

SEM-V

Structural Engineering

Course Code	Course Name
PC-BTC501	Structural Engineering
Course pre-requisites	ES-BTC 302, ES-BTC 351, PC-BTC 402

Course Objectives
<p>The objectives of this course are</p> <ol style="list-style-type: none"> 1. To introduce the students to the method of analysis of three hinged arches, cables and suspension bridges. 2. To introduce the students to the concept of Influence line diagrams. 3. To introduce the students to the methods of finding absolute and relative deflections caused by loads, temperature changes and settlement of supports. 4. To introduce the students to the methods of analysis of indeterminate structures. 5. To prepare the base for the students to study other advanced structural engineering courses at a later stage.

Course Outcomes
<p>Upon successful completion of the course, students should be able to</p> <ol style="list-style-type: none"> 1. Analyse three hinged arches and cables and suspension bridges. 2. Draw influence line diagrams for determinate beams and pin jointed frames. Determine the maximum effect due to moving loads. 3. Find absolute and relative deflections caused by loads, temperature changes and settlement of supports and to identify and determine the type and degree of indeterminacy in structures. 4. Analyse indeterminate beams using flexibility method and slope deflection method.

Course Content		
Module No.	Details	Hrs.
1	Three hinged arches: Determination of normal thrust, radial shear force and bending moment for three hinged parabolic arch.	03
	Determination of normal thrust, radial shear force and bending moment for segmental arch.	03
2	Cables and suspension bridges: Simple suspension cable, minimum and maximum tensions in the cable supported at same and at different levels, anchor cable, cable supports, suspension cable with three hinged stiffening girder, shear force and bending moment at any section of the three hinged stiffening girder.	05
3	Influence lines for statically determinate structures: Influence lines for reaction, shear force and bending moment at a section in	06

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	cantilever, simply supported and overhanging beams. Criteria for maximum shear force and bending moment at a section, absolute maximum shear force and bending moment under moving loads (udl and series of point loads) for simply supported beams.	
4	Influence lines for statically determinate structures: Influence lines for axial force in pin jointed frames (trusses).	03
5	Deflection of statically determinate structures: Absolute and relative deflections caused by loads, temperature changes and settlement of supports, application to beams, pin jointed frames and rigid jointed frames. Absolute and relative deflections caused by lack of fit in pin jointed frames.	07
	Degree of indeterminacy of structures: Types of structures occurring in practice and their classification. Stable and unstable structure, degree of static and kinematic indeterminacy of structures.	03
6	Introduction to analysis of indeterminate structures by force method: Flexibility coefficients and their use in formulation of compatibility equations. Application of the flexibility method to analyse indeterminate beams.	06
7	Introduction to analysis of indeterminate structures by displacement method: Slope deflection method- application to indeterminate beams.	04

Term Work

Term work shall comprise of

1. At least 20 (twenty) solved problems based on the above modules shall be submitted as term work.
2. Course project*

***Course Project:** There will be a course project where the students will be able to apply and integrate the knowledge gained during the course.

Text Books

1. Reddy C.S.(1999), "Basic Structural Analysis", Tata McGraw hill, ISBN 0070702764, 779 pages.
2. Junnarkar S.B. (2013), "Structural Analysis, Vol. II" Charotar Publishers ISBN 9380358703, 986 pages.
3. Pandit and Gupta (1999), "Structural Analysis Vol. I", Tata McGraw Hill, ISBN 0074634933, 679 pages.
4. L. S. Negi, and R. S. Jangid (1997), "Theory and Problems in Structural Analysis "Tata McGraw Hill, ISBN 0074623044, 828 pages.
5. D.S. Prakash Rao (1996), "Structural Analysis: A Unified Approach", Orient Blackswan

ISBN 8173710279, 672 pages.

Reference Books

1. John Benson Wilbur, Senol Utku, Charles H. Norris (1990), "Elementary Structural Analysis", Tata McGraw Hill, ISBN 9780070659339, 829 pages.
2. Harold I. Laursen (2007), "Structural Analysis", Tata McGraw Hill Higher Education, ISBN 0070366438, 468 pages.
3. Dr. B.N. Thadani And Dr. J. P.Desai (1964), "Modern Methods in Structural Analysis", Asia Publishing House,
4. C. K. Wang (2010), "Intermediate Structural Analysis", Tata McGraw hill. ISBN 0070702497
5. Russell C. Hibbeler (2012), "Structural Analysis", Prentice Hall, IBN 013257053X, 695 pages.
6. Alexander Chajes (1982), "Structural Analysis", Longman Higher Education, ISBN 0138534080, 352 pages.
7. Aslam Kassimali (2014), "Structural Analysis", Cengage Learning, ISBN 1133943896, 613 pages.

Sr. No.	Examination	Module
1	T-I	1, 2 and Part of 3
2	T-II	Part of 3, 4 and 5
3	End Sem	1 to 7

Hydrology and Water Resource Engineering

Course Code	Course Name
PC-BTC502	Hydrology and Water Resource Engineering

Course pre-requisites	
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Course Objectives

The main objectives of the course are

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

Course Outcomes

Upon successful completion of the course, students should be able

1. Measure and analyze rainfall, runoff and water losses
2. Estimate the water requirements of crops
3. To compute groundwater flow.
4. Design various hydraulic structures and irrigation systems.

Course Content

<i>Module No.</i>	<i>Details</i>	<i>Hrs.</i>
1	Introduction: Hydrologic cycle, water-budget equation, applications in engineering, sources of data, <i>Precipitation</i> - forms of precipitation, characteristics of precipitation in India, measurement of precipitation, rain gauge network, mean precipitation over an area, depth area-duration relationships, maximum intensity/depth-duration-frequency relationship, Probable Maximum Precipitation (PMP), rainfall data in India.	06
2	Abstractions from precipitation: evaporation process, evaporimeters, analytical methods of evaporation estimation, reservoir evaporation and methods for its reduction, evapotranspiration, measurement of evapotranspiration, evapotranspiration equations, potential evapotranspiration over India, actual evapotranspiration, interception, depression storage, infiltration, infiltration capacity, measurement of infiltration, modelling infiltration capacity, classification of infiltration capacities, infiltration indices.	06
3	Runoff: runoff volume, flow duration curve, flow-mass curve, hydrograph, factors affecting runoff hydrograph, components of	04

	hydrograph, base flow separation, effective rainfall, unit hydrograph surface water resources of India.	
4	Ground water and well hydrology: forms of subsurface water, saturated formation, aquifer properties, geologic formations of aquifers, well hydraulics: steady state flow in wells, equilibrium equations for confined and unconfined aquifers, aquifer tests.	04
5	Water withdrawals and uses: Water for energy production, water for agriculture, water for hydroelectric generation; flood control. Analysis of surface water supply, Water requirement of crops- Crops and crop seasons in India, cropping pattern, duty and delta; canal systems, alignment of canals, canal losses, estimation of design discharge. Design of channels- rigid boundary channels, alluvial channels, Kennedy's and Lacey's theory of regime channels. Introduction to Canal outlets	06
6	Hydraulic Structures: embankment dams: Classification, design considerations, Estimation and control of seepage, slope protection. Gravity dams: forces on gravity dams, causes of failure, stress analysis, elementary and practical profile. Arch and buttress dams, economic height of dam, and selection of suitable site.	06
7	Spillways: components of spillways, types of gates for spillway crests; Reservoirs- Types, capacity of reservoirs, yield of reservoir, reservoir regulation, sedimentation, Design of Ogee spillway and energy dissipater.	04
Term Work		
Term work shall comprise of		
At least 10 assignments covering the entire syllabus shall be submitted as term work.		

Text Books	
Recommended Data Books	
<ol style="list-style-type: none"> 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. G.L.Asawa (2006); "Irrigation and Water Resources Engineering", New Age International Publishers. ISBN-13 9788122416732. 624p 	

7. K N Muthreja, Applied Hydrology, Tata Mc-Graw Hill.
8. K Subramanya, Water Resources Engineering through Objective Questions, Tata Mc-Graw Hill.
9. L W Mays, Water Resources Engineering, Wiley.
10. J D Zimmerman, Irrigation, John Wiley & Sons C S P Ojha, R Berndtsson and P Bhunya, Engineering Hydrology, Oxford.

Sr.No.	Examination	Module
1	T-I	1, 2
2	T-II	3, 4
3	End Sem	1 to 7

Soil Mechanics

Course Code	Course Name
PC-BTC503	Soil Mechanics
Course pre-requisites	Engineering Geology(BS-BTC305), Mechanics of materials (ES-BTC302), Fluid Mechanics (PC-BTC306)

Course Objectives
<p>All construction that takes place, ultimately transfers the load to the ground, soil mechanics plays a crucial role in all civil engineering projects. The failure to carry out adequate soil study often has had dramatic and expensive consequences on construction projects.</p> <ol style="list-style-type: none"> 1. Introduce the subject of soil mechanics, rock mechanics and basic definitions of terms related to Geotechnical Engineering and the relationship between them. 2. Classify soils, estimate soil permeability, perform seepage analysis, draw flow nets, differentiate between compaction and consolidation of soils and discuss causes of instability of soil slopes. 3. Calculate effective stresses and principal stresses. 4. Introduce methods of soil investigation.

Course Outcomes
<p>The course will enable the learners to:</p> <ol style="list-style-type: none"> 1. Explain the basic principles of soil mechanics 2. Identify and quantify various engineering properties of soil. 3. Analyze soil behavior under the application of loads and estimate stability of slopes 4. Design a soil investigation programme needed before commencement of construction

Course Content		
Module No.	Details	Hrs.
1	<p>Introduction: Importance of geotechnical engineering. Basic definitions of various soil parameters and relationships between them. Soil as a three phase system. Determination of various index properties of soil.</p> <p>Self study: Basic clay mineralogy</p>	02
2	<p>Characterization and Classification of soil: Plasticity and consistency indices. Classification systems based on particle size.</p> <p>Self study: Classification based on AASHTO and textural classification</p>	04
3	<p>Soil water: Capillarity in soils. Quick sand condition. Permeability of soils. Determination of coefficient of permeability in lab and field. Permeability of stratified soils. Introduction to seepage analysis. Effective stress principle</p> <p>Self study: Flow nets</p>	04
4	<p>Compaction of soil: Determination of optimum moisture content</p>	03

	and maximum dry density in lab and field Self Study: Suitability of compaction equipments for various soil types	
5	Stresses in soil: Importance of estimation of stresses in soils. Boussinesq's and Westergaard's theories for point loads. Variation of vertical stress under point load along the vertical and horizontal planes – Newmark's influence chart. Self Study: Uniformly loaded circular and rectangular areas	03
6	Consolidation: Introduction. Normally consolidated soil, over consolidated soil and under consolidated soil. Preconsolidation pressure and its determination. Estimation of settlements - Terzaghi's 1-D consolidation theory – Coefficient of consolidation and its determination. Self Study: Difference between compaction and consolidation, Spring analogy	05
7	Shear Strength: Mohr-Coulomb theory. Direct shear test. Triaxial compression tests: UU, CU and CD. Pore-pressure measurement. Computation of effective shear strength parameters. Unconfined compression test and vane shear test. Self Study: Mohr's circle, principal planes	07
8	Stability of slopes: Types of slopes. Types of slope failures. Slip circle method. Determination of centre of most critical slip circle. Taylor's stability charts and their use. Stabilisation of soil slopes. Introduction to software Self Study: Relative merits and de-merits of various methods	04
9	Soil Exploration: Methods of boring. Types of soil samplers and sampling procedures, Penetrometer tests. Analysis of borehole logs. Self study: geophysical and advance soil exploration methods.	04

Term Work

Term work shall comprise of

1. Exercises on the above topics in the form of design calculations with sketches and or drawings.
2. Examination (MCQ) based on topics mentioned in latest GATE syllabus
3. Course project*

***Course Project:** There will be a course project where the students will be able to apply and integrate the knowledge gained during the course. The projects will be developed by teams of two to four students.

Reference Books

1. Singh A. Soil Engineering in Theory and Practice (Vol. -1). 4th Edition, CBS Publishers And Distributors Pvt. Ltd., India, 2018.
2. Murthy, V. N. S. Geotechnical Engineering: Principles And Practices Of Soil Mechanics And Foundation Engineering. CRC Press, India, 2002
3. Relevant Indian Standard Specifications & Codes, BIS Publications, New Delhi.

Sr. No.	Examination	Module
1	T-I	1, 2, 3, part of 4
2	T-II	Remaining part of 4, 5, 6 and part 7
3	End Semester	1 to 9

Highway Engineering

Course Code	Course Name
PC-BTC504	Highway Engineering

Course pre-requisites	PC-BTC307, PC-BTC354 ,PC-BTC403
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Course Objectives

The main objectives of this course are

1. To Summarize brief History of roads in India, and classification of roads as per different 20 years Road Development Plan, to discuss Highway planning and geometric design of Roads,
2. Design and construction of Flexible as well as Rigid Pavements.

Course Outcomes

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

1. To analyze and Design of Geometric elements of different road types.
2. To implement the knowledge gained for Design & Construction of Flexible Pavements, Rigid Pavements.
3. To execute construction and maintenance of Flexible and Rigid Pavements.

Course Content

<i>Module No.</i>	<i>Details</i>	<i>Hrs.</i>
1	<p>Highway Planing</p> <p>i Classification of roads, brief history of road developments in India, present status of roads in India.</p> <p>ii Highway alignment, basic requirement of ideal alignment, factors governing highway alignment</p> <p>iii Highway location survey, map study, reconnaissance, topographic surveys, highway alignment in hilly area, drawing and report preparation</p>	04
2	<p>1. Geometric Design of Highway:</p> <p>i.Terrain classification, vehicular characteristics, highway cross section elements, salient dimensions, clearances, width of carriage way, shoulders, medians, width of road way, right of way, camber and its profile.</p> <p>ii.Design speed, sight distance, perception time, break reaction</p>	09

	<p>time, analysis of safe sight distance, analysis of overtaking sight distance, intersection sight distance.</p> <p>iii. Horizontal curves: design of super elevation and its provisions, minimum radius of horizontal curves, widening of pavement, transition curves.</p> <p>iv. Gradients: different types, maximum, minimum, ruling and exceptional, grade compensation in curves, vertical curves: design factors, comfort and sight distance. Summit curve, valley curve.</p>	
3	<p>Traffic Engineering: Traffic volume study, spot speed study, traffic sign, traffic signals, intersection at grade, grade separate intersection.</p>	03
4	<p>Pavement Design:</p> <p>i Types of pavements, different method of pavement design, comparison of flexible and rigid pavements, design wheel load, equivalent single wheel load, equivalent wheel load factor.</p> <p>ii Flexible pavement design: IRC approach, Burmister's layers theory, Triaxial method.</p> <p>iii Stress in Rigid Pavements, critical load position, wheel load stress, temperature stress, combine wheel load and temperature stress.</p>	06
5	<p>Highway Construction:</p> <p>i Construction of different types of roads: water bound macadam (WBM) road, different types of bituminous pavements, cement concrete pavement.</p> <p>ii Pavement failure: flexible pavement failure, rigid pavement failure, maintenance of different types of pavements.</p> <p>iii Strengthening of existing pavement: objective of strengthening, design of overlay using Benkelman beam method.</p> <p>iv Highway drainage, necessity, surface drainage, subsurface drainage.</p>	05

Recommended Books
<ol style="list-style-type: none"> 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. 835p.
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.
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

Sr.No.	Examination	Module
1	T-I	Module 1 and part of module 2
2	T-II	Part of module 2 and module 3
3	End Sem	1 to 5

Environmental Engineering – II

Course Code	Course Name
PC-BTC506	Environmental Engineering – II

Course pre-requisites	Environmental Engineering – I
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Course Objectives

The objectives of this course are

1. Understand the physical, chemical and biological properties of sewage
2. Develop a flow Content for sewage treatment and design its units
3. Develop a flow Content for wastewater treatment including primary, secondary and tertiary unit

Course Outcomes

Upon successful completion of the course, students should be able

1. Analyze wastewater quality with respect to its pollution parameters
2. Design hydraulic elements of a sewerage system
3. Understand role of biology in wastewater treatment
4. Design wastewater treatment plant including preliminary, primary, secondary and Tertiary treatment.

Course Content

<i>Module No.</i>	<i>Details</i>	<i>Hrs.</i>
1	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. iii. Wastewater generation per person iv. Exposure to EPANET, the piping network free software.	06
2	Sewage: Characterization and disposal i. Characteristics of sewage: Composition, chemistry of sanitary sewage including all parameters including types of nitrogen, 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.	06

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	iii. Self purification of streams: oxygen economy, sewage farming.	
3	Sewage treatment: Basic flow sheets, Unit Operations and Unit Processes 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
4	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 , trickling filters, stabilization ponds, Aerated lagoons, rotating biological contactors	07
5	Sludge digestion: Principles of aerobic and anaerobic digestion, quantity and characterization of sludge, thickening, stabilization, dewatering, design of sludge digestion tanks, disposal of digested sludge, drying bed, Rural and Low cost sanitation: Septic tanks and Imhoff tanks – principles, operation and suitability, design values, disposal of treated effluent	05
6	Modern Wastewater treatment technologies such as UASB, MBR, MBBR, SBR, FMBR, Natural Wetland system, microbial fuel cell, energy recovery, Advanced Oxidation Processes, Selection of technology depending on area, technology, investment cost, maintenance.	03
7	Wastewater Reuse: Centralized and decentralized treatment process Advanced wastewater technology, Potable and non potable reuse (Flushing, irrigation, construction, industry) Case studies in India and outside India related to wastewater reuse	03

Text 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.	<i>Metcalf & Eddy, Inc. (2003). Wastewater engineering : treatment and reuse. Boston :McGraw-Hil</i>
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. J.W. Clark, W.Veisman, M.J.Hammer (2008); “Water Supply and Pollution Control” Prentice Hall. ISBN-13: 978-0132337175. 864p.
9. Manual on Water Supply and Treatment, (latest Ed.): Ministry of & Housing. New Delhi
10. Relevant Indian Standard Specifications, BIS Publications CPHEEO Manual on Water

Sr.No.	Examination	Module
1	T-I	1, 2
2	T-II	3, 4
3	End Sem	1 to 7

Organizational Communication and Interpersonal Skills

Course Code	Course Name
HSM-BTC507	Organizational Communication and Interpersonal Skills

Course pre-requisites	HSM-BT107
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Course Objectives

The main objectives of this course are

1. To enhance effective corporate communication through professional writing
2. To prepare students for successful career that meets the corporate, industrial and global requirement.
3. To enable students to communicate in professional environment and social context with knowledge of professional etiquette, and understand social responsibilities with multi-disciplinary approach, in all tasks of life.
4. To discern and develop effective organizational writing.
5. To inculcate in students professional and ethical attitude at the workplace and develop an ability to imbibe effective interpersonal skills.

Course Outcomes

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

1. Develop professional communication using precise language and formats and apply the traits of a suitable candidate for a job/ higher education, through training and participation in group discussions, facing interviews and writing resume/ SOP
2. Demonstrate awareness of corporate etiquette and knowledge of professional responsibilities
3. Design technical documents using precise and objective language, apt for organizational communication
4. Deliver formal presentations effectively and develop life skills/ interpersonal skills to progress professionally by building stronger relationships in the society

Real Life Application Mapping with the Course

1. Communication Skills are critical career skills as well as life skills. A student can learn to be a responsible communicator, especially in the professional context.
2. The student will inculcate effective Reading and Writing skills, Speaking and Listening Skills. He or she will be equipped to express ideas in an effective manner and will learn interpersonal skills.
3. The student can use (fiction and non-fiction), magazines, videos, online articles to gain exposure to current affairs and corporate communication
4. Knowledge of good writing skills can help in the verbal section in aptitude tests, GRE, GMAT, CAT, TOEFL

5. In real life situations, students can learn to effectively communicate in various social and professional situations, and develop new perspectives. He or she can learn to participate and contribute to technical and non-technical discussions

Course Content		
Module No.	Details	Hrs.
1	Business writing: <ul style="list-style-type: none"> Types of meetings, Notice, Agenda, Minutes of the meetings, Strategies for conducting effective meetings. Email writing: (Netiquette) 	04
2	Employment Skills: <ul style="list-style-type: none"> Group Discussion SWOT Analysis Resume Writing / Curriculum Vitae Interview Skills Statement of Purpose 	09
3	Introduction to Corporate Etiquette and Core Values: <ul style="list-style-type: none"> Etiquettes and rules of behavior Professional Conduct, Etiquette in Meetings Dining Etiquettes. Core Values of an organization 	03
4	Report writing: <ul style="list-style-type: none"> Objectives of report writing, Language and style in a report, Types of reports. Formats of reports: Memo, Letter, and Project report Survey based. (<i>A Computer- aided presentation of the Project report</i>) Proposal Writing: <ul style="list-style-type: none"> Format and style. Technical Proposals: Objectives of technical proposals, Parts of proposals. 	08
5	Interpersonal Communication and Soft Skills: <ul style="list-style-type: none"> Creating and delivering effective presentations Working and communication in teams Leadership skills Time management Conflict resolution and negotiation skills 	06
Text Books		
1. Lesiker and Petit, “ Report Writing for Business” , Report Writing for Business,		

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<p>Edition 10, Module Nos. 1</p> <ol style="list-style-type: none"> 2. Huckin and Olsen, "Technical Writing for Professional Communication", McGraw Hill, Edition 2, Module Nos. 1, 2 3. Wallace and Masters, "Personal development for Life and Work", Thomson Learning, Edition 12, Modules Nos. 3, 4, 5, 6. 4. Herta Murphy, "Effective Business Communication", McGraw Hill, Edition 7, Module Nos. 1, 2, 3, 4, 6. 5. Fred Luthans, "Organizational Behaviour", McGraw Hill, Edition 12, Module Nos. 3, 5. 6. R.C. Sharma and Krishna Mohan, "Business Correspondence and Report Writing", Tata McGraw Hill, Edition 2, Module Nos. 1, 2, 4, 6. 7. Dr. K. Alex, "Soft skills", S. Chand and company, Edition 3, Module Nos. 3, 5, 6. 8. R. Subramaniam, "Professional Ethics", OUP, module nos. 5. 9. Robbins Stephens, "Organizational Behaviour", Pearson Education, Edition 12, Module Nos. 3.

Sr. No	Text Book Titles	Author/s	Publisher	Edition	Module Nos.
1	Report Writing for Business	Lesiker and Petit	Mc Graw Hill	10	1
2	Technical Writing for Professional Communication	Huckin and Olsen	Mc Graw Hill	2	1, 2
3	Personal development for Life and Work	Wallace and Masters	Thomson Learning	12	3, 4, 5, 6
4	Effective Business Communication	Herta Murphy	Mc Graw Hill	7	1, 2, 3, 4, 6
5	Organizational Behaviour	Fred Luthans	Mc Graw Hill	12	3, 5
6					
7	Business Correspondence and Report Writing	R.C. Sharma and Krishna Mohan	Tata McGraw Hill	2	1, 2, 4, 6
8	Soft skills	Dr. K. Alex	S. Chand and company	3	3, 5, 6
9	Professional Ethics	R. Subramaniam	OUP		5
10	Organizational Behaviour	Robbins Stephens	Pearson Education	12	3

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➤ **List of Reference Books (R – Symbol for Reference Books) to be Referred by Students**

Sr. No	Reference Book Titles	Author/s	Publisher	Edition	Module Nos.
1	How to Speak Fluently	Jones	Indian Publishing House	1st	6
2	Speaking English Effectively	Krishna Mohan N.P. Singh	Macmillan	2nd	6
3	“Business Communication - Concepts Cases and Applications”	Chaturvedi and Chaturdevi	Pearson	2nd	5
4	“Communication Skills for Engineers”	Sunita Mishra and C. Murlikrishna	Pearson	1st	6
5	Business Communication- “Building Critical Skills”	Kitty O Locker	McGraw Hill	3rd	3, 4
6	“Body Language”,	Alan Pease	Manjul Publications	18th	3, 4,6
7	“The Craft of Business Letter Writing”	Monipally	Tata McGraw Hill	1st	6
8	Soft Skills and Professional Communication	Francis Peter	Tata McGraw Hill	1st	3, 6
9	50 ways to improve your Business English	Ken Taylor	Summertown Publishing	1st	1, 5
10	50 ways to improve your Presentation Skills in English	Bob Dignen	Summertown Publishing	1st	6

➤ **List of E - Books (E – Symbol for E-Books) to be Referred by Students**

Sr. No	E- Book Titles	Author/s	Publisher	Edition	Module Nos.
1	Business Communication Today	Courtland L Bovee	Pretince Hall	--	3, 5, 6
2	Excellence in Business Communication	John Thill	Pretince Hall	6	4,
3	Business Communication: Building Critical Skills	Kitty O Locker	Mc Graw Hill	--	3

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1	T-I	Module 1 and part of Module 2
2	T-II	Part of module 2 and module 3
3	End Sem	1 to 5

Highway Engineering (Lab)

Course Code	Course Name
PC-BTC551	Highway Engineering (Lab)

Course pre-requisites	PC-BTC504
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Course Objectives

The main objectives of this course are

1. To understand the Laboratory procedure for computing various properties pavement layer materials.

Course Outcomes

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

1. Understand the suitability of aggregate to be used for construction of Different layers of Pavements.
2. Understand the suitability of binding material to be used for construction of BM and BC layer of flexible Pavements

List of Experiments (At least Six to be performed)

Experiment No.	Details
1	Impact test on aggregates
2	Abrasion test on aggregates
3	Crushing test on aggregates
4	Shape test on aggregates
5	Penetration test on bitumen
6	Ductility test on bitumen
7	Softening point test on bitumen
8	Viscosity test on bitumen

Recommended Books

1. Yoder, E. J., John (1975); "Principles of Pavement Design" Wiley & Sons, Inc., New York. ISBN -13: 9780471977803. 711p.
2. Khanna & Justo (1971); "Highway Engineering", New Chand & Brothers, Roorkee.678p.
3. Dr. L. R. Kadiyali and Dr. N. B. Lal (2005); "Principles and Practices of Highway Engineering", Khanna Publication, New Delhi. ISBN-13: 9788174091659. 835p.
4. Guide lines for the Design of Flexible Pavements, IRC:37 -2001, IRC:37-2012

Environmental Engineering(Lab)

Course Code	Course Name
PC-BTC552	Environmental Engineering(Lab)

Course pre-requisites	
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Course Objectives

The students will learn to

1. To find various parameters of water
2. To analyze and interpret the usability of water for potable purposes
3. To analyze and interpret the treatment technologies to be use for waste reuse or disposal

Course Outcomes

The course will enable the students to

1. Analyze and interpret the data related to water parameters.

Course Content

Module No.	Details
1	Determination of pH, Temperature and Color
2	Determination of Turbidity
3	Determination of Hardness
4	Determination of Alkalinity
5	Determination of Acidity
6	Determination of Solids(Total solids, Suspended Solids, volatile solids)
7	Determination of Chlorides
8	Determination of Optimum dose of alum (Jar Test)
9	Determination of Most Probable Number (MPN)
10	Determination of Residual Chlorine
11	Determination of Dissolved Oxygen
12	Determination of Biological Oxygen Demand
13	Determination of Chemical Oxygen Demand
14	Determination of Sulphate
15	Determination of ammoniacal Nitrogen and Nitrate Nitrogen(Kjeldahl Nitrogen)

Term Work

Term work shall comprise of

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.

Text Books

[1] Eaton, A. D., Clesceri, L. S., Greenberg, A. E., Franson, M. A. H., American Public Health Association., American Water 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)

Soil Mechanics Laboratory

Course Code	Course Name
PC-BTC553	Soil Mechanics Laboratory
Course pre-requisites	Engineering Geology (BS-BTC305), Soil Mechanics

Course Objectives

The objectives of this course are

1. To introduce students to soil types based on grain size and plasticity characteristics
2. To familiarize students with measurement of various soil properties.

Course Outcomes

The course will enable the students to

1. Apply the knowledge of mechanics to soil so as to measure and quantify various soil properties.
2. Demonstrate their capability to prepare soil testing reports showing values of properties tested.
3. Draw a conclusion regarding soil type and expected engineering behaviour based on tests performed.

Course Content

List of tests to be conducted:

1. Field identification of Fine Grained soils.
2. Field Density using Core Cutter method and relative density
3. Specific gravity of Soils.
4. Grain size distribution by Sieve Analysis.
5. Consistency limits by Liquid limit, Plastic limit and Shrinkage limit.
6. Permeability test using Constant-head test method and Falling-head method.
7. Compaction test: Standard Proctor test and Modified Proctor test.
8. Consolidation test
9. Direct Shear test
10. Unconfined compression test
11. Triaxial test

Reference Books

1. Singh A. Soil Engineering in Theory and Practice (Vol. -1). 4th Edition, CBS Publishers And Distributors Pvt. Ltd., India, 2018.
2. Murthy, V. N. S. Geotechnical Engineering: Principles And Practices Of Soil Mechanics And Foundation Engineering. CRC Press, India, 2002
3. Terzaghi, K. Soil Mechanics in Engineering Practice. Wiley, USA, 1943
4. Relevant Indian Standard Specifications & Codes, BIS Publications, New Delhi.

Introduction to Offshore Engineering

Course Code	Course Name
VA-BTC 572	Introduction to Offshore Engineering

Course pre-requisites	
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Course Objectives

- The objectives of this course are
1. to understand the complexities in offshore construction and obtaining resources from the ocean.
 2. to addresses the general engineering concepts that are fundamental to offshore engineering.
 3. to understand types of sites and platform structures, key engineering systems and ocean environmental monitoring

Course Outcomes

- Upon successful completion of the course, students should be able
1. to know various offshore construction methodologies
 2. to addresses the general engineering concepts during construction stages.
 3. to handle complexities and key engineering systems in ocean environment

Course Content		
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<i>Module No.</i>	<i>Details</i>	<i>Hrs.</i>
1	Introduction: History and current state of the art of offshore structures, Definition of Offshore Structures, Met ocean Engineering: wind, wave and current loads on offshore structures	06
2	Environment & Construction: Offshore environment, Construction and launching, offshore project management,	05
3	Ocean construction: Types of Platforms: Jackets, TLPs, Semisubmersibles, Jack-ups, Concrete Gravity,deep water construction in ocean, offshore site investigations	05
4	Offshore Pipelines: Hydrostatic, hydrodynamic analysis and structural design	05
5	Buoys and Mooring systems: mooring configurations, advantages and disadvantages	05
6	Design criteria: Introduction to probabilistic design, extreme load & strength & fatigue, basics of anchoring and mooring system, riser system, Scaling laws & Model testing, Challenges in Deepwater testing: deepwater installations, constructions challenges.	05
7	Case studies in Offshore Engineering, Indian Ocean, Arabian Sea, bay of Bengal	05

References

1. Subrata K. Chakrabarti (2005): Handbook of offshore engineering Volume-I & II, Elsevier, The Boulevard Langford Lane, Kidlington, Oxford OX5 1GB, UK.
2. DeoM C (2013): Waves and Structures, <http://www.civil.iitb.ac.in/~mcdeo/waves.html>
3. American Petroleum Institute, Recommended Practice for Planning, Designing and Constructing Fixed Offshore Platforms - Load and Resistance Factor Design, 1st Edition, 1993. (TP690.A642 RP2A-LRFD)
4. American Petroleum Institute, Recommended Practice for Planning, Designing and Constructing Fixed Offshore Platforms - Working Stress Design, 21st ed., 2000. (TP690.A642 RP2A-WSD).

Legal Aspects in Project

Course Code	Course Name
VAC-BTC573	Legal Aspects in Projects

Course pre-requisites

Course Objectives

The main objectives of this course are

1. To describe fundamentals of common law
2. To discuss the concept of bid cycle
3. To explain Indian contract act
4. To identify the concept contract administration
5. To summarize students with Laws applicable to construction activity
6. To interpret various acts in connection with construction activities
7. To summarize FIDIC contracts

Course Outcomes

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

1. Use of law in general
2. Practice tendering process
3. Utilize Indian contract act and its provision with respect to construction
4. Implement contract administration
5. Use labor laws on construction site
6. Relate acts applicable to construction
7. Use International contract provisions

Course Content

Module No.	Details	Hrs.
1	Law and common man	04
2	Construction through contracts; Types, critical comparison, bid cycle, tender and contract documents, contract conditions, study of contract documents of state PWD and CPWD	06
3	Indian Contract Act; Need, provisions, scope for modifications	06
4	Contract administration Deviations and extras, claims and their management, disputes and dispute resolution methods, Arbitration and Conciliation Act.	06
5	Laws applicable to construction activity need and broad provisions of :Industrial Disputes Act, Workmen's Compensation Act	06
6	Employer's Liability Act, Payment of wages Act, Contract	06

	Labour Act, Minimum Wages Act, Inter-state Migrant workmen act, BOCW Act and other acts introduced from time to time	
7	FIDIC contracts; Contract administration;	06
Term Work		
<p>Term work shall comprise of Assignments consisting of minimum twenty problems covering entire syllabus shall be submitted as term work.</p>		

Recommended Books		
<ol style="list-style-type: none"> 1. Bajirao Shankarrao Patil (1986); "Legal Aspects of Building & Engineering Contracts" S.B. Patil. 471p. 2. G. T. Gajria, Kishore Gajria (2000); "Law Relating To Building & Engineering Contracts In India", Lexisnexis Butterworths India. ISBN 13: 9788187162162. 538p. 3. P. C. Markanda, Naresh Markanda (2013); "Law Related To Arbitration and Conciliation" Lexisnexis Butterworths India. ISBN 13: 9788180388132. 1570p. 4. Edward R. Fisk, Wayne D. Reynolds (2013); "Construction Project Administration" Pearson Education. ISBN 13: 9780133149258. 432p. 5. Indian Contract Act 1872 6. Arbitration Conciliation Act 1996.4. All Referred Bare Acts 7. CPWD Manual Volume I & II, A Handbook For Government Officials And Contractors 		

SEM - VI

Construction Engineering and Management

Course Code	Course Name
PC-BTC601	Construction Engineering and Management

Course pre-requisites	
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Course Objectives

The objectives of this course are

1. To describe the unique features of constructions
2. To understand basics of construction Equipment and methods
3. To summarize the students about various techniques of construction planning, resource scheduling, project monitoring quality control and safety of personnel involved.

Course Outcomes

Upon successful completion of the course, students should be able

1. An idea of how structures are built and projects are developed on the field as well as modern construction practices.
2. A basic ability to plan, control and monitor construction projects with respect to time and cost
3. An idea of how to optimise construction projects based on costs.

Course Content

<i>Module No.</i>	<i>Details</i>	<i>Hrs.</i>
1	<i>Basics of Construction-</i> Unique features of construction, construction projects types and features, phases of a project, agencies involved and their methods of execution; Construction Equipment basics: Conventional construction methods Vs Mechanized methods and advantages of latter; Equipment for Earthmoving, Dewatering; Concrete mixing, transporting & placing; Cranes, Hoists and other equipment for lifting; Equipment for transportation of materials.	06
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. Process of development of plans and schedules, work break-down structure, activity lists, assessment of work content, concept of productivities, estimating durations, sequence of activities, activity utility data;	06
3	Techniques of planning- Bar charts, Gantt Charts. Networks: basic terminology, types of precedence relationships, preparation of CPM networks: activity on link and activity on node representation, computation of float values, critical and semi critical paths, calendaring networks. PERT- Assumptions underlying PERT analysis, determining three time estimates,	06

	analysis, slack computations, calculation of probability of completion.	
4	Planning and organizing construction site and resources- Site: site layout including enabling structures, developing site organization, Documentation at site; Manpower: planning, organizing, staffing, motivation; Materials: concepts of planning, procurement and inventory control; Equipment: basic concepts of planning and organizing; Funds: cash flow, sources of funds; Histograms and S-Curves. Earned Value; Resource Scheduling-, line of balance technique, resource constraints and conflicts; resource aggregation, allocation, smoothening and leveling. Common Good Practices in Construction	06
5	<i>Project Monitoring & Control-</i> Supervision, record keeping, periodic progress reports, periodical progress meetings. Updating of plans: purpose, frequency and methods of updating. Common causes of time and cost overruns and corrective measures. Basics of Modern Project management systems such as Lean Construction; Use of Building Information Modelling (BIM) in project management. Various labour laws.	06
6	Quality control: concept of quality, quality of constructed structure, use of manuals and checklists for quality control, role of inspection, basics of statistical quality control. Safety, Health and Environment on project sites: accidents; their causes, effects and preventive measures, costs of accidents, occupational health problems in construction, organizing for safety and health.	03
7	Construction Costs: Make-up of construction costs; Classification of costs, time cost trade-off in construction projects, compression and decompression.	03

Term work

At least 10 assignments covering the entire syllabus shall be submitted as term work.

Text Books

1. 1.Varghese, P.C., "*Building Construction*", Prentice Hall India, 2007.
2. *National Building Code*, Bureau of Indian Standards, New Delhi, 2017.
3. Chudley, R., *Construction Technology*, ELBS Publishers, 2007.
4. Peurifoy, R.L. *Construction Planning, Methods and Equipment*, McGraw Hill, 2011
5. Nunnally, S.W. *Construction Methods and Management*, Prentice Hall, 2006
6. Jha, Kumar Neeraj., *Construction Project management, Theory & Practice*, Pearson Education India, 2015
7. Punmia, B.C., Khandelwal, K.K., *Project Planning with PERT and CPM*, Laxmi Publications, 2016.
8. Barrie D.S. & Paulson B C (2013); "*Professional Construction Management*" McGraw Hill Education (India) Private Limited. ISBN-13: 978-1259098420. 672p.

9. Chitkara K K (2010); "Construction Project Management" McGraw Hill Education (India) Private Limited. ISBN-13: 978-0070680753. 772p.
10. P K Joy (1991); "Handbook of Construction Management", Macmillan, India. ISBN-13- 9780333926932. 484p
11. King & Hudson (1985); "Construction Hazard and Safety Handbook", Butterworths. ISBN-13: 978-0408013475. 477p.
12. Antill J M & Woodhead R W, (1990); "Critical Path Methods in Construction Practice:" John Wiley & Sons. ISBN-13: 978-0471620570. 448p
13. S.Seetaraman (2000); "Construction Engineering and Management". Umesh pub. ISBN-13 9788188114061. 487p
14. L.S.Shreenath (2001); "CPM and PERT" Affiliated East-West Press (Pvt.) Ltd. ISBN-13: 978-8185336206
15. Dr.B.C.Punmia (2010); "CPM and PERT" Motilal UK Books of India. ISBN-13: 978-8131806982. 250p.
16. Indian Contract act.
17. Various labour laws

Sr. No.	Examination	Module
1	T-I	1, 2
2	T-II	3, 4
3	End Sem	1 to 7

Design of Steel Structures

Course Code	Course Name	
PC-BTC602	Design of Steel Structures	
Course pre-requisites	Mechanics of materials, Structural Mechanics, Structural Engineering	
Course Objectives		
<ol style="list-style-type: none"> 1. To introduce behavior and design of simple steel structures according to limit state design concept. 2. To have the basic knowledge about the design and failure mode of steel structural members. 		
Course Outcomes		
<p>The course will enable the students to:</p> <ol style="list-style-type: none"> 1) Design simple structural elements using IS-800-2007: <ol style="list-style-type: none"> a) Tension members b) Compression members c) Flexural members d) Slab base & Gusseted Base e) Bolted and Welded connections 2) Design simple structural systems using IS-800-2007 & IS-875 <ol style="list-style-type: none"> a) truss (subjected to wind load) b) G+3 steel building 		
Course Content		
Module No.	Details	Hrs.
1	Introduction to types of steel, mechanical properties of steel, advantages of steel as structural material, design philosophies of Working Stress Method (WSM) and Limit State Method (LSM) Limit state method, limit state of strength and serviceability (deflection, vibration, durability, fatigue, fire), characteristics and design loads, Classification of cross section- plastic, compact, semi-compact and slender, limiting width to thickness ratio. Introduction to bolted and welded connections by LSM.	06
2	Design of tension members with welded / bolted end connections using single and double angle sections by LSM, design strength due to yielding of cross section, rupture of critical section and block shear.	04
3	Design of compression members with welded / bolted end connections using single and double angle by LSM, design strength, effective length of compression members. Design of columns with single and built-up sections, design of lacing and batten plates with bolted and welded connections using LSM, column buckling curves, effective length, slenderness ratio, limiting values of effective slenderness ratio, buckling class of various cross sections.	07

4	Design of slab base and gusseted base using bolted and welded connection by LSM, Effective area of a base plate.	04
5	Design of members subjected to bending by LSM, design strength in bending, effective length, laterally supported and unsupported beams. Design of single and built-up rolled steel sections using bolted and welded connections, shear lag effect. Design for shear, web buckling and web crippling, concept of web stiffeners and different types of web stiffeners. Introduction to plate girders	07
6	Beam to beam and beam to column connections, design of framed, un-stiffened and stiffened seat connections	04
7	Truss: Determinate truss, imposed load on sloping roof, wind load on sloping roof and vertical cladding including effect of permeability and wind drag, analysis of pin jointed trusses under various loading cases, computation of forces in members, design and detailing of connections and supports, wind bracing for roof system, supported on columns.	04

Term Work

The Term work shall consist of a Design report and detailed drawings on two projects as indicated below:

- i. Roofing system
- ii. Flooring system including Columns.

Solution of at least 20 problems with neat sketches wherever necessary shall be submitted as term work.

Text Books

1. Dr Ramachandra (2010), "Design Of Steel Structures Vol. II", Scientific Publishers- Jodhpur, ISBN 8172336446
2. N. Subramanian (2008), "Design Of Steel Structures", Oxford, ISBN 0195676815, 864 pages
3. Pasala Dayaratnam (2014), "Design Of Steel Structures", S. Chand Publishing, ISBN 8121923204, 868 pages
4. S. S. Bhavikatti (2009), "Design of Steel Structures by Limit state method as per IS 800:2007", I K International Pvt. Ltd, 414 pages
5. Duggal S K (2010), "Limit State Design of Steel Structures", Tata McGrwaHill
6. Shiyekar M R (2010), "Limit State Design of Steel Structures", PHI Learning
7. SaiRam K S (2010), "Design of Steel Structures", PHI Learning

Reference Books

1. Anand S. Arya, J.L. Ajmani (1977), "Design of Steel Structures", Nem Chand & Bros., India, ISBN 0861861671, 888 pages
2. B. C. Punmia, Ashok Kumar Jain (2006), "Comprehensive Design of Steel Structures", Laxmi Publications, ISBN 8170080932, 1156 pages
3. Edwin H. Gaylord, Charles N. Gaylord, James E. Stallmeyer (1991), "Design Of Steel Structures", Tata McGraw-Hill, ISBN 0070230544, 792 pages
4. T. J. Mac Ginley (1998), "Design Of Steel Structures", Spon Press ISBN 0419179305, 496 pages
5. William T. Segui (1996), "LRFD Steel Design", PWS Pub Co., ISBN 0534954782, 563 pages
6. James K. Nelson Jr., Jack C. McCormac (2002), "Structural Steel Design: LRFD Method", Prentice Hall, ISBN 0130479594, 713 pages
7. Charles G. Salmon, John E. Johnson, Faris A. Malhas (2008), "Steel Structures: Design and Behavior", Prentice Hall, ISBN 0131885561, 888 pages
8. Satinder Singh, Ic Syal (2007), "Design Of Steel Structures", Standard Publishers Distributors, ISBN 8186308646, 780 pages

Sr. No.	Examination	Module
1	T-I	1, 2
2	T-II	3, 4
3	End Sem	1 to 7

Foundation Engineering

Course Code	Course Name
PC-BTC603	Foundation Engineering

Course pre-requisites	Soil Mechanics and Soil Mechanics Lab course
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Course Objectives

1. Description of various earth pressure theories, design and analysis of stability of various types of earth retaining structures
2. Estimation of bearing capacity of shallow foundations by various theories.
3. Assessment of the need for pile foundations and determination of their load carrying capacity.
4. Explanation of basic design principles of flexible retaining system, underground conduits and introduction to reinforced soil.

Course Outcomes

Upon successful completion of this course, the students will be able to :

1. Based on the understanding of soil properties and characteristics studied in soil mechanics and soil mechanics lab course, the students will be able to predict soil behavior under the application of loads and come up with appropriate solutions to foundation design queries.
2. The students will be able to design a suitable retaining structure.

Course Content

<i>Module No.</i>	<i>Details</i>	<i>Hrs.</i>
1	<p><u>Lateral earth pressure theories:</u> Applications of earth pressure theories. Rankine's earth pressure theory, active earth pressure and passive earth pressure for horizontal and inclined backfill for cohesionless and cohesive soils. Coulomb's wedge theory. Coulomb's active pressure in cohesionless soils, expression for active pressure, Coulomb's passive earth pressure.</p> <p>Self Study: Rebhann's construction for active pressure, Culmann's graphical solutions for active pressure.</p>	07
2	<p><u>Rigid retaining structures:</u> Stability analysis of retaining walls, cantilever retaining walls, construction details, drainage and wall joints</p> <p><u>Flexible Retaining Structures:</u> Introduction to sheet pile walls, earth pressure diagrams for cantilever sheet pile walls in granular and cohesive soils</p>	05
3	<p><u>Bearing capacity of shallow foundations:</u> Ultimate bearing capacity, gross, net and safe pressures, allowable bearing pressure. Modes of failure. Bearing capacity theory – Terzaghi and Meyerhof. General bearing capacity equation. Corrections for square and circular footings. Ultimate bearing capacity in case of</p>	08

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	local shear failure. IS 6403 recommendations. Plate load test in detail with reference to IS 1888 and its applications and estimation of settlements.	
4	Axially loaded pile foundations: Introduction. Necessity of pile foundations. Classification of piles. Pile capacity based on static analysis. Dynamic methods and their limitations. Pile load test as per IS 2911 specifications, negative skin friction. Pile groups, ultimate capacity of groups, settlement of pile groups in sand and in clays as per IS 2911 and critical depth method.	06
5	Underground conduits: Classes of underground conduits, load on a ditch conduit, settlement ratio, ditch condition and projection condition, imperfect ditch conduit. Open cuts: Apparent earth pressure diagrams, average earth pressure diagrams in cohesive and cohesionless soils, estimation of strut loads in braced cuts	06
6	Other foundation systems: Introduction to caissons, raft foundations and piled-raft foundations	02
7	Reinforced earth: The mechanism. Types of reinforcement. Applications	02

Term Work

Term work shall comprise of

1. Exercises on the above topics in the form of design calculations with sketches and or drawings.
2. Examination (MCQ) based on topics mentioned in latest GATE syllabus
3. Course project*

***Course Project:** There will be a course project where the students will be able to apply and integrate the knowledge gained during the course. The projects will be developed by teams of two to four students.

Reference Books

1. Singh A. Soil Engineering in Theory and Practice (Vol. -1). 4th Edition, CBS Publishers And Distributors Pvt. Ltd., India, 2018.
2. Murthy, V. N. S. Geotechnical Engineering: Principles And Practices Of Soil Mechanics And Foundation Engineering. CRC Press, India, 2002
3. Relevant Indian Standard Specifications & Codes, BIS Publications, New Delhi.

Sr. No.	Examination	Module
1	T-I	1 and 2
2	T-II	3 and part of 4
3	End Semester	1 to 7

Design of RCC Elements

Course Code	Course Name
PC-BTC604	Design of RCC Elements

Course pre-requisites	Mechanics of materials, Structural Mechanics
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Course Objectives
<ol style="list-style-type: none"> 1. To develop Civil Engineering graduates having clear understanding of concepts of reinforced concrete design using Limit state approach. 2. Application of WSM and 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.

Course Outcomes
<p>Upon successful completion of the course, students should be able</p> <ol style="list-style-type: none"> 1. To understand the concept of WSM and LSM 2. Design RCC members like beam, slab, column, footings using LSM method for safety stability and economy. 3. Use IS 456 for design of RCC members and basic detailing.

Course Content		
Module No.	Details	Hrs.
1	Working state method: Concept of working stress method, permissible stresses as per IS 456, stress strain curve of concrete and steel, assumptions in Working stress method.	02
2	Concept of balanced, under reinforced and over reinforced sections. Analysis and design of singly reinforced and doubly reinforced rectangular beams for flexure by WSM	03
3	Limit State Method: Introduction to limit state method of design as per IS 456 (latest edition): concepts of probability and reliability, characteristic loads, characteristic strength, partial safety factors for loads and materials, introduction to various limit states.	04
4	Limit State of Collapse - Flexure: Limit state of collapse in flexure, shear and Limit state of serviceability in deflection and cracking, design of singly reinforced rectangular sections. 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	08

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	and torsion. Requirements governing reinforcement detailing.	
5	Design of Slabs: Design of one way slab and two way slab	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 and their use 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 .	07

Term Work

Assignments consisting of minimum twenty problems covering entire syllabus shall be submitted as term work (Considering basic aspects of detailing as well)

Text Books

1. P. Dayaratnam,(2011), “Design of Reinforced Concrete Structures”, Oxford &Ibh-Pubs Company-New Delhi, ISBN 8120414195
2. Ashok K. Jain(1993), “Reinforced Concrete: Limit State Design” , Nem Chand & Brothers, ISBN 8185240531, 844 pages
3. Dr. S.R. Karve& Dr. V.L. Shah (1994), “Limit State Theory and Design of Reinforced Concrete”, Structures Publishers, ASIN B007I29ARC, 1140 pages
4. V. Ramakrishnan&P.D. Arthur (1969), “Ultimate Strength Design for Structural Concrete”,Pitman, ISBN 0273403230, 264 pages
5. Dr. H. J .Shah,(2008),”Reinforced Concrete, Volume 2”, Charotar Publishing House Pvt. Limited, ISBN 8185594732, 536 pages
6. S N Sinha, (2002),”Reinforced Concrete Design, Second Revised Edition”, Tata McGraw-Hill Education, ISBN 0070473323, 708 pages
7. Karve& Shah, (2011), “Illustrated Design of Reinforced concrete Buildings”, mihail-koprivchin-3758, 319 pages
8. P.C. Varghese (2009), Limit state design of Reinforced concrete, PHI Learning.
9. B.C. Punmia, Ashokkumar Jain and Arunkumarjain (2007), Limit State Design of Reinforced Concrete.

Reference Books

1. Wang, C.K., Salmon, C.G., and Pincheira, (2007),”J.A. Reinforced Concrete Design”, 7th Ed, John Wiley and Sons, ISBN 0471262862, 948 pages
2. Phil Moss Ferguson, Henry Jacob Cowan, (1981),”Reinforced Concrete Fundamentals, S I Version”, John Wiley & Sons Canada, Limited, ISBN 0471051535, 694 pages.
3. B.P. Hughes (1976),”Limit State Theory for Reinforced Concrete Design”, Pitman, ISBN 0273010239

Sr. No.	Examination	Module
1	T-I	1, 2
2	T-II	3, 4
3	End Sem	1 to 7

Analysis of Indeterminate Structures

Course Code	Course Name
PE-BTC621	Analysis of Indeterminate Structures
Course pre-requisites	ES-BTC 302, ES-BTC 351, PC-BTC 402, PC-BTC 501

Course Objectives

The objectives of this course are

3. To introduce the students to the methods of analysis of indeterminate structures.
4. To introduce the students to the plastic analysis of structures.
5. To prepare the base for the students to study other advanced structural engineering courses at a later stage.

Course Outcomes

Successful completion of the course, students should be able to

1. Analyse indeterminate structures using force methods.
2. Analyse indeterminate structures using displacement methods.
3. Find shape factor, determine collapse load for beams using plastic analysis.

Course Content

Module No.	Details	Hrs.
1	Analysis of indeterminate structures by force method: Application of flexibility method to simple pin jointed frames (including effect of lack of fit for members) with static indeterminacy up to 3, application to simple rigid jointed frames with static indeterminacy up to 3.	06
2	Analysis of indeterminate structures by force method: Theorem of three moments and its applications to indeterminate beams. Application of flexibility method to two hinged parabolic arches.	04
3	Analysis of indeterminate structures by force method: Analysis of indeterminate structures by the theorem of least work. Application of the theorem to indeterminate beams, simple rigid jointed frames with static indeterminacy up to 3 and pin jointed frames with static indeterminacy up to 3.	04
4	Slope deflection method: Application of the method to simple rigid jointed frames. Application to simple rigid jointed frames with inclined member but having only one translational degree of freedom in addition to rotational degree of freedom.	05
5	Moment distribution method: Application of the method to indeterminate beams including the effect of	07

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	settlement of supports and simple rigid jointed frames without and with sway.	
6	<p>Analysis of indeterminate structures by stiffness method: Stiffness coefficients for prismatic members and their use for formulation of equilibrium equations, direct stiffness method, Application of the above methods to indeterminate beams including the effect of settlement of supports and simple rigid jointed frames with kinematic indeterminacy up to 3.</p>	07
7	<p>Introduction to plastic analysis of steel structures: Behaviour of ductile material. Idealized stress strain diagram for plastic analysis. Concept of plastic theory of bending, plastic hinge and plastic moment carrying capacity, shape factor, lower bound, upper bound and uniqueness theorems. Determination of collapse load for single and multiple span beams.</p>	05
Term Work		
There is no Term Work for this Course.		

Text Books	
1.	Reddy C. S. (1999), "Basic Structural Analysis", Tata McGraw hill, ISBN 0070702764, 779 pages.
2.	Junnarkar S.B. (2013), "Structural Analysis, Vol. II" Charotar Publishers ISBN 9380358703, 986 pages.
3.	Pandit and Gupta (1999), "Structural Analysis Vol. I", Tata McGraw Hill, ISBN 0074634933, 679 pages.
4.	L. S. Negi, and R. S. Jangid (1997), "Theory and Problems in Structural Analysis" "Tata McGraw - Hill Education, ISBN 0074623044, 828 pages.
5.	ISBN 0138534080, 352 pages.
6.	Baker & Heyman (1980), "Plastic Design of Steel frames", Cambridge University Press, ISBN 0521297788, 238 pages.
Reference Books	
1.	G. Pandit and S. Gupta (2008), "Matrix Method in Structural Analysis", Tata McGraw hill, ISBN 0070667358, 612 pages.
2.	Dr. B.N. Thadani And Dr. J. P. Desai (1964), "Modern Methods in Structural Analysis", Asia Publishing House.
3.	C. K. Wang (2014), "Intermediate Structural Analysis", Tata McGraw Hill, ISBN 0070702497, 805 pages.
4.	James M. Gere, William Weaver (1990), "Matrix Analysis of Framed Structures", Springer US, ISBN 0442234856, 547 pages.
5.	D.S. Prakash Rao (1996), "Structural Analysis: A Unified Approach", Orient Blackswan ISBN 8173710279, 672 pages.
6.	Dr. A. S. Meghre, and S. K. Deshmukh (2003), "Matrix Methods of Structural Analysis", Charotar Publishing House, ISBN 8185594088, 552 pages.

Sr. No.	Examination	Module
1	T-I	1, 2 and Part of 3
2	T-II	Part of 3, 4 and 5
3	End Sem	1 to 7

Geographic Information Systems Science & Application

Course Code	Course Name
PE-BTC622	Geographic Information Systems Science & Application
Course pre-requisites	Basics of Surveying, Surveying and Geomatics

Course Outcomes

Upon successful completion of the course, students should be able

1. Understand basic GIS theory and principles
2. Be familiar with GIS components
3. Study various methods of spatial data collection and data management
4. Study various database management systems, non-spatial and spatial analysis
5. Be able to use GIS software for basic GIS project

Course Content

<i>Module No.</i>	<i>Details</i>	<i>Hrs.</i>
1	Introduction to GIS, History of GIS, Early developments in GIS, Applications of GIS, Introduction to Geodesy & GNSS, remote sensing techniques and their nexus with GIS	02
2	Maps and map Scales; Introduction to Maps and map elements and their significance, History of Maps, Map Scales, Types of Maps – uses and presentation, Map and Globe Georeferencing and Projections; Understanding Earth, Coordinate System, Map Projection, Transformation, Georeferencing Spatial Data Input and Editing; Primary Data, Secondary Data, Data Editing	08
3	Spatial Database Management Systems; Introduction, Data Storage, Database Structure Models, Database Management system, Entity Relationship Model, Normalization Data Models and Data Structures; Introduction to Data Models and Data Structures, GIS Data Model, Vector Data Structure, Raster Data structure, Geodatabase and metadata Spatial Analysis; Introduction to spatial analysis, Vector Operations and Analysis, Network Analysis, Raster Data Spatial Analysis Interpolation; Introduction to Interpolation, Global Methods of Interpolation, Local Methods of Interpolation	08
4	Cartographic Principles and Design; Introduction, Map layout, Data presentation, Toposheet Indexing, Distribution Maps Web GIS; Introduction to Web GIS, OGC Standards and services, Mobile GIS	06
5	Project; Project is intended to provide a deeper understanding of a GIS application through experience. Students will work	12

	<p>individually or in groups of 2 on projects. The project should investigate a particular research problem using ArcGIS or QGIS. The project must be an original piece of work developed for this course, marked by a set of milestones from data collection, data management, data preprocessing, spatial analysis and modeling, and result presentation.</p>	
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Text Books

1. Paul Bolstad, 2008. GIS Fundamentals, a First Text on Geographic Information Systems. 3rd Edition. Eider Press, ISBN 978-0-9717647-2-9.
2. Longley,P.A., Goodchild, M. F., Maguire, D. J., and Rhind, D. W., Geographic Information Systems and Science, 2nd Edition, John Wiley and Sons, 2005.

Reference Books

1. Burrough, P.A., and McDonnell, R.A., Principles of Geographical Information Systems, 2nd Edition, Oxford University Press, 1998.
2. Demers, M. N., Fundamentals of Geographic Information Systems, John Wiley & Sons, 3rd Edition, 2002.
3. Longley,P.A., Goodchild, M. F., Maguire, D. J., and Rhind, D. W., Geographic Information Systems and Science, 2nd Edition, John Wiley and Sons, 2005.
4. Kang-tsung Chang,"Introduction to Geographic Information Systems", McGraw-Hill Book Company,2006
5. Ormsby, T., E. Napoleon, R. Burke, C. Groessl, and L. Bowden 2010, Getting to Know ArcGIS Desktop: for ArcGIS 10, 2nd Edition, ESRI Press, Redlands, CA, ISBN: 978-1-58948-260-9

Hydraulic Structures and Irrigation Engineering

Course Code	Course Name
PE-BTC631	Hydraulic Structures and Irrigation Engineering

Course pre-requisites	
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Course Objectives

The main objectives of the course are

1. To understand design principles of hydraulic structures for irrigation purpose.
2. To Know about the basics of design of canals, weir, barrage and appurtenance works
3. To provide knowledge on various hydraulic structures such as energy dissipaters, head and cross regulators, canal falls and structures involved in cross drainage works

Course Outcomes

Upon successful completion of the course, students should be able

1. Estimate the crop water requirement, design of unlined and lined canals, falls and regulators.
2. To design barrage, cross drainage works.

Course Content

<i>Module No.</i>	<i>Details</i>	<i>Hrs.</i>
1	Design principles for gravity and earthen dams. Key issues in designing irrigation channels and hydraulic structures used in irrigation systems	04
2	Estimation of crop water requirement; Design of lined and unlined channels; Analysis for surface and sub-surface flow at hydraulic structures	04
3	Site selection and investigations for diversion works; Hydraulics of flow over weirs/under sluices; Components of barrage- waterway, under sluice/weir, glacis, stilling basin and appurtenance works, cutoff, u/s and d/s protection works, Bligh's creep theory, Khosla's Theory	06
4	Design of canal falls, regulators	06
5	Cross drainage works: Types of cross drainage works. Design aspects of aqueducts, siphon aqueducts, super-passage, siphon	06
6	Instrumentation and maintenance aspects in earth and gravity dams: Measurements of deformations, pore pressures; Quality control; Foundation preparation and treatment; Quality control of materials and control of moisture, laying and compaction; Tests for quality control; Diversion during construction Deterioration of concrete in dams and remedial measures.	06
7	Discussion on various case studies in Hydraulic structures and Irrigation engineering	04

Term Work

Term work shall comprise of

At least 10 assignments covering the entire syllabus shall be submitted as term work.

Text Books

Recommended Data Books

1. S. R. Sahasrabudhe (2011); "Irrigation Engineering and Hydraulic Structures" S. K.Kataria& Sons
2. S. K. Sharma; "Design of Irrigation Structures", S. Chand and Co. ISBN-13 – 9788121903295
3. R. S. Varshney and R. C. Gupta (1988); "Theory and Design of Irrigation Structures: Canal and storage works" Nem Chand & Bros. ISBN-13 – 9788185240022
4. G.L.Asawa (2006); "Irrigation and Water Resources Engineering", New Age International Publishers. ISBN-13 9788122416732. 624p
5. M.Michael,(2014); "Irrigation Theory and Practice" 2nd Edition, Vikas Publishing Pvt. Ltd.

Sr.No.	Examination	Module
1	T-I	1, 2
2	T-II	3, 4
3	End Sem	1 to 7

Introduction to Offshore Engineering

Course Code	Course Name
PE-BTC632	Introduction to Offshore Engineering

Course pre-requisites	
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Course Objectives

The objectives of this course are

1. to understand the complexities in offshore construction and obtaining resources from the ocean.
2. to addresses the general engineering concepts that are fundamental to offshore engineering.
3. to understand types of sites and platform structures, key engineering systems and ocean environmental monitoring

Course Outcomes

Upon successful completion of the course, students should be able

1. to know various offshore construction methodologies
2. to addresses the general engineering concepts during construction stages.
3. to handle complexities and key engineering systems in ocean environment

Course Content

<i>Module No.</i>	<i>Details</i>	<i>Hrs.</i>
1	Introduction: History and current state of the art of offshore structures, Definition of Offshore Structures, Met ocean Engineering: wind, wave and current loads on offshore structures	06
2	Environment & Construction: Offshore environment, Construction and launching, offshore project management,	05
3	Ocean construction: Types of Platforms: Jackets, TLPs, Semisubmersibles, Jack-ups, Concrete Gravity,deep water construction in ocean, offshore site investigations	05
4	Offshore Pipelines: Hydrostatic, hydrodynamic analysis and structural design	05
5	Buoys and Mooring systems: mooring configurations, advantages and disadvantages	05
6	Design criteria: Introduction to probabilistic design, extreme load & strength & fatigue, basics of anchoring and mooring system, riser system, Scaling laws & Model testing, Challenges in Deepwater testing: deepwater installations, constructions challenges.	05
7	Case studies in Offshore Engineering, Indian Ocean, Arabian Sea, bay of Bengal	05

References

1. Subrata K. Chakrabarti (2005): Handbook of offshore engineering Volume-I & II, Elsevier, The Boulevard Langford Lane, Kidlington, Oxford OX5 1GB, UK.
2. DeoM C (2013): Waves and Structures, <http://www.civil.iitb.ac.in/~mcdeo/waves.html>
3. American Petroleum Institute, Recommended Practice for Planning, Designing and Constructing Fixed Offshore Platforms - Load and Resistance Factor Design, 1st Edition, 1993. (TP690.A642 RP2A-LRFD)
4. American Petroleum Institute, Recommended Practice for Planning, Designing and Constructing Fixed Offshore Platforms - Working Stress Design, 21st ed., 2000. (TP690.A642 RP2A-WSD).

Special Construction Materials & Methods

Course Code	Course Name
PE-BTC641	Special Construction Materials & Methods

Course pre-requisites	
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Course Objectives

The objectives of this course are

1. To describe the unique materials used in constructions
2. To understand the need and basics of constructions chemicals.
3. To summarize the students about various techniques of sub structure and super structure construction

Course Outcomes

Upon successful completion of the course, students should be able

1. An idea of how structures are built with Eco friendly Construction Materials/ Green Construction materials/ unique materials
2. An idea about sub structure and super structure construction in special situations.

Course Content

<i>Module No.</i>	<i>Details</i>	<i>Hrs.</i>
1	Design, production, application, specification, and quality control of construction materials unique to civil engineering. Eco friendly Construction Materials/ Green Construction materials	06
2	Materials used in construction Especially for masonry work and concrete work , such as Lightweight Autoclaved Aerated Concrete Blocks, Geopolymer bricks, slag sand, Rebaring materials, Predefined Concrete solutions such as Concrete Cover/spacers blocks. Construction Chemicals: in Concrete, water proofing, tiling:Admixtures & Surface Treatments,Grouts and anchors,Industrial Flooring,Concrete repairs and crack filling,Protective Coating,Joint sealants,Water proofing and adhesives,Cement additives	06
3	Reflective coating materials, thermal Insulation materials, Fire proof insulation materials, Earthquake resistant Materials and materials used in special requirements of construction, Ferro cement Plumbing material Precast concrete construction methods/Pre Engineered Building: Recycling of Construction and Demolition wastes, Use of plastics in Construction 3D printing	06
4	Basics of construction methods for Bridges; Identification of cutting edge sustainable construction materials, technologies, and project management strategies for use in the construction industry and evaluation of their potential to reduce the negative	06

	environmental impacts of construction activity.	
5	Sub Structure Construction- Techniques of Box jacking – Pipe Jacking -under water construction of diaphragm walls and basement-Tunnelling techniques – Piling techniques - well and caisson - sinking cofferdam - cable anchoring and grouting-driving diaphragm walls, sheet piles - shoring for deep cutting - well points -Dewatering and stand by Plant equipment for underground open excavation;	06
6	Super Structure Construction- Launching girders, bridge decks, off shore platforms – special forms for shells - techniques for heavy decks – in-situ pre-stressing in high rise structures, Material handling - erecting light weight components on tall structures - Support structure for heavy Equipment and conveyors - Erection of articulated structures, braced domes and space decks;	06

Text Books

1. Dr. B.C. Punamia(2008); “Building Construction” Laxmi Publications (P) Ltd.ISBN-13: 978-8131804285. 666p.
2. S. S. Bhavkatti (2012); “Building Construction” VikasPublishing House Pvt Ltd. ISBN-13: 978-9325960794. 356p.
3. S. P. Arora and S. P. Bindra (2010); “Textbook of Building Construction”, Dhanpat Rai & Sons publication, ISBN-13: 978-8189928803. 688p
4. [Sushil Kumar](#) (2010); “Building Construction” Standard Publishes-Distributors. ISBN-13: 978-8180141683. 796p.
5. Construction Technology: Analysis,and Choice, 2ed,Bryan, Wiley India
6. Construction Planning, Equipment and methods – Peurifoy-Tata McGraw Hill Publication
7. Construction Equipment Planning and Applications – Dr. Mahesh Varma
8. Brochures Published by various agencies associated with construction..
9. Journals such as CE & CR. Construction world, International Construction.
10. Document Reports of actual major works executed.
11. Construction Technology by Roy Chudley and Roger Greeno, Prentice Hall, 2005

Solid and Hazardous Waste Management

Course Code	Course Name
PE-BTC651	Solid and Hazardous Waste Management
Course pre-requisites	EVS, EEI

Course Objectives

The students will learn to –

1. Explain the various units in integrated solid waste management
2. Quantify and characterize the solid waste
3. Utilize solid waste as renewable energy
4. Deliberate and propose the kind of collection system to be used
5. Develop flowsheets based on various characterization of waste

Course Outcomes

The students will be able to -

1. Develop flowsheets based on type of solid waste management
2. Evaluate Quantities of waste generated
3. Analyze the type of waste generated and its end use
4. Understand laws related solid waste management

Course Content

Module No.	Details	Hrs.
1	Introduction- History, notifications related to Solid Waste; Hazardous Waste, Plastic Waste, E Waste, Construction and Demolition Waste Definition of solid waste Domestic: garbage, ashes, rubbish, dust, debris. Biodegradable, non biodegradable and inert (ruminant) waste. Commercial: wastes from offices, shops and markets etc. Hazardous waste: household, industrial. Biomedical waste Segregation at source	04
2	Sources, Quality and Quantity of solid wastes : Household wastes. Waste from commercial establishments, offices, markets Solid waste from construction activities. Hospital wastes, dead animals. Quantity, composition and properties of solid wastes : Per capita municipal solid waste (city wise – as per CPHEEO manual). Quantity of industrial solid waste per unit produced. Compositions: physical, chemical and biological constituents. Sampling and characterization of solid wastes.	08

3	Collection, segregation, storage and transportation of solid waste : How to do segregation at source: Household level, society level, community level House to house collection, collection centers: location, sizes, types and maintenance. Transportation methods: manual, mechanical, methods with or without compaction, economy in transportation of waste, optimization of transportation routes, Application of GIS	05
4	Disposal of solid waste : Segregation, reduction at source, recovery and recycle Disposal methods : pen dumping, sanitary land filling, composting-anaerobic and aerobic, windrow composting, in vessel composting, incineration, sea disposal, vermin-composting Scientific closure of open dumping site with case study Modern trends : Thermal, biological and chemical conversion technologies.; Disposal of other waste: Construction and demolition, E- Waste, biomedical, sanitary waste Case studies (Household level, society level, municipal level) Site visit to SWDF (Ramky Taloja)	12
5	Management of specific types of waste Plastic waste, E Waste, Biomedical waste and construction and demolition waste Waste as resource Case studies	05
6	Introduction to hazardous waste: generation, minimization at source, treatment and disposal.	04
7	Effect of solid waste on environment: effects on air, soil, water surface and ground, health hazards Municipal solid waste in Indian conditions, legal aspects of solid waste disposal. Qualitative exposure to waste to energy	07

Term Work

Term work shall comprise of

Each student shall prepare a report on any industrial / hazardous / municipal solid waste comprising source, characterization, transportation, recycles treatment and disposal.

The report mentioned above, assignments shall be submitted as term work.

Text Books

1. Integrated Solid Waste Management: Techobanglous, Thisen and Vigil, McGraw Hill International.
2. Hazardous Waste Management: Lagrega, Buckingham and Evans, McGraw Hill International.
3. Solid Waste Management in Developing Countries: A.D. Bhide, Nagpur publications

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4. Environmental Pollution Control Engineering: C.S. Rao, Wiley Eastern,
Manual of solid waste of management, CPHEEO

Sr. No.	Examination	Module
1	T-I	1, 2
2	T-II	3, 4
3	End Sem	1 to 7

Air and Noise Pollution Control

Course Code	Course Name
PE-BTC 652	Air and Noise Pollution Control

Course pre-requisites	
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Course Objectives

The students will learn to –

1. Quantify Composition of air and quantification of gases and particulates
2. Understand effects of air and noise pollution
3. Design of control devices such as fabric filters, cyclones, electrostatic precipitators for air pollution
4. Mitigation measures for control of noise pollution

Course Outcomes

Upon successful completion of the course, students should be able

1. Understand nature and characteristics of air pollutants, noise pollution and basic concepts of air quality management
2. Identify, formulate and solve air and noise pollution problems
3. Design stacks and particulate air pollution control devices to meet applicable laws

Course Content

<i>Module No.</i>	<i>Details</i>	<i>Hrs.</i>
1	Air Pollution, Definition, Air Pollution and Global Climate, Units of measurements of pollutant, Air quality criteria, emission standards, National ambient air quality standards – Air pollution indices, Air quality management in India	2
2	Sources and classification of air pollutants, Manmade, Natural sources, Type of air pollutants, Pollution due to automobiles , Analysis of air pollutants , Chemical, Instrumental and biological methods. Principle and methods for analysis (online assessment of air pollutants) Air pollution and its effects on human beings, plants and animals, Economic effects of air pollution.	3
3	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.	4
4	Plume patterns, plume dispersion, Gaussian model for predicting concentration, downwind from a single source, diffusion coefficients, Methods and instruments for sampling and analysis of air for stack and ambient air monitoring. Assessment models such	5

	as AERMOD, CALINE, ISC Emission factors for different pollutants and its sources for doing Emission modeling; Emission from vehicular sources	
5	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, Control of SO _x , NO _x New techniques to control particulate matters like filters, thermal oxidation; use of catalyst like TiO ₂ to control NO _x , CO, VOCs; Design of household air purifiers	9
6	Sources of noise, Units and Measurements of Noise, Characterization of Noise from Construction, Mining, Transportation and Industrial Activities, Airport Noise, General Control Measures, Effects of noise pollution, auditory effects, non-auditory effects. Noise Menace, Prevention and Control of Noise Pollution, Control of noise at source, control of transmission, protection of exposed person, Control of other types of Noise Sound Absorbent Introduction to noise modeling software like SoundPlan, Caustik	7
7	Government of India: air and noise pollution laws. Indian standards- emission and air quality standards, noise standards Indian and International. Continuous Emission Monitoring Requirement Discussion of occupational hazard and Safety	4
Text Books		
<ol style="list-style-type: none"> 1. C. S. Rao, "Environmental Pollution Control Engineering", Wiley Eastern Limited, 2000. 2. M. N. Rao, H. V. N. Rao, Air pollution, Tata McGraw Hill Pvt Ltd, New Delhi, 1993 3. Dr. Y. Anjaneyulu, "Air Pollution and Control Technologies", Allied publishers Pvt. Ltd., 2002. 		
Reference Books		
<ol style="list-style-type: none"> 1. Noel De Nevers, "Air pollution control Engineering", McGraw Hill International Edition, McGraw Hill Inc, New Delhi, 2000. 2. Air Pollution act, India, 1981 3. Peterson and E.Gross Jr., "Hand Book of Noise Measurement", 5 th Edition, 1963 4. Mukherjee, "Environmental Pollution and Health Hazards", causes and effects, 1986 5. Antony Milne, "Noise Pollution: Impact and Counter Measures", David & Charles PLC, 1979. 6. Kenneth wark, Cecil F.Warner, "Air Pollution its Origin and Control", Harper and Row Publishers, New York, 1981. 		

Sr. No.	Examination	Module
1	T-I	1, 2
2	T-II	3, 4
3	End Sem	1 to 7

Pavement Subgrade and Materials

Course Code	Course Name
PE-BTC 661	Pavement Subgrade and Materials

Course pre-requisites	PC-BTC307 ,PC-BTC403,Soil Mechanics
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Course Objectives
<ol style="list-style-type: none"> 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
<ol style="list-style-type: none"> 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.	Details	Hrs.
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,	6

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	correction for plate size, correction for worst moisture content.	
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

Termwork

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

Reference 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.

Sr.No.	Examination	Module
1	T1	1,2
2	T2	3,4
3	End Sem	1-7

Ground Improvement Techniques

Course Code	Course Name
PE-BTC662	Ground Improvement Techniques

Course pre-requisites	Soil Mechanics
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Course Objectives

The objectives of this course are

1. To understand the necessity and importance of ground improvement techniques.
2. To learn the principles behind mechanical stabilization, physical and chemical ground improvement methods, their suitability and limitations

Course Outcomes

Upon successful completion of the course, the learners should be able

1. Demonstrate an understanding of mechanical and chemical methods available for improvement of granular and clayey soils
2. Understand the application of slope reinforcement techniques such as use of geosynthetics, and methods of stabilizing rock mass
3. Analyse the suitability of the ground improvement technique applicable to a particular site and effectively use it to engineer an economical solution.
4. Competently devise engineering solutions to modify soils so as to make them suitable for specific construction requirements.

Course Content		
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<i>Module No.</i>	<i>Details</i>	<i>Hrs.</i>
1	Need for engineered ground improvement, different types of difficult soils, classification of ground modification techniques, objectives of soil improvement	03
2	Densification methods for granular soils, vibratory methods, dynamic compaction	05
3	Ground improvement by drainage and de-watering, pre-loading, vertical drains and design, vacuum consolidation, stone columns construction methods	08
4	Cement stabilization, cement columns, lime columns, Compaction grouting, and jet grouting	06
5	Reinforced soil slopes, reinforced earth walls, use of geosynthetics for reinforcement, drainage and seepage control using geosynthetics	07
6	Soil nailing, ground anchors, rock bolting, shotcreting	05
7	Case studies in ground improvement	02

Term Work

Term work shall comprise of

1. Examination (MCQ) based on above topics
2. Course project*

***Course Project:** There will be a course project where the students will be able to apply and integrate the knowledge gained during the course. The projects will be developed by teams of two to four students.

Reference Books

1. Hausmann, M. R. Engineering Principles of Ground Modifications. McGraw-Hill, USA, 1990.
2. Purushothama Raj, P. Ground Improvement Techniques. Laxmi Publications, India, 1999.
3. Nayak, N. V. Foundation Design Manual. 7th Edition, Dhanpat Rai Publications, India, 2018.
4. Relevant journal and conference papers for case studies.
5. Relevant IS codes

Sr. No.	Examination	Module
1	T-I	1, 2, part of 3
2	T-II	Remaining part of 3, 4, Part of 5
3	End Semester	1 to 7

Repairs and Rehabilitation of Structures

Course Code	Course Name
PE-BTC623	Repairs and Rehabilitation of Structures
Course pre-requisites	ES-BTC302, PC-BTC402, PC-BTC501, PC-BTC604

Course Objectives

The objectives of this course are:

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

Upon successful completion of the course, students shall be able to develop collaborative skills to work in a team/group and technical skills to:

1. Select and apply various repair techniques and appropriate materials as per the requirement of the problem.
2. Select and apply various structural strengthening techniques and appropriate materials.
3. Select and apply appropriate materials for repair and restoration of heritage structures.
4. Prepare protection & maintenance schedule against environmental distress.

Course Content

Module No.	Details	Hrs.
1	Introduction: Need for strengthening due to various reasons such as ageing, natural calamities, increase of load, change of function and design, construction errors. Structural Audits- Proforma 'B'-MCGM.	03
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	08
3	Specialized Repairs: Basics of Corrosion, Electro chemical repair using cathodic protection, impressed current cathodic protection (ICCP), re-alkalization and chloride extraction techniques, Specialized repairs for chemical disruption, fire, marine exposure etc., Repair of damaged structures of water retaining structures, hydraulic structures, Pavements and Runways, Tunnels, Bridges, Piers and	08

	Flyovers, Parking Garages, Underwater repair, Masonry Repair.	
4	Seismic Retrofitting: Seismic strengthening of existing RC structures, Use of FRP for retrofitting of damaged structures	05
5	Retrofitting by composite materials: Fiber reinforced concrete, Ultra-high performance fibre reinforced concrete (UHPFRC), Fiber reinforced composites, Carbon fibre reinforced polymer (CFRP), Fibre wrapping (Carbon, Aramide, Glass)	07
6	Post-Repair Maintenance of Structures: Protection & Maintenance schedule against environmental distress to all those structures	03
7	Repair and Restoration of Heritage Structures: Study of Construction chemicals required for repair i.e. reinforcement coating, band coat, polymer modified mortar, microconcrete, protective coating.	02
Term Work		
Term work shall comprise of		
<ol style="list-style-type: none"> 1. Exercises on the above topics. 2. Course project* 		
<p>*Course Project: There will be a course project where the students will be able to apply and integrate the knowledge gained during the course. Each student will have to work on a different case study.</p>		

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.

12. ACI 440 – Guideline for use of composite for repair CPWD hand book on Seismic retrofit of buildings published by DG (Works), CPWD, Government of India, IBC & IIT-Madras. http://cpwd.gov.in/units/finaldraft handbook_apr2007.pdf

Sr. No.	Examination	Module
1	T-I	1, 2
2	T-II	3, 4
3	End Sem	1 to 7

Prestressed Concrete

Course Code	Course Name
PE-BTC 624	Prestressed Concrete
Course pre-requisites	ES-BTC302,PC-BTC402,PC-BTC501,PC-BTC604

Course Objectives
<p>The objectives of this course are</p> <ol style="list-style-type: none"> 1. To understand prestress force and its effect in structural members, prestressing systems and industrial applications. 2. To understand the materials which can be used for prestressed structure. 3. To understand the concept of deflections due to prestressing force along with other forces 4. To understand the concept of composite structures and concordance of cables. 5. To understand the design concept using prestressing force and familiarize with IS-1343.

Course Outcomes
<p>At the end of the course the students shall be able to develop collaborative skills to work in a team/group and analytical/technical skills to</p> <ol style="list-style-type: none"> 1. Analysis of prestressed concrete structures 2. Design simple beams and bridge girder.

Course Content		
Module No.	Details	Hrs.
1	Introduction to basic concepts and general principles of prestressed concrete, materials used in prestressed concrete and methods and techniques of prestressing, prestressing systems.	02
2	Analysis of prestressed concrete sections for flexure considering loading stages, computational of sectional properties, critical sections under working loads for pretensioned and post tensioned members, load balancing method of analysis of prestressed concrete beams, losses in prestress, application to simply supported beams and slabs, concept of debonding of cables in pre tensioned units.	08
3	Design philosophy of prestressed concrete sections, permissible stresses in concrete and steel, design approaches using working stress method as per IS 1343 – 2012, limit state of collapse – flexure and shear as applied to prestressed concrete beams, kern points, choice and efficiency of sections, cable profile and layouts, cable zone, deflection of prestressed concrete sections.	08
4	End zone stresses in prestresses concrete members, pretension	05

	transfer bond, transmission length, end block of post tensioned members.	
5	Design of simply supported pre-tensioned and post tensioned slabs and beams. Design of bridge girders subjected to IRC loadings.	05
6	Analysis and design of composite prestressed concrete structures, concept and behaviour of long term creep and relaxation of prestressed members.	04
7	Introduction to application of prestressing to continuous beams, linear transformation and concordance of cables, deck continuity.	04

Text Books

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| <ol style="list-style-type: none"> 1. T. Y. Lin, "Design of Prestressed Concrete Structures", John Wiley Publishers 2. N. Krishna Raju, "Prestressed Concrete", Tata McGraw Hill 3. Y. Guyon, "Prestressed Concrete", Contractors Record Ltd. 4. R. H. Evans & E. W. Bennette, "Prestressed Concrete", McGraw Hill Book Co |
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Sr.No.	Examination	Module
1	T1	1,2
2	T2	3,4
3	End Sem	1 to 7

Open Channel Flow

Course Code	Course Name
PE-BTC 633	Open Channel Flow

Course pre-requisites	
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Course Objectives

The objectives of this course are

1. To introduce Open Channel Flow to students, explaining the types of open channel and their behaviours, the causes and principles of such behaviours, and applications open channels, enabling the students to identify the open channels, and to analyse, design and manage channels.
2. To understand a mathematical study of one dimensional flow in open channels, including uniform, gradually varied flow and sediment transport in channel

Course Outcomes

Upon successful completion of the course, students should be able to

1. Understand and analyse uniform flow in channels
2. Analyse gradually varied and sediment transport in channel flow
3. Differentiate between prismatic and non prismatic channels and its applications in the field.

Course Content

<i>Module No.</i>	<i>Details</i>	<i>Hrs.</i>
1	Uniform flow: Uniform flow formulas, Hydraulically most efficient channels, Design of channels	03
2	Specific Energy and Specific Force: Specific Energy, force concept, Channel Transition, Classical hydraulic jump, jump types, Energy dissipation, Control of hydraulic jump and its importance, Types of Hydraulic Jump, Energy loss.	06
3	Gradually Varied Steady Flow: Gradually varied steady flow and rapidly varied steady flow in open channels, surface profiles in GVF-analysis	06
4	Computation of Gradually Varied Steady Flow: Different method of computations, Chow'-s methods, Direct step methods, standard step method, introduction to professional software's.	06
5	Spatially Varied Flow Differential Equation of spatially varied flow (increasing and decreasing), applications	06
6	Sediment Transport: incipient motion, mechanism of sediment transport, sediment load, design of alluvial channels.	06
7	Case studies: Applications to various field problem with case studies	03

Reference Books

1. Open Channel Hydraulics – VenTe Chow, Mc-Graw Hill, 1959.
2. Flow in Open Channel – K. Subramanya, Tata Mc-Graw Hill, 1986.
3. Flow through Open Channel-K.G.Ranga Raju, Tata Mc-Graw Hill, 1993.
4. Open Channel Hydraulics- Richard H. French, Mc-Graw Hill, 1986.
5. Open Channel Flow- F. M. Henderson, Macmillan Publishing Co. Inc., 1966.

General Reading Suggested:

Codes: 1) I.S. 4997 (1968). “Criteria for design of hydraulic jump type stilling basins with horizontal and sloping apron”. Bureau of Indian Standards, New Delhi.

5. **Hand books: 1)** Peterka, A.J. (1984). “Hydraulic design of stilling basins and energy

Sr. No.	Examination	Module
1	T-I	1, 2
2	T-II	3, 4
3	End Sem	1 to 7

Ground water Development and Management

Course Code	Course Name
PE-BTC 634	Ground water Development and Management

Course pre-requisites

Course Objectives

The objectives of this course are

1. To understand the problems of groundwater in India.
2. To study the elements of groundwater hydrology as well as well hydraulics
3. To summarize the various methods of groundwater exploration
4. To evaluate sources groundwater pollution in detail and devise methods for controlling them

Course Outcomes

Upon successful completion of the course, students should be able

1. Design, construction and development of shallow and deep wells.
2. Able to choose suitable type of method for groundwater exploration
3. Develop a mitigation plan for ground water pollution.

Course Content

Module No.	Details	Hrs.
1	Introduction: Problems and perspectives regarding groundwater in India; Use of groundwater and its impact on irrigation water management;	02
2	Hydrologic properties of water bearing formation, occurrence, storage and distribution of groundwater; Use of groundwater zone maps; Groundwater resource assessment and budget	05
3	Elements of Groundwater Hydrology: Ground water recharge, ground water balance, aquifer properties Surface investigations of groundwater; Well hydraulics- steady and unsteady flows; Water wells- test holes and well logs; Design, construction and development of shallow and deep wells, design of screen and gravel packs	06
4	Surface and Subsurface investigations (Geologic methods; remote sensing; geophysical explorations; electrical resistivity and seismic refraction), Water Wells: Construction; completion, development, protection and rehabilitation of wells;	06
5	Ground water conservation and artificial recharge: sustained yield, water balance equation; Ground-water and surface-water interaction, interference of wells; Watershed conservation measures in irrigation commands	06
6	Groundwater quality: agricultural sources of pollution, causes and monitoring; Technical, socio-economic and organizational	06

	aspects of groundwater management	
7	Case Studies: Discussion on case studies and field applications in Ground water development and management	05
Term Work		
Term work shall comprise of		
At least 10 assignments covering the entire syllabus shall be submitted as term work.		

Reference Books		
<ol style="list-style-type: none"> 1. Bear, J., "Hydraulics of Groundwater", McGraw Hill.1979 2. Karanth, K. R., "Groundwater Assessment, Development and Management", Tata McGraw Hill.1987 3. Rastogi, A.K., "Numerical Groundwater Hydrology", Penram International.2007 4. Raghunath, H.M., "Groundwater", New Age International.2007 5. Sharma, H.D. and Chawla, A.S., "Manual on Ground Water and Tube Wells", Central Board of Irrigation and Power.1977 6. Sterrett, R.J., "Groundwater and Wells", Smyth Companies. 2008 7. Todd, D. K and Mays, L.W. "Groundwater Hydrology", John Wiley.2005 		

Sr. No.	Examination	Module
1	T-I	1, 2
2	T-II	3, 4
3	End Sem	1 to 7

Urban Hydrology and Hydraulics

Course Code	Course Name
PE-BTC 635	Urban Hydrology and Hydraulics

Course pre-requisites	
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Course Objectives

The objectives of this course are:

1. to give basic concepts of urban storm water collection systems
2. to give information about field practices in storm water collection system design,
3. to enable students to design a storm water collection system and design a storm water drainage system using real data
4. to enable students applications of GIS in urban hydrology

Course Outcomes

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

1. understand the basic concepts of urban storm water collection systems
2. understand the field practices in storm water collection system
3. design a storm water collection and design system using real data
4. enable students applications of GIS in urban hydrology

Course Content

Module No.	Details	Hrs.
1	Introduction: Scope, Design storm, IDF curve, SCS-CN, Estimation of urban floods, Hydraulic analysis and design of urban, highway, and small watershed drainage problems; discussion of overland and drainage.	05
2	Storm Water Management Practices: Storm Water Drainage System and appurtenance	05
3	Storm Water Drainage Design: channel flows; hydraulics of storm-drain systems and culverts; determination of design flow; Road Surface Drainage	06
4	Sub Surface Drainage: Different Types of Filter Material, Disposal of Acceptable Quality of Storm Water	06
5	Storm Water Drainage of Special Locations: Infiltration of Storm Water, Ground Water Recharging, Ponds and Rain Water Harvesting, Drainage Through Pumping Maintenance of Drains: Enforcement for Cleaning Drains,	06
6	GIS: Role of Geographical Information System and Master Plan, applications in flood plain mapping.	04
7	Case studies: Various applications in Urban hydrology	04

Reference Books

1. Guidelines on Urban drainage: IRC: SP: 50-2013
2. Butler, D. & Davies, J.W. Urban Drainage, Spon Press, 2nd Edn., 2004.
3. Akan A.O and Hioughtalen R.J. Urban Hydrology, Hydraulics and Stormwater Quality “ Engineering Applications and Computer Modeling, John Wiley & Sons 2003
4. Hall, M.J. Urban Hydrology. Elsevier, 1984.
5. Shaw, E.M. Hydrology in Practice. 3rd Edn., Chapman & Hall, 1994

Sr. No.	Examination	Module
1	T-I	1, 2
2	T-II	3, 4
3	End Sem	1 to 7

Disaster Risk Preparedness, Planning And Management

Course Code	Course Name
PE-BTC 642	Disaster Risk Preparedness, Planning And Management

Course pre-requisites

Course Outcomes

Upon successful completion of the course, students should be able

1. Applying concepts of disaster to management
2. Analysing relationship between development and disasters
3. Ability to understand categories of disasters
4. Realization of the responsibilities to society

Course Content

Module No.	Details	Hrs.
1	Introduction Concepts and definitions: UNISDR; disaster, hazard, vulnerability, risk, severity, frequency and details, capacity, impact, prevention, mitigation	03
2	Disasters – Disasters classification; natural disasters (floods, draught, cyclones, volcanoes, earthquakes, tsunami, landslides, coastal erosion, soil erosion, forest fires etc.); manmade disasters (industrial pollution, artificial flooding in urban areas, nuclear radiation, chemical spills, transportation accidents, terrorist strikes, etc.); hazard and vulnerability profile of India, mountain and coastal areas, ecological fragility.	05
3	Disaster Impacts – Disaster impacts (environmental, physical, social, ecological, economic, political, etc.); health, psycho-social issues; demographic aspects (gender, age, special needs); hazard locations; global and national disaster trends; climate change and urban disasters.	05
4	Disaster Risk Reduction (DRR) – Disaster management cycle – its phases; prevention, mitigation, preparedness, relief and recovery; structural and non-structural measures; risk analysis, vulnerability and capacity assessment; early warning systems, Post disaster environmental response (water, sanitation, food safety, waste management, disease control, security, communications); Roles and responsibilities of government, community, local institutions, NGOs and other	10

	stakeholders; Policies and legislation for disaster risk reduction, DRR programmes in India and the activities of National Disaster Management Authority.	
5	Disasters, Environment and Development – Factors affecting vulnerability such as impact of developmental projects and environmental modifications (including of dams, land use changes, urbanization etc.), sustainable and environmental friendly recovery; reconstruction and development methods.	08
6	Hazard, Vulnerability Risk Assessment (HVRA) Definitions; risk, hazard, vulnerability, severity, exposure, Rating scale or classification of levels of exposure, vulnerability, threat, hazard, Hazard probability, Risk calculation, Hazard mapping, Risk mapping	05

Text Books

1. Singh B.K. (2008); “Handbook of Disaster Management: Techniques & Guidelines” Rajat Publication; ISBN-10: 9788178803555; 312p.
2. Asthana P. and Asthana N.C. (2014); “Disaster Management” Aavishkar Publishers; ISBN-10: 8179104605;
3. Baas S., Ramasamy S., Dey de Pryck J., Battista F. (2008); “Disaster risk management systems analysis A guide book” FAO, Electronic Publishing Policy and support branch Communications Division, FAO, Italy; ISBN 978-92-5-10605-8; 78p.

Reference Books

1. Ghosh G.K. (2006); Disaster Management”, APH Publishing Corporation; ISBN-10: 813130017X; 863p.
2. Sahni P. (2004); “Disaster Risk Reduction in South Asia”, Prentice Hall; ISBN-10: 9788120322004; 388p.
3. <http://ndma.gov.in/> (Home page of National Disaster Management Authority)
4. <http://www.ndmindia.nic.in/> (National Disaster management in India, Ministry of Home Affairs).

TQM and MIS in Construction

Course Code	Course Name
PE-BTC644	TQM and MIS in Construction

Course pre-requisites	
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Course Objectives

The objectives of this course are

1. To study the concept of quality in construction.
2. To describe the need of MIS in Construction.
3. To explain the need of TQM, ISO and SIX Sigma in Construction.

Course Outcomes

Upon successful completion of the course, students should be able

1. To carry out quality control in construction.
2. To develop Total quality management system and Management Information System.

Course Content

<i>Module No.</i>	<i>Details</i>	<i>Hrs.</i>
	Quality in Construction	
1	a) Quality – Various definitions and interpretation. Importance of quality on a project in the context of global challenges. b) Factors affecting quality of construction, reasons for poor quality & measures to overcome.	06
	MIS	
2	a) Introduction to Management Information systems (MIS) Overview, Definition. b) MIS and decision support systems, Information resources, Management subsystems of MIS.	06
	TQM in Construction	
3	a) TQM – Necessity, advantages, Six sigma as a tool in TQM. b) Defects & it's classification in construction. Measures to prevent and rectify defects.	06
	TQM, ISO & Quality Manual	
4	a) Difference between, quality control, quality assurance, total quality control and total quality management (TQM). b) Process based approach for achieving TQM. Study of ISO 9001	06

	principles. ISO implementation procedure in Construction Industry. c) Quality manual – Importance, contents, documentation. Importance of check-lists in achieving quality. Typical checklist for concreting activity, formwork activity, steel reinforcement activity. Importance of third party certification in Quality Control(ISO, Six Sigma, DUPONT certifications)	
5	Management Control a) Management information system structure based on management activity whether for Operational control, management control or strategic planning. b) Supply chain management as a tool in TQM, Benchmarking in TQM, Kaizen in TQM c) Categories of cost of Quality.	06
6	Modern tools in TQM Implementation a) Development of an MIS for a construction organization associated with building works, study and use of various modules of ERP software for construction. b) Introduction to smart phone technology & incorporating GIS, GPS, Android subsystems for documentation and monitoring of construction projects.	06

Text Books

1. Juran's Quality Handbook – Juran Publication
2. Management –Principal, process and practices by Bhat – Oxford University Press.
3. Financial management by Shrivastava- Oxford University Press
4. Management Information Systems – Gordon B. Davis, Margrethe H. Olson – Tata McGraw Hill Publ. Co.
5. Total Project Management – The Indian Context - P.K.Joy Macmillan India Ltd.
6. Total Quality Management-- Dr. Gunmala Suri and Dr. Puja Chhabra Sharma— Biztantra
7. Quality Control and Total Quality Management by P.L.Jain- Tata McGraw Hill Publ.Company
8. Total Quality Management - Dr. S.Rajaram and Dr. M. Sivakumar-- Biztantra
9. Total Engineering Quality Management – Sunil Sharma – Macmillan India Ltd.
10. E- Sources: www.nptel.ac.in , www.mobile.enterpriseappstoday.com

Sr. No.	Examination	Module
1	T-I	1, 2
2	T-II	3, 4

Sardar Patel College of Engineering, Andheri (West), Mumbai 400058
Year: 2021-22

3	End Sem	1 to 6
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Rural Water Supply and Sanitation

Course Code	Course Name
PE-BTC 653	Rural Water Supply and Sanitation
Course pre-requisites	EE1, EEII, EE laboratory

Course Objectives
<p>The students will learn to –</p> <ol style="list-style-type: none"> 1. Comprehend the global picture of water/sanitation/hygiene and health; 2. Know the major technologies and processes of water/sanitation infrastructure in developing countries; 3. Understand the social and cultural factors (e.g., gender issues, children's needs) that must be considered and incorporated into the planning and implementation of water supply and sanitation systems in developing countries; 4. Familiar with the patterns of domestic water use and waste disposal in developing countries, and to describe the modes of transmission of water-related diseases; 5. Understand the principles of operation of a range of appropriate water and sanitation technologies, and to be able to critically evaluate them with respect to multiple criteria; <p>Investigate the concept of community participation and its role in enabling project success and sustainability</p>

Course Outcomes
<p>The students will be able to</p> <ol style="list-style-type: none"> 1. Design the rural water supply system based on the characteristics of water and requirement of community 2. Provide solution to basic infrastructure and hygiene problems faced by the community 3. Design rural sanitation system in affordable and hygienic manner

Course Content		
Module No.	Details	Hrs.
1	Introduction to water and sanitation development	01
2	Rural Water Supply: Issues of rural water supply –Various techniques for rural water supply- merits- National rural drinking water program- rural water quality monitoring and surveillance-operation and maintenance of rural water supplies. Network of water supply Low Cost water Treatment: Introduction – Epidemiological aspects of water quality methods for low cost water treatment - Specific contaminant removal systems; Pot chlorination	10
3	Epidemiology : Communicable diseases, Micro-organisms, Methods of communication, Diseases communicated by discharges of intestines, nose and throat, other communicable diseases and their control	03
4	Rural Sanitation: Introduction to rural sanitation- Community and	10

	sanitary latrines - Planning of wastewater collection system (network) in rural areas- Treatment and Disposal of wastewater - Compact and simple wastewater treatment units and systems in rural areas stabilization ponds - septic tanks - Imhoff tank- soak pits- low cost excreta disposal systems Effluent disposal. Identify problems pertaining to rural water supply and sanitation. Design water supply and sanitation system for rural community Recycle and reuse using low cost technology like constructed wetlands, anaerobic digester, modification of septic tanks, grey water recycling technologies	
5	Industrial Hygiene and Sanitation: Hygiene requirements for Schools- Public Buildings-Hospitals- Eating establishments-Swimming pools – Cleanliness and maintenance and comfort-Industrial plant sanitation.	04
6	Solid Waste Management: Disposal of Solid Wastes- Pit Composting- land filling incineration- Biogas plants - Rural health - Other specific issues and problems encountered in rural sanitation. In vessel composting, waste to energy	04
7	Case study – Utility pro poor approach to Bangalore slums Business model for providing affordable sanitation and water; Water and sanitation requirement for religious purposes	04

Text Books

1. 'Water Treatment and Sanitation – Simple Method for Rural Area' by Mann H.T. and Williamson D.
2. Operation and maintenance of rural water supply and sanitation systems by Brikké F
3. 'Water Supply for Rural Areas & Small Communities' by Wanger E.G. and Lanoix J.N.
4. WHO 'Water Supply and Sewerage', by E.W.Steel&T.J.Mcghee, McGraw Hill.
5. 'Manual on Water Supply and Treatment', CPHEEO, Ministry of Urban Development, Govt. of India.
6. 'Manual on Sewerage and Sewage Treatment', CPHEEO, Ministry of Urban Development, Govt. of India
7. 'Environmental Engineering' by D. Srinivasan, PHI Learning Pvt. Ltd. 2009.

Cairncross, Sandy, and Richard Feachem. *Environmental Health Engineering in the Tropics: An Introductory Text*. Chichester, UK: John Wiley & Sons, 1993, chapter 1 and appendix C. ISBN: 97804719388

Sr. No.	Examination	Module
1	T-I	1, 2
2	T-II	3, 4
3	End Sem	1 to 7

Physicochemical Processes

Course Code	Course Name
PE-BTC 654	Physicochemical Processes

Course pre-requisites	
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Course Objectives

The objectives of this course are

1. Understand the basic concepts of physico chemical processes
2. Application of concepts in water, air and wastewater engineering

Course Outcomes

Upon successful completion of the course, students should be able

1. Understand the basic concepts of physicochemical engineering processes
2. Incorporate the concepts studied for water, air and wastewater pollution control
3. Design units based on the concepts in water, air and wastewater engineering

Course Content

<i>Module No.</i>	<i>Details</i>	<i>Hrs.</i>
1	Structure and properties of the water molecule: <ul style="list-style-type: none"> • Aquatic chemistry of strong and weak acids/bases in water. • Inorganic carbon system. • Alkalinity and acidity. • Buffering capacity. 	02
2	Contaminants in natural waters; coupling water quality with aquatic chemistry; water quality criteria and standards. Transport of contaminants in natural aquatic systems: <ul style="list-style-type: none"> • Advection. • Diffusion. • Dispersion. • Derivation of advection-dispersion equation. • Examples of contaminant transport and transformations in rivers, lakes and aquifers 	05
3	Gas-liquid mass transfer: <ul style="list-style-type: none"> • Henry's constant, mass transfer between gaseous and aqueous phases. • Two film theory. 	10
4	Solid-liquid mass transfer: <ul style="list-style-type: none"> • Langmuir and Freundlich and other isotherms. • linear isotherms, i.e., partitioning coefficients. • Hydrophobicity and partitioning. 	06

	<ul style="list-style-type: none">• Adsorption rates and factors affecting the adsorption rates	
5	Reactors and reactor efficiency; completely mixed, plug flow and mixed flow reactors.	05
6	Engineered physico-chemical processes in water treatment: <ul style="list-style-type: none">• Neutralization.• Precipitation.• Oxidation-reduction.• Sedimentation.• Coagulation-flocculation.• Filtration.• Adsorption, gas stripping, etc.	08

Text Books

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| <ol style="list-style-type: none">1. Environmental Engineering Science. First Edition (2001). By: William W. Nazaroff and Lisa AlvarezCohen. John Wiley and Sons Inc.2. Chemistry for Environmental Engineering. Fourth Edition (1994). By: Clair N. Sawyer, Perry L. McCarty and Parkins, G. F3. Physicochemical processes (1972)By Walter J Weber.Interscience New York |
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Low Cost Roads

Course Code	Course Name
PE-BTC 663	Low Cost Roads
Course pre-requisites	PC-BTC406,Highway Engineering,Soil Mechanics

Course Objectives

- The objectives of this course are
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 Outcomes

- Upon successful completion of the course, students should 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.

Course Content

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.	05
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 subgrade soils.	06

4	Design and construction of Rural Roads: Flexible pavement, semi rigid pavements, roller compacted concrete pavements; equipment's used during construction of roads.	06
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 rice 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
Term Work		
Term work shall comprise of At least 10 assignments shall be submitted as term work. Report based on site visit to road site.		

Text Books	
<ol style="list-style-type: none"> 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. 	

Traffic Engineering and Control

Course Code	Course Name
PE-BTC 664	Traffic Engineering and Control
Course pre-requisites	BS-BTC401 ,Highway engineering

Course Objectives
<p>The objectives of this course are</p> <ol style="list-style-type: none"> 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
<p>Upon successful completion of the course, students should be able</p> <ol style="list-style-type: none"> 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.	Details	Hrs.
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	05

	inter section, mini round about.	
5	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
6	Economic Evaluation of Transportation Plan: cost and benefits of transportation project, different methods available for economic evaluation.	04
7	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

Term work shall comprise of

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, McGraw-Hill, 1970.
 3. Traffic System Analysis for Engineering and Planners: Wohl and Martin, McGraw Hill, 1983.
 4. Principles of Transportation Engineering: ParthaChakroborty and Animesh Das, Prentice hall (India)
 5. Traffic Flow Theory and Control: Drew D.R., McGraw – Hill , New York, 1964
- Highway Capacity Manual, Transportation Research Board, National Research Council, Washington D.C.

Introduction to Geotechnical Earthquake Engineering

Course Code	Course Name
PE-BTC665	Introduction to Geotechnical Earthquake Engineering

Course pre-requisites	Engineering Geology, Soil Mechanics
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Course Objectives

The objectives of this course are

1. To provide basic understanding of earthquake engineering in the context of geotechnical issues.
2. To learn about behaviour of soil under seismic loading

Course Outcomes

Upon successful completion of the course, the learners should be able

1. Understand the principles of earthquakes, wave propagation, and measurement of earthquakes
2. Understand the importance and influence of dynamic soil properties in determining hazards arising due to earthquakes
3. Interpret and use data obtained from geophysical tests
4. Analyse and quantify earthquake hazard and predict behaviour of geotechnical structures

Course Content

<i>Module No.</i>	<i>Details</i>	<i>Hrs.</i>
1	Introduction, Causes of earthquake, Major earthquakes over the world, Interior of earth, Plate tectonics, Theory of continental drift, Earthquake data sources, Elastic rebound theory, Theory of continental drift, Hazards due to earthquakes	04
2	Dynamic loads, single degree of freedom systems, free and forced vibrations, damped and undamped systems, Equations of motion.	06
3	Magnitude and intensity of earthquakes, Richter magnitude, moment magnitude, Mercalli intensity scale, seismic energy and correlations, spectral parameters, frequency content and duration of earthquake, attenuation relationships, method to locate earthquake epicenter, Earthquake zonation of India.	04
4	Dynamic soil properties – stiffness, damping, lab and in-situ testing, basics of liquefaction, evaluation of liquefaction potential, effects of liquefaction, sand boiling. Case studies related to after effects of earthquakes, remedial and preventive measures	07
5	Geophysical soil investigations using MASW and SASW. Introduction to GPR	03
6	Introduction to Deterministic Seismic Hazard Analysis (DSHA), Probabilistic Seismic Hazard Analysis (PSHA), Earthquake source characterization, site amplification, ground response analysis, site	04

	classification.	
7	Pseudo-static method, pseudo-dynamic method and modified pseudo-dynamic method. Seismic analysis of retaining wall, seismic bearing capacity of c- ϕ soils resting beneath shallow foundations	08

Term Work

Term work shall comprise of

1. Examination (MCQ) based on above topics
2. Course project*

***Course Project:** There will be a course project where the students will be able to apply and integrate the knowledge gained during the course. The projects will be developed by teams of two to four students.

Reference Books

1. Prakash, S. Soil Dynamics. McGraw-Hill, USA, 1981.
2. Kramer, S. L. Geotechnical Earthquake Engineering. Pearson-India, India, 2007.
3. Day, R. W. Geotechnical Earthquake Engineering Handbook. 2nd Edition, McGraw-Hill, USA, 2012.
4. Relevant journal and conference papers for case studies.
5. Relevant IS codes

Sr. No.	Examination	Module
1	T-I	1, 2, part of 3
2	T-II	Remaining part of 3, 4, 5
3	End Semester	1 to 7

Human Resources Development and Organizational Behavior

Course Code	Course Name
OE-BTC611	Human Resources Development and Organizational behavior

Course pre-requisites	
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Course Objectives

The students will learn about :

1. to develop a systematic and planned approach through which the efficiency of employees is improved.
2. Development of the integrated use of training, organization, and career development efforts to improve individual, group, and organizational effectiveness.
3. To understand the key competencies that enable individuals in organizations to perform current and future jobs through planned learning.

Course Outcomes

The students will be able to:

1. To set the future goals and objectives for the entire organization and for self.
2. To apply integrated use of training, organization, and career development efforts
3. To understand the importance of key competencies that enable individuals in organizations to grow.

Course Content

<i>Module No.</i>	<i>Details</i>	<i>Hrs.</i>
1	Introduction to Human Resource Development: Emergent of HRD, Critical roles, challenges, HRD Process Model: identification of needs and Design and development of HRD programs, Process Model: Methods of Implantation, Evaluation of programs.	05
2	HRD interventions: Mentoring for employee development: Role of mentoring in development, Employee counseling for HRD: Overview of counseling programs, employee assistance program, stress management, employee wellness and health promotion, Competency framework of HRD: steps in competency mapping.	06
3	Career Planning, management, and development: Career development stages and activities, role of individual and organization in career planning, Organizational Learning, and learning organizations.	05
4	The future of HRD and Ethics: Research, practice and education of HRD for innovation and talent development and management, Role of HRD in developing ethical attitude and behavior and development, Ethical problems with HRD roles.	05
5	Organizational Behavior:	05

	Introduction, What is organizational Behavior? Diversity in Organizations, Attitudes and Job Satisfaction, Emotions and Moods, Personality and Values, Perception and Individual Decision Making, Motivation Concepts.	
6	Foundations of Group Behavior: Understanding Team work, Communication, Leadership, Power and Politics, Conflict and Negotiation, Foundations of Organization Structure, Organizational Culture, Human Resource Policies and Practices, Organizational Change and Stress Management.	05
7	Case Studies: Based on survey done with various industries.	05
Text Books		
<ol style="list-style-type: none"> 1. Werner and DeSimone (2006). Human Resource Development. Thomson Press, Network. 2. David Mankin (2009). Human Resource Development, Oxford University Press: Delhi. 3. Rosemary Harison (2000). Employee Development. University Press: Hyderabad. 4. John P. Wilson (2005). Human Resource Development. Kogan Page. 5. Stephen P. Robbins and Timothy A. Judge (2013) Organizational behavior, Copyright © 2013, Pearson Education, Inc., publishing as Prentice Hall. 		

Sustainable Development

Course Code	Course Name
OE-BTC612	Sustainable Development
Course pre-requisites	Probability and Statistics, Environmental Science (mandatory course)

Course Outcomes
<p>Upon successful completion of the course, students should be able</p> <ol style="list-style-type: none"> 1. Understand the basic concept of Sustainable Development (SD), history of SD, the environmental, social and economic dimensions of SD and be able to discuss the SD concept on the national as well as on the global scale. 2. Gain knowledge about the fundamental concepts related to interaction of industrial and environmental/ecological systems, sustainability challenges facing the current generation, and systems-based approaches required to create sustainable solutions for society. 3. Have a broader perspective in thinking for sustainable practices by utilizing the engineering knowledge and principles. 4. Be familiar with potential strategic options and tools for assessing SD (efficiency, sufficiency).

Course Content		
Module No.	Details	Hrs.
1	<p>Principles of Sustainable Development: History and emergence of the concept of Sustainable development, Definitions, Environmental issues and crisis, Resource degradation, greenhouse gases, desertification, social insecurity, Industrialization, Globalization and Environment Sustainability metrics – simple and complex indicators, Sustainable methods - green buildings, Renewable energy, CSR, Biodiversity, Technology and human factors Development (SD)</p>	04
2	<p>Sustainable Development and International Contribution: Components of sustainability, Complexity of growth and equity, International Summits - Brundtland, Rio, SDGs, Conventions, Agreements, Transboundary issues, Action plan for implementing sustainable development, Moral obligations and Operational guidelines.</p>	06
3	<p>Socio-economic Sustainable Development Systems: Socio-economic policies for sustainable development, Strategies for implementing eco-development programmes, Sustainable development through trade, Economic growth, Carrying Capacity,</p>	04

	Public participation. Agenda for Future Global Sustainable Development - Role of developed countries in the sustainable development of developing countries, Demographic dynamics and sustainability, Integrated approach for resource protection and management	
4	<p>Strategies and measurements of SD:</p> <p>LIFE CYCLE ASSESSMENT - Detailed methodology and ISO framework - detailed example on LCA comparisons, LCA benefits and drawbacks, historical Development and LCA steps from ISO framework, life cycle inventory and impact assessments unit processes and system boundary data quality, procedure for life cycle impact assessment, LCIA in practice with examples, interpretation of LCIA results, factors for good LCA study - ISO terminologies, LCA steps recap, chemical release and fate and transport, and green sustainable materials</p> <p>LCA - DATA COLLECTION AND METHODOLOGY</p> <p>Environmental data collection issues, statistical analysis of environmental data, common analytical instruments, overview of LCA methodology - goal definition, life cycle inventory, life cycle impact assessment, life cycle interpretation, LCA software tools</p>	12
5	<p>Design For Sustainability</p> <p>Environmental design for sustainability: economic, environmental indicators, social performance indicators, sustainable engineering design principles and environmental cost analysis.</p> <p>Case Studies</p> <p>Architectural, environmental, transportation, water resources, and other areas</p>	10

Text Books	
1.	Allen, D. T. and Shonnard, D. R., Sustainability Engineering: Concepts, Design and Case Studies, Prentice Hall.
2.	Bradley. A.S; Adebayo,A.O., Maria, P. Engineering applications in sustainable design and development, Cengage learning
3.	Environment Impact Assessment Guidelines, Notification of Government of India, 2006
Reference Books	
1.	ECBC Code 2007, Bureau of Energy Efficiency, New Delhi Bureau of Energy Efficiency Publications-Rating System, TERI Publications - GRIHA Rating System
2.	Ni bin Chang, Systems Analysis for Sustainable Engineering: Theory and Applications, McGraw-Hill Professional.
3.	Twidell, J. W. and Weir, A. D., Renewable Energy Resources, English Language Book

Society (ELBS).

4. Mackenthun, K.M., Basic Concepts in Environmental Management, Lewis Publication, London, 1998

Watershed Development and Management

Course Code	Course Name
OE-BTC 613	Watershed Development and Management

Course pre-requisites	
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Course Objectives

The main objectives of the course are

1. To explain the concept of watershed and its management.
2. To study watershed hydrology and its behavior.
3. To describe erosion process.

To summarize the engineering measures for soil and water conservation

Course Outcomes

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

1. Apply the engineering measures for soil and water conservation
2. Develop watershed management plan

Course Content

<i>Module No.</i>	<i>Details</i>	<i>Hrs.</i>
1	Components of watershed and need of watershed management; Principal factors influencing watershed operations; Delineation of watersheds; Engineering surveys; Data requirement	04
2	Watershed hydrology, water resources assessment in watershed, hydrological cycle; Surface water assessment-rainfall-runoff analysis; Groundwater assessment, infiltration and its measurement	04
3	Watershed Behavior- Physical elements of watershed, effects of land use changes on hydrological cycle components, watershed experiments, Land capability classification; Erosion process- factors affecting erosion, types of erosion, soil erosion models	06
4	Engineering measures for soil and water conservation- Contour bunding, graded bunding, bench terracing, land leveling and grading; Small storage structures- Types and design data requirement, loose boulder dams, gabions, check dams and their design criteria	06
5	Rainwater harvesting, direct and indirect methods, filter design, planning and design; Layout and execution; Impact assessment, operation and maintenance issues	06
6	Watershed management plan- Methodology of planning a watershed, identification of watershed problems, socio-economic issues.	06
7	Case studies: Application of Remote sensing and GIS in	04

	watershed management	
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Reference Books

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| <ol style="list-style-type: none">6. Das, G., "Hydrology and Soil Conservation Engineering", Prentice Hall.(2002)7. Debarry, P. A., "Watershed: Processes, Assessment and Management", John Wiley.(2004)8. Lyon, J. G., "GIS for Water Resources and Watershed Management", Taylor and Francis.(2003)9. Schwab, G.O., Fangmeier, D.D., Elliot, W. J., Frevert, R. K., "Soil and Water Conservation Engineering", John Wiley.(2002)10. Suresh, R., "Soil and Water Conservation Engineering", Standard Publishers.(2006)11. Tideman, E.M., "Watershed Management", Omega Scientific Publisher.(2002) |
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Artificial Intelligence Techniques

Course Code	Course Name
OE-BTC614	Artificial Intelligence Techniques

Course pre-requisites	
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Course Content		
Module No.	Details	Hrs.
1	Introduction to Soft computing techniques- soft computing techniques, importance, types of soft computing techniques, advantages and limitations.	03
2	Fuzzy logic: Fuzzy sets- Fuzzy set operations- Fuzzy relations- Cardinality of Fuzzy relations-Operations on Fuzzy relations- Properties of Fuzzy relations- Membership Functions-Features of Membership functions- Fuzzification-Methods of Membership value Assignments- Fuzzy Rule Base-Defuzzification-Defuzzification methods- Fuzzy logic controller, applications to water resources engineering.	05
3	Artificial Neural Networks: Basic concepts- Biological foundations, ANN models, Types of activation function, Neural network Architectures-Single layer feed forward network- Multilayer feed forward network, Perceptron networks-Back Propagation networks-Radial base function network, applications to water resources engineering, applications to water resources engineering.	06
4	Fundamentals of genetic algorithms and Genetic programming: Intuition behind Genetic Algorithms, Biological Inspiration, What is Genetic Algorithm?, Steps Involved in Genetic Algorithm, Initialization, Fitness Function, Selection, Crossover, Mutation, Application of Genetic Algorithm, Feature Selection, Difference between GA & GP, applications to water resources engineering.	06
5	Model Trees: Introduction, model trees, CART, Building initial tree, Standard deviation reduction, Pruning the tree, Smoothing, M5 algorithm and M5P algorithms.	05
6	Support Vector Machine: Margins: Intuition, functional and geometric margins, the optimal margin classifier, Lagrange duality, Lagrange multipliers, Karush-Kuhn-Tucker (KKT) conditions, Kernals, applications to water resources engineering.	05
7	Case studies: case studies on FL, ANN, GA, GP, MT, SVM	06

Text Books

1. S.Rajasekharan, G.A.VijayalakshmiPai, *Neural Network, Fuzzy Logic and Genetic Algorithms Synthesis and Applications*, Prentice Hall India.
2. S.N.Sivanandam, S.N.Deepa, *Principles of Soft Computing*, Wiley India.
3. Timothy J Ross, *Fuzzy logic with Engineering Applications*, McGraw Hill, New York.
4. S.Haykins, *Neural Networks a Comprehensive foundation*, Pearson Education.
5. D.E.Goldberg, *Genetic Algorithms in Search Optimization and Machine Learning*, Pearson Education.
6. 6.Breiman, L., Friedman, J.H., Olshen, R.A. & Stone, C.J. (1984). Classification and regression trees. Belmont CA: Wadsworth.
7. <http://www.genetic-programming.org/>

NUMERICAL COMPUTATIONS

Course Code	Course Name
OE-BTC615	NUMERICAL COMPUTATIONS

Course pre-requisites	Engineering Mathematics
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Course Objectives

With the development of powerful computer, now it has become easier to design and develop complex engineering system with its help. Numerical techniques are brain behind this capability. The objective of this course is to equip students with such techniques of computation so that they can understand and solve real life problems.

Course Outcomes

- Upon successful completion of the course, students should be able to :
1. understand the basic concept of modeling, numerical computation and associated errors.
 2. apply numerical techniques of common mathematical tools to solve real life problem.
 3. analyze and compare different techniques with reference to errors, convergence and accuracy.
 4. demonstrate potential to develop code which can be used with available programming resources.

Course Content

<i>Module No.</i>	<i>Details</i>	<i>Hrs.</i>
1	<p>Exposure to Numerical Software</p> <p>Introduction to MATLAB and numerical programming through it, Using EXCEL worksheet in numerical computation.</p>	06
2	<p>Fundamentals of Modeling and Error:</p> <p>Fundamentals of mathematical modeling - needs and limitations. Mathematic modeling of simple engineering systems Significance of analytical and numerical methods in engineering analysis.</p> <p>Error analysis; significant figures, accuracy and precision, Error definitions, Round-off and truncation error</p>	04
3	<p>Numerical Solution of Systems of Linear Algebraic Equation:</p> <p>Direct Methods: Matrix inversion, Gauss Elimination, LU Decomposition, TDMA</p> <p>Nature of iterative solution, Role of eigen values in convergence, Successive under relaxation, Iterative Methods - Jacobi, Gauss Siedel,</p>	06

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	Effect of rounding off on iterative solution and ill-conditioned system.	
4	Numerical Solution of Systems of Non-linear Equations: Roots of equations: Bisection, False position, Secant, Newton-Raphson methods. Problems based on real-life application.	04
5	Numerical Integration and Differentiation: Newton-Cotes Integration Formulas - Trapezoidal rule, Simpson's rule, Finite Difference Methods - Forward difference, Backward difference and Central Difference	06
6	Numerical Solution of Ordinary Differential Equation: Explicit and Implicit Marching Method, Modified Euler's Method, Runge- Kutta Methods - RK-II and RK-IV, ODE System: Initial value problem, Boundary value problem, Predictor-corrector methods -Adams Method, Adams-Bashforth-Moulton Method, Milne's Method, Adams- Moulton Method , Stiff ODE System	08
7	Curve Fitting; Regression - Least- square regression Interpolation - Newton's divided difference polynomials, Lagrange's polynomials, Spline interpolation;	06
Termwork		
The term work shall comprise of problems and case studies covering different topics taken from course studied in the semester. Assignment shall consist of programmes written in pseudo code, any programming language or MATLAB.		

Text Books	
1. Sastry, S S. Introductory methods of numerical analysis . PHI Learning Pvt. Ltd., 2012.	
2. Chapra, Steven and Canale. Numerical methods for engineers . New York: McGraw – Hill, 7ed.	
3. Applied numerical analysis : Curtis Gerald	

Environmental Studies

Course Code	Course Name
MC102	Environmental Studies

Course pre-requisites	
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Course Objectives

1. Imparting basic knowledge about environment, sustainability and ecology
2. Creating awareness about environment issues
3. Developing basic skills for identifying and resolving environmental issues

Course Outcomes

The student will be able to

1. Define basic concepts of sustainability, environment and ecology
2. Analyze impact and suggest suitable control measures related to Environmental Pollution
3. Create awareness about environmental issues in community

Course Content

<i>Module No.</i>	<i>Details</i>	<i>Hrs.</i>
01	Introduction to Environmental Studies : History of Environmental Studies, Historical Climate change, Aqueducts of Greece; Harappa Civilization Air Pollution Episodes: Meuse Valley; Donora Pennsylvania; London smog; Bhopal Gas Tragedy.	02
02	Ecology and Sustainability: <ol style="list-style-type: none"> i. Ecology: Definitions: Ecosystem; Ecology; Biome; Biodiversity; Productivity; Respiration, Concept of primary and secondary productivity ii. Concept and Definition of Sustainable Development. iii. Social, Economic and Environmental aspects of sustainable development. iv. Control measures: 3R (Reuse, Recovery, Recycle), v. Sustainable Structures (Green building) vi. Concept and example of life cycle analysis 	05
03	Environmental Pollution: <ol style="list-style-type: none"> i. Air: Definition, Sources, classification, Effects: global, On human, plants and materials, Mitigation Measures for particulate and gaseous pollutants; introduction to emission inventory; urban heat island ii. Soil: Definition, Sources, Effect: Global, on human, plants and materials, Mitigation measures: Remediation measures iii. Noise: Definition; Classification of air pollutants; Effect, Mitigation iv. Water: Definition; Classification of pollutants, Surface water quality, water quality in lakes, rivers and ground water, Effects of 	09

	<p>water pollution, Remediation of water body; introduction to phyto-remediation</p> <p>v. Thermal: Definition, Sources, Effect on receiving Bodies, Mitigation Measures: Cooling ponds</p> <p>vi. Radioactive Pollution</p> <p>vii. Solid waste : Definition; Sources, Effects; Management; Disposal</p> <p>viii. Cost of Environmental Damage</p>	
04	<p>Treatment of Water and Wastewater in short</p> <p>i. Principle of Treatment, Flowsheet to treat Surface and Ground Water treatment; Function of units.;</p> <p>ii. Principle of Treatment, Flowsheet of wastewater treatment; function of units</p>	02
05	<p>National Laws and International Conventions related to environment</p> <p>International conventions related to environment</p> <p>Ramsar Convention, Kyoto Protocol, Montreal Protocol, Stockholm convention</p> <p>i. Water Act, 1974</p> <p>ii. Air Act 1981</p> <p>iii. EPA, 1986</p> <p>iv. Hazardous Wastes and Other Wastes (Management and Transboundary movement) 2016</p> <p>v. Solid Waste Management Rules, 2016</p> <p>vi. E-waste management Rules, 2016</p> <p>vii. Environment Impact Assessment (EIA), Notification 2006 and its subsequent Amendment</p> <p>viii. Develop Control Regulation 2016, Mumbai</p>	05

Text Books

1. Gilbert Masters and Wendell Ella, Introduction to Environmental Engineering and Science, Pearson Edition:2013

Reference books

1. Raman Siva Kumar Introduction to Environmental Science and Engineering Mc Graw Hill Second Edition:2015

Geographical Information Systems (GIS and Its Applications)

Course Code	Course Name
VA-BTC 671	Geographical Information Systems (GIS and Its Applications)

Course pre-requisites

Course Objectives

The objectives of this course are

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

Course Outcomes

Upon successful completion of the course, students should be able

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.

Course Content

<i>Module No.</i>	<i>Details</i>	<i>Hrs.</i>
1	Introduction to GIS: Definition, sources of data, types of data, concept of space and time in GIS, spatial information theory, history of GIS, elements of GIS, objectives of GIS, hardware and software requirements of GIS, application of GIS	04
2	Data models of spatial information: Representation of spatial data models in computer: raster and vector models, comparative overview between raster and vector models	04
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	04

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	generation	
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.	04
7	Applications: Forest resource management, agriculture and soil management, water resource management, land use and land suitability, disaster management	08

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,