roads, design speed, cross sectional elements, sight distance, horizontal and vertical curve, super elevation, extra widening, gradients	06
3	**Pavement Materials** subgrade soil classification for highway engineering purpose soils as per PRA system, revised PRA system, Grading requirements for aggregate, Grading of aggregate for WBM type bases and subbase construction, material selection for Bituminous Course of Rural Roads. Suitability of aggregate and binding material for construction of rural roads. CBR test, triaxial test on subgrade soils, plate bearing test, modulus of subgrade reaction, E – Value of subgrase soils	05
4	**Design and construction of Rural Roads:**	06

	Flexible pavement, semi rigid pavements, roller compacted concrete pavements; equipment's used during construction of roads	
5	**Use of waste materials:** Different methods of stabilization, use of fly ash in embankment and subgrade, construction of lime – fly ash – soil, construction of Lime – Fly ash bound macadam, lime fly ash concrete, roller compacted concrete pavement, dry lean concrete for base course. Use of other waste materials like rise husk ash, recycled concrete, iron and steel slag, natural and synthetic fibers, geotextile and geogrids.	06
6	**Maintenance of Rural roads:** Distresses in flexible, rigid and semi-rigid pavements, routine maintenance, periodic maintenance, maintenance of earth road, gravel roads, WBM type roads, Bituminous macadam types roads etc.	04
7	**Quality Control:** Quality control test prior to construction and during construction on different pavement layer materials and pavement layers. frequency of tests,	04
	TOTAL	**37**

Term work:-

At least 10 assignments shall be submitted as term work. Report based on site visit to road site.

Recommended Books:-

1. S. K. Khanna, C. E. G. Justo & A. Veeraragavan (2014); "Highway Engineering", Xth Edition New Chand & Brothers, Roorkee.
2. Dr. L. R. Kadiyali and Dr. N. B. Lal (2005); "Principles and Practices of Highway Engineering", Khanna Publication, New Delhi. ISBN-13: 9788174091659.
3. Guide lines for the Design of Rigid Pavements, IRC: 58:2002, IRC: 58:2011.
4. Guide lines for the Design of Flexible Pavements, IRC: SP: 20 2002.
5. Specification for Rural Roads – 2014, Ministry of Rural Development

Sardar Patel College of Engineering Andheri (West), Mumbai 400 058
Academic Year: 2019-20

PE-BTC811 Course :-Elective-II – Industrial Wastewater Treatment

(AY 2019-20)

Course Objectives

The students will learn to –

1. Analyse and understand the difference between Industrial and municipal waste and wastewater
2. Predict DO levels using Streter Phelps modeling
3. Understand advanced treatment techniques for industrial waste effluents
4. Develop treatment schemes for industries such as pulp and paper, textile, tannery, dairy, electroplating, cane sugar and distilleries
5. Emphasize on in plant control and good housekeeping

Course Outcomes

The students will be able to

1. Develop various units for treatment based on initial characterization
2. Analyse and developschemes for various types of impurities present in the effluent
3. Predict DO at various stages in a river and suggest changes in the present industries Understand environmental laws as a restrictive measure for pollution

Module No	Details	Hrs
1	General: liquid wastes from industries – their volumes and characteristics, Effect of disposal into natural water courses, Municipal sewers and on land, River standards and effluent standards; Standards prescribed by MoEF (Stream water – I to IV) Lessons from history: a study of a few accidents/violations such as Minamata bay Japan screening of documentaries to ease the students into the course	06
2	Stream sanitation: Effects of industrial wastes on self-purification of streams and fish life, Aquatic bio system; Statement and significance of the parameters of Streeter and Phelps's equation and BOD equations, deoxygenation and reaeration , Oxygen sag, Case study of Eutrophication	06
3	Sampling and analysis of industrial wastes, Storage of Samples; Treatability study	02
4	General treatment of industrial wastes: neutralization, equalization, segregation, MBBR, MBR, SBR, Natural Wetland system, RO, RO-MEE, Newer treatment flowsheets	04

5	Modification of conventional aerobic and anaerobic biological treatment methods. Dewatering and disposal of sludges – floatation, vacuum filtration, centrifugation, filter press, In plant control measures for volume and strength reduction Selection of technology based on area, effluent characteristics, investment cost, maintenance issues, concept of zero liquid discharge	04
6	Detailed consideration of wastes produced from following industries: Processes followed Volume of wastewater generated by specific industry and effects of raw and treated effluent on streams, sewers and land by wastewater of specific industry. Treatment methods and schemes for specific industry , reuse-recovery 1) Textiles: cotton and synthetic 2) Pulp &paper:- Sulphate process 3) Electroplating 4) Dairy 5) Sugar- sugarcane 6) Distilleries 7) Tanneries 8) Mining Pharmaceutical	14
7	Provision of various acts pertaining to industrial wastes / effluents, introduction to environmental impact assessment and environmental and water audit	08
	TOTAL	**44**

Theory Examination:-

1. Question paper will consist of total seven questions carrying 20 marks each.
2. Only five questions need to be attempted.
3. In question paper, weightage of each module may be proportional to the number of respective lecture hours as mentioned in the syllabus.

TextBooks:-

1. Waste Water Treatment: Rao &Datta, Oxford & IBH Publishing Co.
2. Industrial Water Pollution Control: W W Eckenfelder Jr, Mc Graw Hill
3. Industrial Water Pollution Management: E F Gurnham, John Wiley
4. Biological Waste Treatment: Eckenfelder & Connor Pergamon Press
5. Theories and Practices of Industrial Waste Treatment: AdisonWesley
6. Pollution Control in Process Industries: S P Mahajan , Tata mcgraw Hill
7. Industrial Waste: W Rudolfs ,(Ed), L E C Publishers Inc
8. The Treatment of Industrial Wastes: E D Besselievre Mcgraw Hill
9. Industrial Waste Disposal: R D Ross , (Ed), Reinhld Bok Corporation
10. Standard Methods of examination of water and wastewater, APHA, 2010
11. Anaerobic Sewage Treatment: A practical guide for regions with hot climate A.C. Handel and G. Lettin

Sardar Patel College of Engineering Andheri (West), Mumbai 400 058
Academic Year: 2019-20

PE-BTC812 Course :-Elective-II : Earthquake Engineering

(AY 2019-20)

Prerequisites BT201, BTC201

Course Objectives:

- To develop civil engineering graduates having clear understanding of concept of dynamic loads, dynamic analysis, Seismic analysis of structures.
- To apply the knowledge of structural dynamic to evaluate the seismic response of structures subjected to different ground motion. To apply response spectrum concept to characterize the ground motion.
- To apply provisions of IS 1893-2016& IS 13920-2016 to design seismic resistant structures.
- To inculcate ethics to deal with social, environmental & economic issues.

Course Outcomes:

After completing the course students will be able to develop collaborative skills to work in a team/group and analytical/technical skills to

1. Evaluate dynamic loads; carry out dynamic analysis of Single and Multiple degrees of freedom systems.
2. Interpret basic seismology, ground motion characteristics and construct response spectrum for ground motions.
3. Evaluate the seismic response of various structures subjected to different ground motions.
4. Design earthquake resistant structures using the provision of IS -1893-2016 & IS 13920-2016.

Module No	Details	Hrs
1	**Introduction:** Introduction to structural dynamics, definition of basic problem in dynamics, static v/s dynamic loads, different types of dynamic loads.	02
2	**Single degree of Freedom (SDOF) systems:** Undamped vibration of SDOF system, natural frequency and period of vibration, damping in structures, viscous damping and Coulomb damping, effect of damping on frequency of vibration and amplitude of vibration, logarithmic decrement. Forced vibration, response to harmonic forces, periodic loading, dynamic load	08

	factors, response of structure subjected to general dynamic load, Duhamel's integral, numerical evaluation of dynamic response of SDOF systems subjected to different types of dynamic loads. Use of Fourier Series for periodic forces, introduction to vibration isolation.	
3	**MDOF systems:** Direct determination of frequencies and mode shapes, orthogonality principle, approximate methods for determination of frequencies and mode shapes. Forced vibration of MDOF system, modal analysis, applications to beams and multistoried frames with rigid girders subject to lateral dynamic loads including ground motion.	06
4	**Seismological background:** Seismicity of a region, earthquake faults and waves, structure of earth, plate tectonics, elastic-rebound theory of earthquake, intensity and magnitude of earthquake, measurement of ground motion, seismogram, earthquake frequency, local site effects, seismotectonics and Seismicity of India. Effect of near-field and far-field earthquake ground motions.	04
5	**Characterization of ground motion:** Earthquake response spectra, factors influencing response spectra, design response spectra for elastic systems, peak ground acceleration, response spectrum shapes, deformation, pseudo-velocity, pseudo-acceleration response spectra, peak structural response from the response spectrum, response spectrum characteristics, construction site specific response spectra.	05
6	**Deterministic earthquake response:** Types of earthquake excitation, lumped SDOF elastic systems. translational excitation, lumped MDOF elastic systems, translational excitation, time history analysis, multistoried buildings with symmetric plans, multi storied buildings with un symmetric plans, torsional response of symmetric plan building, distributed - parameter elastic systems, translational excitation, combining maximum modal responses using mean square response of a single mode, SRSS and CQC combination of modal responses.	04
7	**I. S. code method of seismic analysis:** Equivalent static method and its limitation, response spectrum method, IS 1893-2016 provisions for seismic analysis of buildings and water towers, seismic evaluation and retrofitting, types of structural systems used in building to resist earthquake loads. Review of damages during past earthquakes and remedial measures, seismic design considerations, allowable ductility demand, ductility capacity, reinforcement detailing for members and joints as per IS 13920-2016.	06 03

	TOTAL	**38**

Term work:-

At least 20 (twenty) solved problems based on the above syllabus shall be submitted as term work. Exposure to computer aided analysis using available software be considered.

Text Books:-

1. Dynamics of Structures by Anil K Chopra, Prentice Hall of India
2. Structural Dynamics of Earthquake Engineering: Theory & Application using MATHEMATICA & MATLAB by S Rajasekaran, Woodhead Publishing Ltd.
3. Earthquake Resistance Design & Risk Reduction by David Dowrick, Wiley India
4. Seismic Analysis of Structures by T K Dutta, John Wiley & Sons (Asia) Pvt.Ltd
5. I.S. Codes No. 1893, 4326, 13920 (All latest codes)

Reference Books:-

1. Fundamentals of Earthquake Engineering by N M Newmarks & E Rosenblueth, Prentice Hall
2. Earthquake Spectra & Design by N M Newmarks & W J Hall, Earthquake Engineering Research Institute, Berkeley, California
3. Dynamics of Structures by Clough & Penzien, McGraw-Hill, Computers & Structures
4. Fundamentals of Earthquake Engineering by Amr S Elnashai & Luigi Di Sarno, Wiley India
5. Fundamentals of Earthquake Resistant Construction by Ellis L Krinitzsky, James P Gould & Peter H Edinger, Wiley India
6. Design of Earthquake Resistant Structures by E Rosenblueth, Pentech Press, London
7. Design of Seismic Isolated Structures: From Theory to Practice by Farzad Naeim & James M Kelly, John Wiley & Son
8. Mechanics of Rubber Bearings for Seismic and Vibration Isolation by James M Kelly & Dimitrios A Konstantinidis, Wiley
9. Seismic Engineering by Jacques Betbeder-Matibet, Wiley
10. Seismic Design of Reinforced Concrete & Masonary Buildings by T. Paulay & M J N Priestley, Wiley India
11. Plate Tectonics: An Insider's History of The Modern Theory of The Earth by Naomi Oreskes, Westview Press
12. Elementary Seismology by C R Richter, W.H. Freeman & Company, San Francisco
13. "Proceedings on World Conference on Earthquake Engineering" 1956-2000.

Sardar Patel College of Engineering Andheri (West), Mumbai 400 058
Academic Year: 2019-20

PE-BTC814: Water Resources Economics Planning and Management

(AY 2019-20)

Course Objectives:

The main objectives of the course are

1.To study the water resources planning processes

2. To acquire the knowledge of system approach and decision making

Course Outcomes:

At the end of the course the students shall be able to

1. demonstrate the water resources planning processes
2. apply the knowledge of system approach during project selection
3. To understand discounting techniques in water resources engineering
4. apply discounting techniques in WRE.

Module No	Details	Hrs
1	**Planning and decision making process**: Importance and necessity of planning, Decision making process and types	06
2	**Systems Approach To Water Resource Planning:** Water as economic commodity, Principles of economics	04
3	**Discounting techniques:** Price theory, Resource allocation, project optimality conditions. Cost benefits studies, Role of benefit cost parameters in project selection. Economic feasibility tests.	04
4	Decision making under uncertainty and risk. Cost benefit studies of single & multipurpose projects. Economic planning, capacity expansion.	05
5	**Multi objective planning:** Methods of analysis. Stakeholders' participation, Preparation of feasibility report, interstate water disputes,	07
6	**International development on water transfer**. Concept of IWRM. Importance and necessity.	07
	TOTAL	**31**

Books Recommended:

1. Water Resources Project Economics by Kuiper , (1971), Buttersworth, London.

2. Water Resources System Planning and Management by M.C. Chaturvedi, (1987), Tata McGraw Hill Co. New Delhi.

3. Water Resources Planning and Management by O.J. Helweg., (1985), John Wiley and Sons Inc., USA

Sardar Patel College of Engineering Andheri (West), Mumbai 400 058
Academic Year: 2019-20

PE -BTC815 Course :-Elective-II : Advanced Engineering Geology

(AY 2019-20)

Course Objectives:

1. To discuss the behavior of highly variable earth materials such as rock, soil, water on the earth's surface and their application in engineering planning and development.
2. To describe the formation of soil, rock, fault distribution and bedrock properties of an area to determine their engineering properties and their interaction with the proposed construction.
3. To discuss the agents modifying the earth's surface like earthquakes and the preventive measures undertaken for structures constructed in earthquake prone areas.
4. To explain the importance and methods of surface and sub-surface investigations and geological considerations while selecting sites and construction for dams, reservoirs, tunnels, bridges, etc.

Course Outcomes:

After successful completion of this course the students will be able

1. To carry out critical analysis and have an advanced knowledge of the application of geological processes to civil engineering design.
2. To conduct proper geological and geotechnical investigations for major civil engineering projects.
3. To examine and give opinions regarding the geological hazards, erosion, dewatering, seismic investigations and its impact on structures, etc.
4. To estimate the safety of slopes, foundations, for construction of tunnels, dams and design suitable remediation measures to mitigate problems and ensure safety under service conditions.

Module No	Details	Hrs
1	**Introduction** Importance of geological studies in engineering investigations, precautions to avoid misleading conclusions likely to be drawn while interpreting drilling data with particular reference to RQD, case studies illustrating economics made possible by proper geological studies **Earthquakes** Terminology, Classification, Causes, Effects, Recording of an Earthquake, Location of Epicenter, Earthquake problems in India	06

2	**Engineering Geology of Deccan trap basalts.** Factors affecting strength and water tightness, stability of cuts and ability to stand without support, significance of features like gas cavities, jointing weathering, hydrothermal alteration, volcanic breccias, tachylytes, dykes fractures, field structures of flows, stratigraphic sequence of flows etc. and their significance in civil engineering projects **Construction material** Deccan trap basalts and sedimentary rocks as construction Material. Use of compact basalt and amygdaloidal basalt as Rubble for masonry metal for concrete making	06
3	**Geophysical Investigations** Seismic and electrical resistivity methods of explorations **Role of geology in planning and development** Influence of geological factors upon urban development & planning, locating non-renewable resources and geothermal energy	04
4	**Dams** Strength and water tightness of deccan trap rocks from foundation point of view, physical properties such as compressive strength, water absorption etc. of basalts, effect of weathering and hydrothermal alteration on engineering properties of rocks, deterioration of rock masses on exposure to atmosphere Investigations for determining the foundation treatment for adversegeological features, determination of foundation levels/cutoff levels for dams, groutability of rocks, correction of adverse feature by purpose of consolidated and curtain grouting, determining depth and zones of grouting, relation of zones of grouting with height of dams, foundation treatment for fractures having different manifestations, jointed rocks, tachylytes and dykes. Erosion of tail channel as a factor in selecting site for spillway causes of rapid erosion from side spillways, geological conditions leading to erosion. Case histories	06
5	**Tunneling** Methodologies of investigations for different types of tunnels for different purposes, location spacing ,angles &depths of drill holes for different types of tunnels, difference in behaviour of basalts because of jointing as exemplified by compact basalts & amygdaloidal basalts. difficulties introduced by tachylytes, volcanic breccias, tuffs, intercropping beds, fractures, dykes, hydrothermal alteration, and flow contacts unfavourable field characters. Computing structural discontinuities in rock unfavourable field characters. Computing structural discontinuities in rock masses, RQD, joint frequency index. RMR values, Q system, standup time. Selection & provision of protective measures such	06

	as guniting, rock bolting, shotcreting, steel supports depending on geological conditions. Suitability of TBM for tunneling. Case histories of India	
6	**Bridges** Investigations for bridge foundations, computing SBC for bridge foundation based on nature & structure of rock, foundation settlements Case histories	04
7	**Geology of soil formation** Residual & transported soils. Rock weathering conditions favourable for decomposition& disintegration, influence of climate on residual & transported soils in the deccan trap area. Nature of alluvium of deccan traps rivers & its engineering character. Effect of deposition of calcium carbonate. Scarcity of sand in the rivers in decentral area	04
		36

List of Practicals

1. Logging of drill core, preparation of litho logs and interpreting drilling data, calculation of RQD and joint frequency index. Preparing geological cross sections from drill hole data and using them for designing of civil engineering structures.
2. Use of electrical resistivity method for determining depth of bed rock.
3. Study of geological aspects of an engineering projects and writing a report based on studies carried out during visit to civil engineering projects.

Term work:-

Reports on experiments performed as detailed above shall be submitted as term work.A compulsory guided tour to study geological aspects of an engineering projects & writing a report based on studies carried out during visits to civil engineering projects.

Text Books:-

1. PWD Hand Book, Engineering Geology, Government of Maharashtra
2. Text Book of Engineering Geology: R.B.Gupte, PVC Prakashan
3. Geology of India: D.H.Wadia, McGraw Hill, New Delhi.
4. Geology of India and Burma: M,S,Krishnan, CBS Publications
5. Engineering and General Geology: Parbin Singh, Kataria S. K., New Delhi
6. Test book of Engineering Geology: N.Chenna.Kesavulu
7. Principles of Geomorphology: Thornbury,W.D
8. Earthquake Geography and Management: Srivastav,H,N

Sardar Patel College of Engineering Andheri (West), Mumbai 400 058
Academic Year: 2019-20

PE-BTC816 Course :- Rock Mechanics

(AY 2019-20)

Course Objectives:

1. To describe the engineering characteristics of rock masses and their use in construction.
2. To classify rock and rock massess based on RMR, Geo-Engineering classification, Deere and Miller's Engineering Classification and other such factors.
3. To discuss the stress distribution in rocks based on field and laboratory test and the response of rocks with respect to compressive strength, strength due to induce anisotropy and stress – strength models.
4. To estimate the bearing capacity of rock and discuss the factors affecting the stability of rock slopes.
5. To discuss the processes involved in rock bolting, grouting, anchoring, tunneling and their application in engineering construction.

Course Oucomes:

At the end of this course the students will be able

1. To classify rocks based on various classification methods and predict the behavior of rock mass under the application of loads.
2. To estimate the stability of rocks slopes and determine the bearing capacity of rocks on which structures are to be constructed.
3. To predict the proper construction techniques to be undertaken such as the various type of rock bolting, grouting, anchoring, tunneling, depending on the properties of rock

Course Content

Module No	Details	Hrs
1	Structural geology of rocks, subsurface investigations in rocks and engineering characteristics of rock masses	04
2	Engineering Classification of Rocks and Rock Masses: Classification of intact rocks, rock mass classifications {rock quality designation, rocks structural rating, geomechanics classification (RMR)}, strength and modulus from classifications, classification based on strength and modulus, geo engineering classification, Deere and Miller's Engineering Classification.	06
3	Stress Distribution in Rocks:Field and Laboratory Tests on Rocks	04
4	Strength, Modulus and Stress-Strain Responses of Rocks: Factors influencing rock responses, strength criteria for isotropic intact rocks, modulus of isotropic intact rocks with confining pressure, uni-axialcompressive strength of intact anisotropic rocks, strength due to inducedanisotropy in rocks, compressive strength and modulus from SPT, stress-strain models (constitutive models, elastic stress-strain model, elasto-plasticstress-strain model, equivalent material concept), influence of intermediateprincipal	06

	stress	
5	Bearing Capacity of Rocks: Estimation of bearing capacity (foundation on intact rock, heavily fractured rock, UBC with Hoek-Brown criterion, foundation on slope), stress distribution in rocks, factor of safety, strengthening measures (concrete shear keys, bored concrete piles, tensioned cable anchors, concrete block at toe), settlement in rocks (from joint factor,for horizontal joints, from field tests).	06
6	Stability of Rock Slopes: Modes of failure, rotational failure, plane failure, wedge method of analysis, buckling failure, toppling failure, improvementof slope stability and protection.	4
7	Opening in Rocks, Rock Bolting and Grouting Introduction to theory of elasticity, lines and unlined tunnels, pressure tunnels and tunnels for other purposes .Grouting in rocks, objectives, contact grouting, consolidation grouting, process of grouting, grout requirement, types of grout, stage grouting, grout curtain. Rock bolts, rock bolt types and applications, theory of rock bolting, rock anchors, modes of failure, uplift capacity.	6
	Total	36

List of Practicals

Practicals include confined and unconfined compression test, point load test, Brazilian tensile test, permeability test and modulus of elasticity of rocks.

Term work:-

Each student shall prepare a report on experiments conducted and a project report covering the selection of design parameters, design analysis including drawing on any aspect of rock mechanics included in the syllabus.

The project report referred above, at least five examples report on experiments shall be submitted as term work.

Text Books:-

1. Fundamentals of Rock Mechanics: J. C. Jaeger and N. G. W. Cook, Oxford Press.
2. Rock Mechanics and Design of Structures on Rock: Obert, Leon and W. I. Duvall
3. Rock Mechanics in Engineering Practice: K. G. Stagg and O. C. Zienkiewicz, John Willey & Sons, New York.
4. Rock Mechanics - Vol. I & II: Jumukis, Trans Tech Publication, USA.

Sardar Patel College of Engineering Andheri (West), Mumbai 400 058
Academic Year: 2019-20

PE-BTC817 Course :- Geographic Information System
(AY 2019-20)

PrerequisitesES-BTC303, PC-BTC303, PC-BTC404

A surveyor enjoys diverse responsibilities as part of his or her everyday routine. Surveying technicians primarily work outside collecting data and establishing control points and boundaries. Others work inside an engineering office helping in site design activities and developing plans from the field data.

Course Objectives:

The students will learn:

1. About various softwares and their utility for geographical information systems (GIS), Digital elevation modeling, etc.
2. Demonstrate and use state-of-the-art computer softwares in conjunction with the fundamentals of civil and site design.

Course Outcome:

The students will be able to

1. Demonstrate an appropriate mastery of fundamental knowledge and software of GIS, DEM, and other technological processes inherent to their specific field of study.
2. Apply fundamental knowledge along with GIS technology and skills to conduct small projects.

Module No	Details	Hrs
1	Introduction to GIS: Definition, sources of data, types of data, concept of space and time in GIS,s patial information theory, history of GIS, elements of GIS, objectives of GIS, hardware and software requirements of GIS, application of GIS	06
2	Data models of spatial information: Layers and coverage, conceptual models of spatial information, representation of spatial data models in computer: raster and vector models comparative overview between raster and vector models	06
3	Data models of non-spatial information: Database management systems, hierarchical structure, network structure, relational structure	04
4	Digitizing, Editing and Structuring of map data: Digitizing: manual, semi-automatic and automatic, editing: error detection and correction, tolerances, topology creation, attribute map generation	06
5	Digital Elevation Model:Need of DEM, Various structures of DEM: line, TIN, grid.	04

6	Integration of GIS, GPS & RS:Integrated systems, its advantages, development of integrated systems.	05
7	Applications: Forest resource management, agriculture and soil management, water resource management, land use and land suitability, disaster management	05
	Total	**36**

List of Practicals:

At least TEN practicals shall be performed from the list given below.

1. Installation of GIS software and getting familiarized with GIS menu and Tools.
2. Map Projections and Map digitization.
3. Georeferencing.
4. Creating Vector and Creating Raster data / data layers.
5. Creating attribute table.
6. Measurements; length and area.
7. Data viewing based on Single Symbol, Graduated Symbol.
8. Data viewing on Continuous color and unique value.
9. Labeling the features.
10. Selection tool and Geo-processing tool (Buffer, Clip, intersect and difference).
11. Coordinate capture – to save in notepad.
12. Joining layers based on common field.
13. Data conversion (raster to vector), polygon to polyline.
14. Add Graphic overlay to a vector layer.
15. Import and export data and Map Layout.

Term work:-

Report on practicals conducted, at least 5 assignments shall be submitted as term wo

Text Books:-

1. Geographic Information Systems and Science, Second Edition 2005: Longley, Paul A., Michael F. Goodchild, David J. Maguire, David W. Rhind, John Wiley & Sons, New York.
2. Modeling Our World: The ESRI Guide to Geodatabase Design: Zeiler, M. 1999. ESRI Press, Redlands, California
3. GIS, Spatial Analysis and Modeling: Maguire, D., M. Batty, and M. Goodchild. 2005, ESRI Press.
4. Introduction to geographic Information Systems: Kang-tsung Chang, Tata mcgraw Hill.
5. Advanced Surveying (Total Station, GIS and Remote Sensing) First Edition 2007: SatheeshGopi, R. Sathikumar, N. Madhu.

Sardar Patel College of Engineering Andheri (West), Mumbai 400 058
Academic Year: 2019-20

PE-BTC818 Course :-Elective-II : Environmental Impact Assessment & Audit

(AY 2019-20)

Course Objectives:

1. Enable graduates to identify attributes for EIA
2. Enable graduates to conduct EIA study
3. Enable graduates to formulate Environmental Management Plans

Course Outcomes: At the end of the course the student will be able to:

1. Identify environmental attributes for the EIA study
2. Understand methodology and conduct EIA study
3. Specify methods for prediction of the impacts
4. Formulate environmental management plans

Detailed Syllabus

Module	Topics	No. of Lectures
1.	Introduction: The Need for EIA, EIA notification and its emergence ; EIA notification 2006 and its subsequent amendments The EIA Cycle and Procedures, Screening, Scoping, Baseline Data, Impact Prediction, Assessment of Alternatives, Delineation of Mitigation Measure and EIA Report, Public Hearing, Decision Making, Monitoring the Clearance Conditions, Components of EIA, Roles in the List of projects requiring Environmental clearance, Application form, Composition of Expert Committee, Ecological sensitive places, International agreements. , Consent to establish and operate	5
2.	Identifying The Key Issues: Key Elements of an Initial Project Description and Scoping, Project Location(s), Land Use Impacts, Consideration of Alternatives, Process selection: Construction Phase, Input Requirements, Wastes and Emissions, Air Emissions, Liquid Effluents, Solid Wastes, Risks to Environment and Human, Health, Socio-Economic Issues and Management, Ecological Impacts including biodiversity, Global Environmental Issues.	5

3.	EIA Methodologies: EIA methodology (as per EIA 2006 notification_ impact identification, impact measurement, impact interpretation & Evaluation, impact communication, development of Leopold Matrix, predictive models for impact assessment, Applications for RS and GIS. Role of consultants, NABET, QCI	5
4	Reviewing Contents of EIA Report: Scope, Baseline Conditions, Site and Process alternatives, Public hearing. Construction Stage Impacts, Project Resource Requirements and Related Impacts, Prediction of Environmental Media Quality, Socio-economic Impacts, Ecological Impacts, Occupational Health Impact, Major Hazard/ Risk Assessment, Impact on Transport System, Integrated Impact Assessment.	6
6	Case Studies: Preparation of EIA for developmental projects- Factors to be considered in making assessment decisions, Water Resources Project, Pharmaceutical industry, thermal plant,.	4
7	Case Studies :Nuclear fuel complex, Highway project, Sewage treatment plant, Municipal Solid waste processing plant, Tannery industry, Construction Projects	4

References

1. Canter, L.W., Environmental Impact Assessment, McGraw Hill Pub. Co., 1997

2. David P. Lawrence, Environmental Impact Assessment: Practical Solutions to Recurrent Problems, John Wiley & Sons, 2003

3. Hosetti, B. B., Kumar A, Eds, Environmental Impact Assessment & Management, Daya Publishing House, 1998

4. UNESCO, Methodological Guidelines for the Integrated Environmental Evaluation of Water Resources Development, UNESCO/UNEP, Paris, 1987

5. Anjaneyulu.Y., and Manickam. V., Environmental Impact Assessment Methodologies, B.S. Publications, Hyderabad, 2007

6. Wathern.P., Environmental Impact Assessment- Theory and Practice, Routledge Publishers, London, 2004

7. EIA notification (2006)

8. EIA manuals of different sectors (available online)

Sardar Patel College of Engineering Andheri (West), Mumbai 400 058
Academic Year: 2019-20

PE- BTC819–Course :-Elective-II : Appraisal and Implementation of Infrastructure Projects

(AY 2019-20)

Course Objective:

1. To discuss about Infrastructure project and their feasibility.
2. To explain appraisal of construction project.
3. To describe the need of financial and environmental appraisal of project.
4. To outline project audit, financing and its implementation.

Course Outcome:

1. To carry out construction project appraisal.
2. To evaluate construction economic and environmental analysis.

To practice various method for implementation of construction project including arrangement of finance

Module No	Details	Hrs
1	Components of Infrastructure, Infrastructure scenario in India, Key issues sector wise, Urban Infrastructure, Rural infrastructure, characteristics of construction project, stakeholders in Infrastructure projects, Phases of infrastructure project.	04
2	Project Feasibility Project management cycle, Detailed Project report, project formulation project implementation, Agencies involved in implementation, methods of implementation like Build, operate and transfer (BOT) method and its variants like BOO, BOOT, BOLT etc, SWOT analysis of project.	04
3	Project Appraisal Introduction, Need of appraisal, steps of appraisal Market appraisal, Demand analysis, forecasting demand, sources of information, market survey, uncertainties in demand forecasting Technical appraisal Location, land, buildings, technology and its appropriateness, size of plant, plant and machinery, raw materials, energy requirements, water supply, effluent disposal Management appraisal	08
4	Financial and Environmental Appraisal of project Break-even analysis, financial projections, financial appraisal tools: paybackperiod, accounting rate of return, net present value, internal rate of return,benefit cost ratio, cost of capital, risk analysis, social cost benefit analysis. Guidelines for environmental Appraisal for infrastructure project	08
5	Project Audit Project budget and schedule, causes of project failure, reason for audit, Construction Contract audit and phases of project audit.	04
6	Project financing Norms and policies of financial institutions, Types of financing, sources(local and international),Cash flows by financial institutions, planning	04

	commission/Niti Aayog, various issues in financing	
7	Road and bridge Infrastructure Development Issues and challenges in construction and maintenance of road and bridge Infrastructure, sustainable development of Infrastructure, role of PPP in road and bridge infrastructure development.	04
	Total	**36**

Term work:-

At least 10 assignments shall be submitted as term work.

Recommended Books:-

Project Preparation, Appraisal, Budgeting, and Implementation: Prasanna Chandra, Tata McGraw Hill

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PE-BTC820 Course :- Risk & Disaster Management

(AY 2019-20)

Course Objectives:

1. To discuss the concept of risk management.
2. To explain various quantitative techniques of risk management and mitigation measures
3. To describe the concept of disaster management.
4. To summarize the disaster management process.

Course Outcome:

1. To carry out risk assessment operation and corresponding risk mitigation measures.
2. To identify potential disaster and accordingly formulate disaster management plan.
3. To implement disaster management plan.

Course Content

Module No	Details	Hrs
1	Basic concept of Risk, Definition of Risk, Types of risk, Risk &Uncertainty, Failure Mode Effect analysis, Performance Measures, Scope ofrisk control during project life cycle.	04
2	Decision analysis determination of risk value, formalization of quantitative risk assessment, probabilistic risk assessment	06
3	Risk registers, risk priority number, risk identification analysis and response measures, probability matrix measures	06
4	Risk analysis in construction projects, Sensitivity analysis, Break even analysis, Scenario analysis, Decision trees, Monte-Carlo simulation, Spider diagram, Probability contours	06
5	Nature & Extent of disasters, Industrial Hazards, Development of Disaster Management Plans	06
6	Role of Organizations in disaster management, Financing relief operations, Legal aspects.	04
7	Hazard Analysis, personnel training, Information management, Emergency operations and facilities, creating awareness, Effective implementation of Disaster Management system.	04

Term work:-

Assignments consisting of minimum twenty problems covering entire syllabus shall be submitted as term work.

Text Books:-

1. Risk & Decision Analysis in projects, John Schuyler,PMI.
2. Risk Management & Construction, Roger Flangan& George Norman, Blackwell science

3. Risk Management for Design & Construction, OvidiuCretu, Robert B. Stewart and Terry Berends
4. NICMAR publications

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PE-BTC821 Course :- Advanced Design of Steel Structures

(AY 2019-20)

Course Objective

1. To develop Civil Engineering graduates having clear understanding of concepts, and practical knowledge of modern Civil Engineering techniques for design of steel structures.
2. Use of various relevant IS codes for designing steel structures.
3. To encourage students and faculty to interact with industry, alumni and other reputed institutes for purpose of better understanding of industry requirements
4. To deal with social, environmental and economic issues

Course Outcome

At the end of the course the students shall be able to develop collaborative skills to work in a team/group and technical/analytical skills to

1. Design various steel structures.
2. Analysis and design gantry girder, lattice tower , steel chimney.

Module No	Details	Hrs
1	Moment Resistant Beam End Connections: Design of moment resistant bolted and welded beam end connections.	04
2	Round Tubular Structural Members Properties of steel tubes, design of tension and compression members, design of welded connections, design of flexural members, analysis and design of tubular trusses including purlins and supports.	06
3	Elevated Steel Tanks and Stacks: Loads acting on tanks including wind and earthquake, design of circular tanks with hemispherical and conical bottom, supporting ring beam, staging for circular tanks including design of columns and foundation,.	06
4	Design of rectangular steel tanks including design of staging, columns and foundation	04
5	Gantry Girder: Loads acting on gantry girder. Analysis and design of gantry girder	06
6	Lattice Tower: Different configurations of lattice towers, loads acting on lattice towers, analysis and design of lattice tower including welded or riveted connections for members.	04

7	Steel Chimney: Forces acting on chimney, design of self supporting welded chimney and its components including design of foundation.	06
	TOTAL	**38**

Term work:-

The term work shall consist of a design report and detailed drawings on three projects as indicated below:

1. Design of tubular trusses
2. Design of elevated circular tank with conical bottom or rectangular steel tank
3. Design of lattice tower or steel chimney.

The drawings should be drawn with pencil only on minimum of A1 (Imperial) size drawing sheets.Term work as mentioned above shall be submitted as term work.

Text Books:-

1. Design of steel structures: Subramanian, Oxford Press.
2. Design of steel structures: Negi L.S., Tata McGraw Hill
3. Design of steel structures: Kazimi S.M. A. & Jindal R.S., Prentice Hall of India.
4. Design of steel structures: Krishnamachar B.S, &Ajitha Sinha D.
5. Design of steel structures: Arya and Ajmani, New Chand & Bros.
6. Design of steel structures, Vol I & II: Ramchandran, Standard Book House, New Delhi.
7. Design of steel structures: Dayaratnam, Wheeler Publication, New Delhi
8. Comprehensive design of steel structures: Punamia, A.K. Jain &Arun Kumar Jain, LaxmiPublicalions Pvt. Ltd.
9. Design of steel structures: I C Sayal&Salinder Singh, Standard Publishers & Distributors.

Reference Books:-

1. Steel structures, Controlling behavior through design: R. Englekirk, Wiley
2. Design of steel structures: Breslar, Lin and Scalzi, John Willey, New York.
3. Design of steel structures: Mac. Ginely T.
4. Structural steel work: Reynolds TJ., Kent L.E. &Lazenby, D.W., English University Press.

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PE-BTC822 Course :- Soil Dynamics

(AY 2019-20)

Soil dynamics is a branch of soil mechanics that deals with behaviour of soil and foundations under dynamic loading. Operation of rotary machines or hammers, and earthquake ground motions are examples of dynamic loads that challenge engineers in their design of different foundations.

Course Objectives:

1. To explain the basics of a vibrating system, degrees of freedom, wave propagation in soil
2. To evaluate liquefaction potential, understand dynamic earth pressure on retaining walls
3. To explain the principles of machine foundation design, vibration isolation and screening methods
4. To recommend field and laboratory tests to determine dynamic properties of soil

Course Outcomes:

The students will be able too understand

1. Apply the basics of dynamics to soil
2. Predict dynamic behaviour of soils,
3. Assess the effects of dynamic loads on behaviour of soil;/rock
4. Design machine foundations and other soil systems subjected to dynamic loading

Module No	Details	Hrs
1	Vibration of elementary system, Degree of freedom, Analysis of system with one degree of freedom , spring- mass system Harmonic vibration , uniform circular motion, natural frequency, free and forced vibrations with and without damping Type of damping.	04
2	Wave propagation in elastic rods, in an elastic infinite medium, and in semi-elastic half space, wave generated by surface footing.	04
3	Liquefaction of soils , criterion and factors affecting liquefaction of soil, laboratory and field studies on liquefaction, liquefaction studies in oscillatory simple shear, evaluation of liquefaction potentials, liquefaction of clay.	06
4	Principles of machine foundation design, criteria for satisfactory machine	06

	foundation, degree of freedom of a block foundation analysis of vertical and sliding vibration of a machine foundation, mass of soil participating in vibration.	
5	Vibration isolation and screening methods, improvement of distressed machine foundation.	04
6	Field and laboratory tests for evaluation of dynamic properties of soil under vertical vibration coefficient of elastic uniform compression, coefficient of elastic uniform shear, spring constant damping modulus of elasticity typical values of soils	06
7	Basics of dynamic earth pressure on retaining walls: conventional gravity type, reinforced soils, distribution of pressure, point of application of the resultant, simple examples.	06
	Total	**36**

Term work:-

Each student shall prepare a project report covering the selection of design parameters, design analysis including drawing on any aspect of soil dynamics included in the syllabus.

The project report referred above, at least five examples shall be submitted as term work.

Text Books:-

1. Soil Dynamics: Shamsher Prakash, McGraw-Hill Book Company
2. Principles of Soil Dynamics: Braja M. Das, PWS-Kent Publishing Company
3. Dynamics of Bases and Foundations: D. D. Barkan, McGraw-Hill Book Company.
4. Relevant IS Codes

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PE-BTC823 Course: Building Services

(AY 2019-20)

Course Objectives:

1. To discuss the concept of various machineries like lift, escalators, vibrators, concrete mixers etc.
2. To explain utility services in building like pluming system, electrical system, fire safty installation and rainwater harvesting system etc.

Course Outcomes:

The course will enable the students

1. To implement installation of utility services.
2. To identify drawback if all service lines are not install properly or used any faulty materials.
3. To carry out water audit.

Module No	Details	Hrs
1	Machineries: Lifts and Escalators – Special features required for physically handicapped and elderly – Conveyors – Vibrators – Concrete mixers – DC/AC motors – Generators – Laboratory services – Gas, water, air and electricity -Hot Water Boilers –Pumps	06
2	Plumbing Systems in Building: Plumbing services:-Water distribution system-Material for service pipes-Service connection-size of service pipe-Water meter-Valves-Storage tanks-Drainage system:-Pipe and traps-Sanitary fittings-system of plumbing-House drainage plans-Septic tank-Soak pit	06
3	Electrical Systems& Illumination Design in Buildings: Electrical Systems in Buildings : Basics of electricity – Single / Three phase supply – Protective devices in electrical installations – Earthing for safety – Types of earthing – ISI specifications – Types of wires, wiring systems and their choice – Planning electrical wiring for building – Main and distribution boards – Transformers and switch gears – Layout of substations Principles of Illumination Design: Visual tasks – Factors affecting visual tasks – Modern theory of light and colour – Synthesis of light – Additive and subtractive synthesis of colour –Luminous flux – Candela – Solid angle illumination – Utilization factor –Depreciation factor –	06

	MSCP – MHCP – Lans of illumination –Classification of lighting – Artificial light sources – Spectral energy distribution Luminous efficiency – Colour temperature – Colour rendering. Design of modern lighting – Lighting for stores, offices, schools, hospitals and house lighting. Elementary idea of special features required and minimum level of illumination required for physically handicapped and elderly in building types.	
4	Refrigeration Principles & Applications: Thermodynamics – Heat – Temperature, measurement transfer – Change of state – Sensible heat – Latent heat of fusion, evaporation, sublimation –saturation temperature – Super heated vapour – Sub cooled liquid – Pressure temperature relationship for liquids – Refrigerants – Vapour compression cycle – Compressors – Evaporators – Refrigerant control devices – Electric motors – Starters – Air handling units – Cooling towers – Window type and packaged air-conditioners – Chilled water plant – Fan coil systems – Waterpiping – Cooling load – Air conditioning systems for different types of buildings – Protection against fire to be caused by A.C. Systems	06
5	Fire Safety Installation: Causes of fire in buildings – Safety regulations – NBC Planning considerations in buildings like non-combustible materials, construction, staircases and lift lobbies, fire escapes and A.C. systems. Special features required for physically handicapped and elderly in building types – Heat and smoke detectors – Fire alarm system, snorkel ladder – Fire lighting pump and water storage – Dry and wet risers – Automatic sprinklers	06
6	Rain Water Harvesting: Water Audit of India, Concept of rain water harvesting, Methodologies for Percolation/ recharge bore pit, Percolation/ recharge bore well, Percolation/ recharge well cum bore pit, Harvesting rooftop rainwater, Harvesting driveway runoff. National water harvesters network (NWHN). Some case studies.	04
7	Introduction to Green Building:Need for a green building, planning and design of green buildings, obstacles, Materials used in green building technology, Rating System (According to LEED-INDIA)	02
	TOTAL	**36**

Term work:-

At least one site visit should be arranged to give an exposure to various construction techniques discussed in the above syllabus. A report on site, at least 10 assignments (including sketches) shall be submitted as term work.

Text Books:-

1. Heat Pumps and Electric Heating: E.R.Ambrose, John and Wiley and Sons, Inc., New York, 1968.
2. Handbook for Building Engineers in Metric systems, NBC, New Delhi, 1968.
3. Philips Lighting in Architectural Design, McGraw-Hill, New York, 1964.
4. The Lighting of buildings: R.G.Hopkinson and J.D.Kay, Faber and Faber, London, 1969.
5. Air-conditioning and Refrigeration: William H.Severns and Julian R.Fellows, John Wiley and Sons, London, 1988.
6. Air-conditioning and Energy Conservation: A.F.C. Sherratt, the Architectural Press, London, 1980.
7. National Building Code.
8. Building Construction: Dr. B.C. Punmia, Ashol K Jain, A.K Jain
9. Construction Engineering and Management: S. SeetharamanUmeshPublicatins, Delhi.
10. Water supply and Sanitory Installations: A. C. Panchdhari New age international publication, Delhi
11. Fire Safety in Building: V. K. Jain, New age international publication, Delhi
12. Green remodeling: David Johnston.
13. Green Building , Project Planning and Cost Estimation: R.S.Means
14. LEED – INDIA (Abridged Reference guide for Core and Shell, Version 1.0).

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PE-BTC824 Course :- Design of Hydraulic Structures

(AY 2019-20)

Course Objectives:

1. To discuss different types of dams and their design criteria.
2. study different types of dams and data collection for site selection.
3. To study design criteria for selection of gravity dam.
4. To study different types of arch and buttress dams.
5. To study advantages and limitations of earth and rock fill dams.
6. To study spillways and flood control works.
7. To study principles of hydraulic design of components of hydraulic structures.
8. To study design details of surplus weir, flush escape, direct sluice, canal drop, canal regulator, cross drainage works.

Course outcomes:

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

1. Select site for dam with preliminary and final investigations, fix storage capacity, analyse reservoir losses, and estimate sedimentation in reservoirs.
2. Analyse forces acting on gravity dam its failure and carry out stability analysis of gravity dams.
3. Understand forces on an arch and buttress dams and its design.
4. Understand details of construction and maintenance of earth fill and rock fill dams including stability analysis criteria.
5. Understand design principles of spillways and flood control works.
6. Design small bridges and culverts and its principles of hydraulic design

Module No	Details	Hrs
1	Dams{General}: Introduction, classification, comparative study of different typesof dams, selection of type of dam, selection of site of dam, preliminary and final investigations of dam sites, fixation of storage capacity, reservoir losses, sedimentation in reservoirs, density currents.	04
2	Gravity dams: Criteria for selection of dam site, construction material, forces acting on gravity dam, modes of failure, stability analysis, safety criteria, methods of design , stress analysis and stress contours, galleries, instrumentation, joints, keys, water seals, temperature control in concrete dams, foundation treatment.Spillways and other energy dissipating devices: types.	06

3	Arch and buttress dams: Types of arch dams, forces on an arch dam, design. Types of buttress dams.	06
4	Earth and rock fill dams: Advantages and limitations, foundation of earth dams, causes and failures of earth dams, design criteria, design considerations in earthquake regions, seepage line for different conditions, filters, upstream blankets, stability analysis, Swedish circle method with pore pressure, details of construction and maintenance, types of rock fill dams, stability analysis, advantages.	06
5	Spillways and flood control works: Factors affecting design of spillway, types of spillways, design principles of ogee spillway, chute spillway, siphon spillway and shaft spillway. Design of bucket type energy dissipater and stilling basin, flood mitigation reservoirs. Crest gates, types, advantages, choice, and design of radial gate. Outlet works through dams, intake structures.	06
6	Design of small hydraulic structures: Design of small bridges and culverts, data collection, high flood discharge, linear waterway calculation, scour depth, causeways and culverts, principles of hydraulic design.	04
7	Miscellaneous topics: Design details of surplus weir, flush escape, direct sluice, canal drop, canal regulator, cross drainage works. Vibration and cavitations in hydraulic structures. Design of air vent.	04
	TOTAL	**36**

Term work:-

Assignments (on each module) consisting of theory and problems covering entire syllabus shall be submitted as term work.

Text Books:-

1. Irrigation and Water Power Engineering: Dr. B.C. Punmia and Dr. PandeB.B.Lal, Laxmi Publications Pvt. Ltd. New Delhi.
2. Irrigation Water Resources and Water Power Engineering: Dr. P.N. Modi, Standard Book House. Delhi.
3. Irrigation Engineering and Hydraulics Structures: S. K. Gerg, Khanna Publishers. Delhi.
4. Irrigation: Design and Drawing: Murty.
5. Design of Irrigation Structures: S. K. Sharma, S. Chand and Co.
6. Theory and Design of Irrigation Structures: R. S. Varshney and R. C. Gupta, Nem Chand
7. Engineering for Dams, Vol. I to III: by Crager, Justin and Hinds, John Wiley
8. Design of Small Dams: USBR
9. Hydro Power Structures: R. S. Varshney, Nem Chand and Bross.
10. Concrete Dams: R. S. Varshney, Oxford and IBH Publishing Co.

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PE-BTC825–Course :- Transportation Planning and Economics

(AY 2019-20)

Course Objective:

1. To develop skill for four stage modeling and traffic forecasting in transportation planning including the impacts due to land use changes.
2. To impart the knowledge of economic assessment so as to enable students to decide worthiness of any infrastructure project.
3. To make students aware of effectiveness of public transport systems with their suitability and role in developing countires like India.
4. Create awareness about modern computation techniques for transporation planning, modeling and analysis.

Course Outcome:

1. Graduate students should be able to understand travel behavior, forecast trips and assess the travel pattern for future infrastructural facilities. They should be able to justify provision of infrastructural facility based on economic assessment and should be able todecide suitability of a particular mass transport system

Module No	Details	Hrs
1	Transportation Planning and management: General Travel Forecasting Principles and techniques, Generalized demand, price and capacity relationship applied to travel forecasting, Practical problems of forecasting travel. Introduction to the process of urban transport planning.	**06**
2	Travel demand forecasting: Trip generation analysis, trip classification, multiple regression analysis, category analysis, trip distribution analysis: introduction, methods of trip distribution, uniform and average factor method, Fratar method, Furness method, the gravity model and its calibration, Intervening and competing opportunities model, linear programming approach to trip distribution. Modal split analysis: introduction, Modal split analysis: Profit analysis, Logic analysis and Discriminant analysis, modal split models with behavioral basis. Traffic Assignment: purpose of trafficassignment,trafficflow characteristics, Assignment techniques: All or nothing assignment, Multiple route assignment, Capacity restraint assignment, Diversion curves. Rout building algorithms.	**06**

3	Land-use transport models: Introduction, selection of Land-use transport models, The Lowry model, Grain – Lowry model, Applications of Lowry model.	04
4	Introduction to advanced/soft computational techniques for transportation planning like Expert Systems, Neural Networks, Fuzzy Logic, Genetic Algorithm, Simulated Annealing, Hybrid systems etc.	06
5	Transport Economics: Economic evaluation of highway schemes, need for economic evaluation, cost and benefits of transportation projects, basic principles of economic evaluation, Net present value method, benefit/cost ratio method, internal rateof return method. Vehicle operating costs, Value of travel time saving, Accident costs and road pricing.	04
6	Public Transportation Introduction to various mass transportation systems, Classification of mass transit modes: Street transit or surface transit, Semi rapid transit, Rapid transit or mass rapid transit System, Special transit systems: magnetic levitation, monorails, water borne transport, Automated Guided Transit, Detailed capacity assessment of some selected technologies: Conventional bus on bus bays, Light rail transit, Rail Rapid Transit, Regional rail Transit or Suburban Railway, Suitability of Transit Systems for different travel demand for Indian Cities,	06
7	Suitability of Transit Systems for Indian Cities of Different Population sizes and forms, Influence of other factors in selection of Mass Transit Systems, Transit System Operations: Introduction, Route Development, Stop location and stopping policy, Schedule development, Capacity of transit systems.Future of Public transportation.	04
	TOTAL	**36**

Term work:-

Mini Project work based on transportation planning or on Public transportation system / Application of transport planning or transport economics software, assignment consisting of at least 15 problems shall be submitted as term work.

Text Books:-

1.Traffic Engineering and Transport Planning: L.R. Kadiyali, Khanna publishers Delhi
2.Principles of Traffic Engineering: G.J. Pingnataro, Mc Graw-Hill, 1970.
3.Traffic System Analysis for Engineering and Planners: Wohl and Martin, Mc Graw Hill, 1983.
4.Introduction to Urban Transport Systems, Planning: B.G. Hutchinson, McGraw-Hill, 1970.
5.Economics of Transportation: Fair and Williams, Harperand Brothers, Publishers, New York.
6.Economic Analysis for Highway: Winfrey, Robley, International Textbook Co., Pennsylvania, USA, 1969.
7.Public Transportation Planning Operation and Management: Gray and Hoel, Prentice Hall Publication.
8.Principles of Transportation Engineering: ParthaChakroborty and Animesh Das, Prentice hall (India)

PE-BTC826 –Course : Advanced Construction Engineering

(AY 2019-20)

Equipments : Construction is the ultimate objective of a design and it is the machines whichmake it possible in a fast and economical way. For the successful completion of a project a constructor has to choose the right set of equipments to complete a particular work in the specified time and with involvement of minimum labour. Thus planning, selection and utilization of any construction equipment helps one to analyze the operational problems on the site and to arrive at practical solutions for completing a task.

Techniques: Simply relying on the appropriate use of suitable equipments cannot be replied upon for the successful completion of any construction project. Understanding the correct construction techniques is vital for making optimal use of the equipments used.

Course Objectives:

1. to learn about the characteristics and complexities of major construction activities
2. to study the excavation methods in various types of soils for large and heavy engineering projects
3. to understand the importance of selection of appropriate equipment and techniques in concrete construction for heavy engineering projects
4. To study prefabricated construction.

Course Outcomes:

At the end of this course the students will

1. Be able to select appropriate equipment for large and heavy construction project from planning to execution relating to excavation for foundations, concreting, pre-fabricated construction, steel construction.
2. Understand importance of implementing quality and safety measure during fabrication and erection of steel, structures.
3. Be able to carry out detailed planning related to complex large size construction
4. projects such as dams, power station, airports, bridges etc.

Module No	Details	Hrs
1	Large and heavy engineering projects: Characteristics and complexities, methods statement for major activities like excavation, concreting, steel fabrication and erection for projects like earthen dams, hydropower projects, nuclear power plant, refineries and other industrial projects etc. New materials and equipment for construction	08
2	Excavation for heavy engineering projects: Excavation in various types of soils, selection of equipment, safety measures in excavation, drainage in excavation, New materials and equipment for construction	08
3	Concrete construction for heavy engineering projects: Selection of equipment for batching, mixing, transporting, placing and compacting for various types of jobs, safety measures during concreting, Special concretes and mortars: preplaced aggregate concrete, roller ompacted concrete, grouting, New materials and equipment for construction	07
4	Prefabricated construction: Planning for pre-casting, selection of equipment for fabrication, transport and erection, quality measures, safety measures during erection	05
5	Steel construction: Planning for field operations, selection of equipment and erection tools,tools and methods of welding, tools and methods of cutting and joining ,bridge erection, quality measures, safety measures during fabrication anderection	
6	Specific issues related to planning, site layouts, equipment selection and pre-project activities for large size construction projects like earthen dams, concrete dams, thermal power stations, nuclear power stations, light houses, airports and ports, bridges, Information related to special equipments and their applications to off-shore construction, underground utility construction,	10
7	Case studies of heavy construction projects	05
	TOTAL	**43**

Term work:-A detail report of site visit to any heavy construction work, at least five assignments shall be submitted as term work.

Text Books:-

1. Erection of Steel Structures: Thomas baron
2. Handbook of Heavy Construction: Stubbs, McGraw Hill, New York
3. Journals of Civil Engineering and Construction Engineering

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PE-BTC827- Conventional & Nonconventional Materials in Highway (AY 2019-20)

Course Objectives:

1. To Explain the Laboratory & Field Procedure for Testing of Subgrade,
2. To discuss use conventional & Nonconventional Materials in Subgrade.

Course Outcome:

1 Learn how to conduct static and cyclic triaxial test & how to use these data in pavement design. How to conduct static & cyclic plate bearing test, CBR test in field & lab.

2 Learn about different ground improvement technique, use of different stabilizers like, lime, fly ash, fibres in highway subgrade

Detailed Syllabus

Module No	Topics	No. of Lecture
1	Subgrade: Functions, importance of subgrade soil properties on pavement performance, subgrade soil classification for highway engineering purpose soils as per PRA system, revised PRA system, Burmister system, Compaction System.	10
2	Test on subgrade soils: Static and cyclic triaxial test on subgrade soils, resilient deformation, Resilient strain, resilient modulus. CBR test, effect of lateral confinement on CBR and E – value of Subgrade soil. Static and cyclic plate load test, estimation of modulus of subgrade reaction, correction for plate size, correction for worst moisture content.	06
3	Ground Improvement Technique: Different method of soil stabilization, use of geo- textile, geogrid and fibres, lime, fly ash in highway subgrade. Vertical sand drain: design criteria, construction and uses.	08

Recommended Books:

1. Principles of Pavement Design, Second edition, 1975: Yoder, E. J., John Wiley & Sons, Inc., New York.
2. Concrete Roads: HMSO, Road Research Laboratory, London.
3. Highway Engineering: Khanna & Justo, New Chand & Brothers, Roorkee.

Principles and Practices of Highway Engineering: Dr. L. R. Kadiyali and Dr. N. B. Lal, Khanna Publication, New Delhi