Bharatiya Vidya Bhavan's

SARDAR PATEL COLLEGE OF ENGINEERING

(Government Aided Autonomous Institute under Mumbai University) Andheri (W), Mumbai – 400058

COURSE CONTENTS

Regulation 18

Sem. VII

Year 2024-25 B.Tech. (Civil) ENGINEERING

Academic Year 2024-2025

Course Contents for Sem VII for Regulation 18

Design of Concrete Structures PC-BTC701

Course Code	Course Name
PC-BTC 701	Design of Concrete Structures

Course pre-requisites	PC-BTC604

Course Objectives

The objectives of this course are

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

Course Outcomes

Upon successful completion of the course, students should be able

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

Course Content

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

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

Term Work

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

Text Books

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

Reference Books

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

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

PE III- Advanced Structural Analysis PE-BTC721

Course Code	Course Name
PE-BTC721	Advanced Structural Analysis

Course pre-requisites	Structural Mechanics, Structural Engineering

Course Objectives

The main objectives of the course are;

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

Course Outcomes

At the end of the course the students shall be able to,
1. Analyse various types of structures, using stiffness matrix method.
2. Analyse pin jointed/rigid jointed plane frames (including frames with inclined members) subjected to different loadings including settlement of supports, temperature changes and elastic supports by flexibility method/elastic centre method/column analogy method.
3. Analyse framed structures using approximate conventional methods for preliminary design structure.
4. Construct the ILD for indeterminate beams
5. Carry out plastic analysis of structures and apply it for the design of structures.
6. Use computer software (SAP/ETABS) for analysis of various real-life structures

Course Content

Module No.	***Details***	***Hrs.***
1	Introduction to Stiffness Method in Matrix Form: Basic concepts of stiffness coefficients, member stiffness matrix for member of plane truss, member of rigid jointed plane frame, member of plane grid and member of space frame. Properties of stiffness matrix, co-ordinate transformation matrix, stiffness matrix in local and global co-ordinate axes system, assemblage of structural stiffness matrix and application of boundary conditions.	06

2	Stiffness Matrix Method cont. Joint loads, Equivalent joint loads, method of solution for displacements and computation of internal forces in members. Application of stiffness method to beams, pin jointed trusses, rigid jointed plane frames and simple plane grid structures.	04
3	Conventional Form of Stiffness Method, Modified Moment Distribution Method: Symmetric structure, Symmetric and anti-symmetric loads, Modification of stiffness and carryover factors for symmetric and anti-symmetric loads both for sway and non-sway cases for frames with different support conditions. Application to frames (without inclined members) with and without side sways.	06
4	Flexibility Method: Review of concepts of flexibility coefficients, Selection of primary structure, concept of structure flexibility matrix, compatibility equations, solution for redundant forces, computation of internal forces, and joint displacements. Application to pin jointed trusses and rigid jointed plane frames for different loading including the effect of settlement of support, temperature changes and elastic supports. Conventional Form of Flexibility Method: Elastic Center Method and its application to rectangular box, rigid jointed portal frames and fixed arches. Column Analogy Method and its application to analysis of non-prismatic beams, simple rectangular frames, determination of stiffness coefficients and carry over factors for non-prismatic beam members. Self-Learning: Application of Elastic Center Method to fixed arches.	03 06
5	Influence Line Diagrams for Indeterminate Structures: Muller Breslau's Principle for drawing influence line diagrams for statically indeterminate structures. Influence Lines Diagrams for propped cantilevers, fixed beams and continuous beams. Self-Learning: ILD for indeterminate beams.	05

6	Approximate Methods for Analysis of Building Frames: Approximate methods for gravity loads: Substitute frame and equivalent frames. Approximate methods for lateral loads: Portal and cantilever method.	03
7	Plastic Analysis of Steel Structures: Application to single bay single story rectangular frames.	03

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

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

Reference Books

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

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

PEIII Structural Analysis by Matrix method PE-BTC722

Course Code	Course Name
PE-BTC 722	Structural analysis by matrix methods

Course pre-requisites	NA

Course Outcomes
Upon successful completion of the course, students should be able 1. Analyse Plane Trusses, and Continuous Beams using Matrix Stiffness Method. 2. Analyse Plane Frames, and Grids . 3. Analyse Space Trusses and Space Frames . 4. Use computer Programs for analysis of Framed Structures.

Course Content

Module No.	*Details*	*Hrs.*
1	**Introduction:** Matrix methods for skeletal structures, Basic considerations of structural analysis, Boundary conditions, Flexibility Method, Displacement Method, Stiffness relationships	05
2	**Matrix Displacement Method** Bar element with axial force, Member stiffness matrix, Bar element subjected to torsion, Stiffness matrix of a beam element, Assembly of the structure stiffness matrix	06
3	**Plane Frames. Trusses and grids** Pin-jointed frames, Rigid jointed frames, inclined supports, Grid structures, Bandwidth of stiffness matrix, Member Stiffness Relations in the Local Coordinate System, Coordinate Transformations, Stiffness in the Global Coordinate system	07
4	**Loading** Loading between joints, Effects of temperature change and lack of fit	05
5	**Space Frames and trusses** Pin-jointed space frames, Rigid-jointed space frames, Structure Stiffness Relations	06
6	**Programming for Stiffness Method** Flow Charts, Continuous Beam Program, Plane Truss Program, Plane Fra me Program, Space Truss Program, Introduction to software for analysis.	07

Reference Books
1. William Weaver and James Gere, " Matrix Analysis of Framed Structures ", Springer Publication,1990. 2. Damodar Maity , " Computer Analysis of Framed Structures", I. K. International Publication, 2007. 3. Aslam Kassimali, " Matrix Analysis of Structures ", Cengage Learning, 2010. 4. P. N. Godbole, R. S. Sonparote and S. U. Dhote, " Matrix Methods of Structural Analysis", Prentice Hall Publication, 2012.

PEIII Maintenance, Repairs and Rehabilitation of Structures

PE-BTC723

Course Code	Course Name
PE-BTC723	Maintenance, 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 1. Exercises on the 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. Each student will have to work on a different case study.

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/finaldrafthandbook_apr2007.pdf

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

PEIII Surface Hydrology (Hydrology and Flood Control) PE-BTC731

Course Code	Course Name
PE-BTC731	Surface Hydrology (Hydrology and Flood Control)

Course pre-requisites	Hydraulic Engineering, Water Resource and Irrigation Engineering

Course Objectives

The objectives of this course are

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

Course Outcomes

Upon successful completion of the course, students should be able

1. to estimate precipitation, runoff and water losses along with stream flow measurements by various techniques.
2. to carry out the flood estimation, its routing techniques along with importance of flood frequency studies and apply probabilistic as well as stochastic methods in flood estimation.

Course Content

Module No.	*Details*	*Hrs.*
1	**Introduction**: Hydrological cycle, scope of hydrology, water budget equation, sources of data, Introduction to climate change.	03
2	**Precipitation and Water Losses**: Measurement, rainfall records, missing data, mass curve analysis, station year method, depth - area - duration relationship, intensity - duration - frequency relationship. Water losses:Evaporation, evapotranspiration, interception, initial loss, infiltration. Determination of water losses.	06
3	**Streamflow's and Runoff:** Stream gauging techniques, latest methods of measuring depths, current meter-types-calibration, mid-section and mean section methods, rating curves. **Runoff:** Factors affecting runoff, rainfall-runoff relationship, runoff estimation.	06
4	**Hydrograph analysis:** Characteristics, base flow separation, unit hydrograph, S-hydrograph, complex hydrograph, synthetic hydrograph, dimensionless unit hydrograph, instantaneous unit hydrograph.	06
5	**Floods and Flood routing:**	06

	Estimation, envelope curves, flood frequency studies, probability and stochastic methods, estimation of design flood, flood plains, flood hazards,flood control methods, limitations, risk-reliability and safety factor.Reservoir routing, channel routing.	
6	**Hydrological forecasting**: Introduction, General operation of flood forecasting, forecasting by unit hydrograph method.	06
7	**Case studies:** applications of basic principles to hydrology and flood control	03

Reference Books
5. Engineering Hydrology: K. Subramanya, Tata McGraw Hill Publishing Co. Ltd.. New Delhi. 6. Hydrology: H. M. Raghunath, New Age International Publishers, New Delhi 7. Elementary Hydrology: V. P. Singh, Prentice Hall 8. Engineering Hydrology: Principles and practice: V. M. Ponce, Prentice Hall 9. Hydrology and Water Resources Engineering: K. C. Patra, Narosa Publishing House, New Delhi. 10. A Text Book of Hydrology: Dr. P. JayaramiReddi, Laxmi Publications Pvt. Ltd. New Delhi.

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

PEIII Air and Water Quality Modeling PE-BTC841

Course Code	Course Name
PE-BTC741	Air and Water Quality modeling

Course pre-requisites	EEI, EEII, EVS

Course Objectives

The objectives of this course are

1. Develop models based on the mass-balance approach
2. Predict the impact of the of external waste loading on different environmental matrices
3. Predict and generate future conditions under various loading scenarios or management/intervention action alternatives.

Course Outcomes

Upon successful completion of the course, students should be able

3. Understand the idea, methodology and basic tools of environmental modelling
4. Understand the different modelling approaches, their scope and limitations.
5. Understand the fate and transport of pollutants.
6. Become aware of a wide range of applications of modelling in environmental management & decision making.

Course Content

Module No.	*Details*	*Hrs.*
1	**Introduction** Environmental modeling: scope and problem definition, goals and objectives, definition; modeling approaches– deterministic, stochastic and the physical approach; applications of environmental models; the model building process	05
2	**Elementary concepts, laws, theories and processes** The building blocks: extensive and intensive properties, properties relevant to of environmental systems, the material balance approach; the transport processes–advection, diffusion, dispersion, gravitational settling, transport in porous media; the transformation processes–the non-reactive processes, the reactive processes; simulation of transport and transformation processes– introduction, the completely stirred tank reactor, plug flow reactor, mixed flow reactor models; the general material balance models.	10
3	**Water Quality Modeling** Water quality modeling: surface water quality modeling – lakes and impoundments, rivers and streams, estuaries; ground water pollution modeling.	04
4	**Air Quality Modeling**	04

	Air quality modeling: the box model, the Gaussian plume model point sources, line sources, area sources; special topics; Gaussian puff model.	
5	Software's in water quality modeling Understanding WASP, QUAL2E, Modflow	04
6	Software's in air quality modeling Understanding AERMOD, CMAQ, CLINE, HEM	04
7	Case studies Understanding application of models on ground by various research papers	05

Reference Books

References

1. Chapra S.C. (1997) Surface Water-Quality Modelling, McGraw-Hill International Edition.
2. Nirmalkhandan N. (2001) Modeling Tools for Environmental Engineers and Scientists, CRC Press, Boca Raton, Florida.
3. Schnelle K.B. and Dey P.R. (1999) Atmospheric Dispersion Modelling Compliance Guide, McGraw-Hill. 4. Thomann R.V. and Mueller J.A. (1987) Principles of Surface Water Quality Modelling and Control, Harper & Row, New York.
5. Turner D.B. (1994) Workbook of Atmospheric Dispersion Estimates 2nd ed., Ann Arbor, MI, Lewis Publishers.
6. Benarie M.M. (1980) Urban Air Pollution Modelling, Cambridge, MA: The MIT Press.
7. Dunnivant F.M. and Anders E. (2006) A Basic Introduction to Pollutant Fate and Transport, John Wiley & Sons, Inc., New Jersey.
8. Ramaswami A., Milford J.B. and Small M.J. (2005) Integrated Environmental Modelling, John Wiley and Sons, Inc., New Jersey.
9. Schnoor J.L. (1996) Environmental Modeling, John Wiley & Sons, Inc., New York.
10. Zannetti P. (1990) Air Pollution Modelling, Theories, Computational Methods and available Software, Van Nostrand Reinhold, New York.

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

PEIII Pavement Design and Construction PE-BTC761

Course Code	Course Name
PE-BTC761	Pavement Design and Construction
Course Prerequisites	Highway Engineering

Course Objectives
The objectives of this course are 1. To acquire the knowledge about distribution of stress within the pavement 2. To discuss the methods available for design of pavements and utilize the knowledge for implementation. 3. To summarize the importance of strengthening existing pavements and implementation of knowledge for its application.
Course Outcomes
Upon successful completion of the course, students should be able 1. To acquire the knowledge about distribution of stress within the pavement 2. To summarize the methods available for design of pavements and utilize the knowledge for implementation. To understand the importance of strengthening of pavements and implementation of knowledge for its application.

Course Content

Module No.	***Details***	***Hrs.***
1	Pavement structure and functional attributes, factor affecting pavement design, types of wheel loads for highways, Classification of Pavement Design Methods. Stresses in flexible pavements, 1-layer, 2-layer, 3-layers theories, EWLF, ESWL, Stresses in Rigid pavement: wheel load and temperature stresses, combined stresses.	06
2	**Flexible Pavement Design:** i. Testing of subgrade soils.	08

	ii. Empirical methods using no soil strength criteria, GI method, iii. Empirical method based on soil strength criteria: CBR method as specified by IRC: 37: 2001 & IRC: 37: 2012, Fatigue and rutting as a failure criterion, Analysis of flexible Pavement using IITPAVE software.	
3	**Rigid Pavement Design:** Comparison of Flexible and rigid pavements, Design of Rigid Pavement using IRC: 58:2002, IRC: 58:2011, axle load survey.	**3**
4	**Road Construction:** Construction of different layers of Flexible Pavements, size and gradation of aggregate, material selection, Economics in construction. Mix design, concrete strength, size of aggregates, and gradation, and workability, preparation of base form work, mixing, transporting, placing, compaction, finishing and curing, classification of joints. Construction of Roller Compacted concrete pavements, Cell filled Concrete Flexible Pavements.	**5**
5	**Distress Evaluation maintenance and strengthening:** Flexible and rigid pavement distresses, condition and evaluation surveys, present serviceability index, roughness measurement, Benkaleman beam deflections & design of overlays using IRC: 81:1997,	**5**
6	**Highway Drainage:** Surface & Subsurface Drainage, Surface Drainage for Hilly Roads, Design of surface and subsurface drainage system.	**2**
7	**Quality Control:** Quality control test prior to construction and during construction on different pavement layer materials and pavement layers. frequency of tests.	**2**

Term Work
Term work shall comprise of at least 10 assignment shall be submitted as term work.

Text Books

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

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

PEIII Advanced Foundation Engineering PEBTC762

Course Code	Course Name
PE-BTC762	Advanced Foundation Engineering

Course pre-requisites	Soil Mechanics, Foundation Engineering

Course Objectives

In this course, students are taught about the higher level applications of the topics learnt during previous semesters in Soil Mechanics and Foundation Engineering. They will be exposed to the field applications in the form of completion and submission of mini projects.

The objectives of this course are

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

Course Outcomes

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

1. Understand the significance and importance of geotechnical investigations and insist on proper implementation of the same in construction projects.
2. Plan and handle simple site projects based on the field data provided to them.
3. Apply the basics explained in earlier semester to complex and practical problems in design and construction of foundations.
4. Recommend the use of suitable ground improvement techniques where required.

Course Content

Module No.	*Details*	*Hrs.*
1	**<u>Site Exploration and Characterization</u>** Purpose and scope, influence of soil conditions and type of foundation on exploratory programme, project assessment, phasing of site exploration, excavation and boring methods of exploration, types of samplers and their design features, subsurface soundings – static and dynamic methods, planning of subsurface	04

	investigations,as per IS 1892, type and sequence of operations, bore logs, core logs and importance of logging, lateral extent and depth of exploration, interpretation of field and laboratory data.	
2	**Consolidation** Terzaghi's theory of one-d consolidation – derivation of equation (solution in detail need not be covered), estimation of C_c and C_v from laboratory tests, Estimation of P_c by various methods, field consolidation curves, Quasi- preconsolidation and secondary consolidation, practical applications.	08
3	**Stress and Strain Behaviour of Soils** Triaxial test - drained and undrained behaviour of sands and clays, failure criteria in soils - only Mohr - Coulomb's criteria, ideal, plastic and real soil behaviour, shear strength of sands and clays.	04
4	**Estimation of Stresses** Boussinesq's theory, vertical stress due to concentrated load, horizontal and shear stress due to concentrated load, Isobar diagram, vertical stress distribution on horizontal plane, influence diagram, vertical stress distribution on vertical plane, vertical stress due to line load, vertical stress under strip load, maximum shear stress at points under strip loads, vertical stresses under a circular area, vertical stress under a corner of a rectangular area, Newmark's influence charts, Westergaard's theory.	04
5	**Bearing Capacity and Settlement Analysis of Shallow Foundations** Modes of failure, failure criteria, – Terzaghi solutions, Vesic's solutions, IS Code recommendations, assumptions in estimates of ultimate loads, effect of shape, embedment of footing, eccentricity in loading, compressibility (including critical rigidity index), water table. Choice of factor of safety, settlement of foundations on sand – Schmertmann method, Plate load test, evaluation of bearing capacity using standard penetration test, Housel Method	08
6	**Pile Foundations** Use of load tests, Introduction to IS 2911 for estimation of single pile capacity by static and dynamic methods, Group capacity in sand and clay deposits, Separation of skin friction and end-bearing capacity. Settlement of single and group of piles.	05
7	**Ground Improvement** Improvement of deep cohesionless soils and cohesive soils	03

	(including stone columns / band drains), instrumentation – mainly pore pressure gauges and settlement gauges and their applications.	

Term Work

Term work shall comprise of

1. Examination (MCQ) based on above topics
2. Site visit for better understanding various aspects of foundation engineering
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. Murthy, V. N. S. Textbook of Soil Mechanics and Foundation Engineering: Geotechnical Engineering Series. CBS Publishers and Distributors (P) Ltd., 2018.
2. Terzaghi, K., Peck, R. B., and Mesri, G. Soil Mechanics in Engineering Practice. 3rd Edition, Wiley-India, India, 2009.
3. Fang, H. Foundation Engineering Handbook. 2nd Edition, CBS Publishers and Distributors (P) Ltd., 2004.
4. Nayak, N. V. Foundation Design Manual. 7th Edition, Dhanpat Rai Publications, India, 2018.
5. Das, B. Principles of Foundation Engineering. 8th Edition, Cengage India Private Ltd., 2017
6. Relevant journal and conference papers for case studies.
7. Relevant IS codes

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

PEIIIRock Mechanics PE-BTC763

Course Code	Course Name
PE-BTC763	Rock Mechanics

Course pre-requisites	Engineering Geology, Soil Mechanics

Course Objectives

The objectives of this course are

1. Introduce the subject of rock mechanics, explain some theoretical and practical aspects
2. Classify rocks and estimate stresses in rock
3. Discuss problems that arise in rock engineering

Course Outcomes

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

1. Identify and quantify various engineering properties of rock.
2. Analyze their behavior under the application of loads
3. Provide solutions to problems arising during construction in or over rock
4. Apply their understanding of rock mechanics to help in the design of several structures such as tunnels, underground structures and foundations resting on rock.

Course Content

Module No.	*Details*	*Hrs.*
1	Introduction to rock mechanics. Importance of rock mechanics to engineering problems. Rock types and rock structures	04
2	Geological and geophysical investigations, Stereographic plots of joints.	04
3	Classification of rocks – lithological, engineering. Classification of fissures, joints and faults, Engineering properties of rocks. Lab and site measurements	06
4	Definition of stress in rock, simple methods of determining in-situ stresses, induced stresses after excavation	04
5	Ground Response Curves (GRC) and Support Response Curves (SRC). Evaluation of in-situ rock stresses by borehole deformation and flat jack methods. Tunneling by Drill & blast methods Tunnel	08

	boring machine (TBM), NATM.	
6	Problems and remedies in rock engineering such as squeezing and rock-burst, Swelling and water pressure	04
7	Applications of rock mechanics – Tunnels, foundations, underground civic facilities, defense shelters, waste storage	06

Term Work

Term work shall comprise of

1. Examination (MCQ) based on above topics
2. Site visit for better understanding investigations and observing rock cores
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

2. Jaeger, J.C., Cook, N.G.W, Zimmerman, and R.W. Fundamentals of Rock Mechanics. 4th Edition, Wiley-Blackwell, 2007.
3. Jumikis, A. R. Rock Mechanics. Trans Tech Publications, USA, 1983.
4. Look, B. Handbook of Geotechnical Investigation and Design Tables. 2nd Edition, Routledge, UK, 2014
5. Relevant journal and conference papers for case studies.
6. 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

PEIV Structural Dynamics PE-BTC724

Course Code	Course Name
PE-BTC724	Structural Dynamics

Course pre-requisites	Mechanics of Materials

Course Objectives

The objectives of this course are

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

Course Outcomes

At the end of the course the students shall be able to,
1. Distinguish between static and dynamic loads; understand different types of dynamic loads

freedom system for different types of dynamic loads including ground motion in time domain.

dynamic loads including ground motion in time domain.
4. Carry out the dynamic analysis of systems with distributed mass.
5. Understand the frequency domain analysis

Course Content

Module No.	*Details*	*Hrs.*
1	**Introduction:** Introduction to structural dynamics, definition of basic problem in Dynamics, static v/s dynamic loads, different types of dynamic loads.	02
2	**Single degree of Freedom (SDOF) systems:** Un-damped free vibration of SDOF system, natural frequency and period of vibration, damping in structures, Viscous damping and	10

	Coulomb damping, effect of damping on frequency of vibration and amplitude of vibration, logarithmic decrement, computation of damping. Forced vibration, response to harmonic forces, periodic loading, dynamic load factors, and response of structure subjected to general dynamic load, Duhamel's integral, numerical evaluation of dynamic response of SDOF systems subjected to different types of dynamic loads. Distributed mass system idealized as SDOF system, use of Rayleigh's method, response of SDOF system subjected to ground motion.	
3	Use of Fourier Series for periodic forces, introduction to vibration isolation. Concept of Transmissibility. **Introduction to frequency domain analysis**, response of structure in frequency domain subjected to general periodic and non-periodic /impulsive forces of short duration, use of complex frequency response function, Fourier Response Integral, Discrete Fourier Transforms, Fast Fourier Transforms.	03
4	**Generalized Single-Degree of Freedom System:** Generalized properties, assemblages of rigid bodies, systems with distributed mass and elasticity, expressions for generalized system properties. Application to single span beams.	07
5	**Free vibration of Lumped mass multi degree of freedom (MDOF) system:** Coupled and uncoupled systems, direct determination of frequencies of vibration and mode shapes, orthogonality principle, vibration of MDOF systems with initial conditions, approximate methods of determination of natural frequencies of vibration and mode shapes-vector iteration methods, energy methods and use of Lagrange's method in writing equations of motion.	04
6	**Force vibration of Lumped mass multi degree of freedom (MDOF) system:** Decoupling of equations of motion, modal equation of motion, concept of modal mass and modal stiffness, forced vibration of MDOF system, modal analysis, and application to beams and multi	07

	storey frames with rigid girders subjected to lateral dynamic loads.	
7	**Structure with distributed mass system:** Use of partial differential equation, free vibration analysis of single span beams with various boundary conditions, determination of frequencies of vibration and mode shapes, forced vibration of single span beams subjected to the action of specified dynamic loads.	03

Text Books

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

Reference Books

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

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

PEIV Advanced Design of Steel Structures PE-BTC725

Course Code	Course Name
PE-BTC725	Advanced Design of Steel Structures

Course pre-requisites	Design of steel structures

Course Objectives

The objectives of this course are

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

Course Outcomes

Upon successful completion of the course, students should be able

1. To understand the design concept of different types of moment resistant connections
2. To understand the analysis and design concept of round tubular structures
3. To understand the design concept of different type of steel water tank
4. To understand the design concept of lattice tower and steel chimney
5. To understand the design concept of gantry girder
6. Use of various relevant IS codes for designing steel structures

Course Content

Module No.	***Details***	***Hrs.***
1	Moment Resistant Beam End Connections: Design of moment resistant bolted and welded beam end connections.	04
2	Round Tubular Structural Members Properties of steel tubes, design of tension and compression members, design of welded connections, design of flexural members, analysis and design of tubular trusses including purlins	06

	and supports.	
3	Elevated Steel Tanks: Loads acting on tanks including wind and earthquake, design of circular tanks with conical bottom, supporting ring beam, staging for circular tanks including design of columns and base plate.	06
4	Design of rectangular steel tanks including design of staging, columns and base plate	04
5	Gantry Girder: Loads acting on gantry girder. Analysis and design of gantry girder.	06
6	Lattice Tower: Different configurations of lattice towers, loads acting on lattice towers, analysis and design of lattice tower including welded or bolted connections for members.	04
7	Steel Chimney: Forces acting on chimney, design of self-supporting welded chimney and its components including design of base.	06

Text Books

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

Reference Books

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

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

PEIV Prestressed Concrete PE-BTC726

Course Code	Course Name
PE-BTC 726	Prestressed Concrete

Course pre-requisites	ES-BTC302,PC-BTC402,PC-BTC501,PC-BTC604

Course Objectives

The objectives of this course are

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 ofdeflections 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

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

1. To understand the concept of prestressing, its types and methods, and behavior of prestressed structural members
2. To analyse the losses in prestressed sections
3. To analyse and design simple prestressed flexural members
4. To analyse and understand the behavior of prestressed composite sections and indeterminate members
5. To understand the application of IS codal clauses for analysis and design of prestressed structures

Course Content

Module No.	*Details*	*Hrs.*
1	Introduction to basic concepts and general principles of pre-stressed 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 transfer bond, transmission length, end block of post tensioned members.	05
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:

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

PEIV Hydraulic Modelling PE BTC373

Course Code	Course Name
PE-BTC732	Hydraulic Modelling

Course pre-requisites	

Course Objectives		
The main objective of this course is to introduce various concepts which will help in designing hydraulic models.		
Course Outcomes		
At the end of the course students will be able to understand model prototype relationship and basics of physical and digital modelling of hydraulic problems.		
Course Content		
Module No.	***Details***	***Hrs.***
1	**Dimensional analysis:** Similarity mechanics, model laws, distinction between numerical and hydraulic models, classification of hydraulic modelling, materials used in the model, scale effect, design, construction, operation and interpretation of the results.	06
2	**Hydraulic Modelling:** Types of modeling: Physical, numerical, data driven models.	05
3	Gravity dominated models	05
4	Gravity friction models	05
5	Friction dominated models	05
6	Study of open source hydraulic modeling software's	05
7	Applications to various case studies in Hydraulic modelling	05
Reference Books		
P. Novak, V. Guinot, A. Jeffrey and D. E. Reeve (2010): Hydraulic Modelling – an Introduction, Principles, methods andapplications, Spon Press (Taylor and Francis) 270 Madison Avenue , New York, NY 10016, USA		

PEIV Sustainable Engineering & Technology

Course Code	Course Name
PE-BTC742	Sustainable Engineering & Technology

Course pre-requisites	Probability and Statistics, Environmental Science (mandatory course)

Course Outcomes

Upon successful completion of the course, students should be able

1. 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.
2. Have a broader perspective in thinking for sustainable practices by utilizing the engineering knowledge and principles
3. Understand the concepts of life cycle assessment (LCA) along with life cycle inventory (LCI) and life cycle impact assessment (LCIA) including the social and economic dimensions
4. Apply a life cycle assessment methodology to any real world problem.

Course Content

Module No.	***Details***	***Hrs.***
1	Introduction Sustainability concepts and Life Cycle Analysis (LCA), material flow and waste management, importance of sustainability for engineers.	04
2	Risk And Life Cycle Framework Definition- risk, risk assessment, examples and characteristic of environmental problem	06

3	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 LCA - Data Collection And Methodology 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	16

4	Design For Sustainability Environmental design for sustainability: economic, environmental indicators, social performance indicators, sustainable engineering design principles and environmental cost analysis.	05
5	Case Studies Architectural, environmental, transportation, water resources, and other areas	05

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

PEIV Industrial Wastewater Treatment PE-BTC743

Course Code	Course Name
PE-BTC743	Industrial Wastewater Treatment

Course pre-requisites	EE1, EEII

Course Objectives

The objectives of this course are

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

Course Outcomes

Upon successful completion of the course, students should be able

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

Course Content

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

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

Text Books

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

Sr. No.	Examination	Module
1	T-I	1, 2 ,3
2	T-II	4, 5,6 (2 industries)
3	End Sem	1 to 7

PEIV Engineering Risk and Uncertainty PE-BTC751

Course Code	Course Name
PE-BTC751	Engineering Risk and Uncertainty

Course pre-requisites	

Course Objectives
The main objectives of the course are 1.To describe the concept of risk and uncertainty. 2. To understand basics of Risk management. 3. To summarize the students about various techniques of mathematical models based on stochastic and statistical methods for risk management.

Course Outcomes
At the end of the course the students shall be able to 1. An idea of how risk management and analysis is done on modern construction projects. 2.To apply the mathematical models based on stochastic and statistical methods for risk management. 3. To develop risk mitigation Plan in construction projects.

Course Content

Module No.	*Details*	*Hrs.*
1	Basic concept of Risk & Uncertainty, Risk in Civil engineering and mainly in construction,Difference between Risk and Uncertainty, Types of risks in constructions. Importance of Risk, Steps in Risk Management.Integrated risk management.	5
2	Performance Measures, Scope of risk control during project life cycle. Risk Mitigation – by elimination, reducing, transferring, avoiding, absorbing or pooling. Residual risk, Coverage of risk through various policies, role of insurance in risk management.	6
3	Risk analysis and Management for projects (RAMP) Risk analysis in construction projects, Risk Registers, Risk priority number, Risk identification, and analysis& response measures. Failure effect mode analysis (FEMA)	5
4	Use of mathematical models based on stochastic and statistical methods, Probability Risk Assesment.	4
5	Decision making under Risk & Uncertainty, Sensitivity analysis, Break even analysis, Scenario analysis and Decision tree analysis. Risk profile method, Certainly equivalent method; risk adjusted discount rate method, certainity index method,three point estimated method.	6
6	Concept of simulation, Monte Carlo simulation, Use of simulation in risk ide ntification, analysis and mitigation.	5
7	Introduction to PPP projects and Hybrid Annuity model, Typical risks in road construction projects, Risks in PPP contract. Mitigation of Risks in roads and PPP contract.	5

Text Books
1. Project Risk Analysis And Management Guide By John Bartlett APM Publishing Limited, 2004 2nd Edition 2. Industrial Engineering And Management Of Manufacturing Systems.- Dr. Surendra Kumar Satya Prakashan 3. RAMP Handbook By Institution Of Civil Engineers And The Faculty And Institute Of Actuaries Thomas Telford Publishing, London. 4. Construction Engineering And Management – Seetharaman. 5. Projects Planning Analysis Selection Implementation And Review – Prasanna Chandra. 6. Construction Project Management, K. K. Chitkara, Tata Mcgraw Hill Publ. 7. Construction Management Practice, Dr.V.K.Raina, Shroff Publ. 8. Projects, Prasanna Chandra, Tata Mcgraw Hill Publ 9. 9.Reliability Principles and practices-Calabro-McGraw Hill Book Company, 1963 10. Shrivastava, Shenoy & Sharma, Quantitative Techniques for Managerial Decisions, Wiley, 1989. 11. Applied Statistics for Civil and Environmental Engineers by Kottegoda.- Stratford Books

Sr. No.	Examination	Module
1	T-I	1, 2
2	T-II	3, 4
3	End Sem	1 to 6

PE IV Infrastructure Planning and Management PE-BTC752

Course Code	Course Name
PE-BTC752	Infrastructure Planning and Management

Course pre-requisites	

Course Objectives

The objectives of this course are

1. To describe the role of Infrastructure in the development of nation.
2. To understand basics of infrastructure planning and management.
3. To summarize the students about emerging trends in infrastructure.

Course Outcomes

Upon successful completion of the course, students should be able

1. To plan and manage the Infrastructure project.
2. To use the various policies for effective implementation of Infrastructure projects.

Course Content

Module No.	*Details*	*Hrs.*
1	Introduction: Definition of basic terminologies, role of infrastructure in economic development, types of infrastructure, measurement of infrastructure capacity, bases for quantification of demand and supply of various types of infrastructure, Indian scenario in respect of adequacy and quality.	04
2	Infrastructure Planning: Goals and objectives of infrastructure planning; Identification and quantification of the casual factors influencing the demand for infrastructure; review and application of techniques to estimate supply and demand for infrastructure	05
3	Infrastructure Planning: use of econometric, social and land use indicators and models to forecast the demand and level of service of infrastructure and its impact on land use; critical review of the relevant forecasting techniques	05
4	Infrastructure Planning: infrastructure planning to identify and prioritize preferred areas for development; Integration of strategic planning for infrastructure at urban, regional and national levels; case studies in infrastructure planning.	05
5	Infrastructure Management: Concepts, Common aspects of urban and rural infrastructure management systems; pavement and bridge management systems	05
6	Integrated infrastructure management, Case studies; Emerging trends in infrastructure, Overview of Public-Private Participation in infrastructure projects, Understanding stakeholders' concerns, regulatory framework, risk management in infrastructure projects,	06
7	Public policy for infrastructure: Sectoral Overview Highways, railways, waterways, airports, urban and rural infrastructure: roads, housing, water supply, sanitation – case study Example.	06

Text Books
1. Project Preparation, Appraisal, Budgeting, and Implementation: Prasanna Chandra, Tata McGraw Hill. 2. Project Management: K Nagrajan, New Age International Publishers.7th Edition, 2015. 3. Construction Engineering and Management of Projects (for Infrastructure and Civil works),S. C.Sharma, Khanna Publishers.2nd Edition 2011.

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

PEIV Risk and Value Management PE BTC753

Course Code	Course Name
PE-BTC753	Risk and Value Management
Course Pre Requisites	Construction Engineering and Management

Course Objectives

The main objectives of the course are

1. To understand the process of risk management in construction.
2. To identify the tools and techniques for risk assessment.
3. To know different methods of valuation
4. To understand the process of value management in construction along with different techniques for the evaluation of engineering alternatives

Course Outcomes

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

1. Describe the risk management process in construction project.
2. Apply different methods of valuation for land and building.
3. Apply the value management process in case of construction project.
   Compare different engineering alternatives for project selection

Course Content

Module No.	*Details*	*Hrs.*
1	Concept of Risk & Uncertainty, Types of risks in construction projects. Process of risk management- identification of risk, assessment, risk	5
2	Scope of risk control during project life cycle. Residual risk, contingency risk, Role of insurance in risk management, Integrated risk management. Risk Registers Risk Registers, Risk priority number,	5
3	Decision making under Risk & Uncertainty, Risk identification tools and techniques, qualitative risk assessment and quantitative risk assessment, Sensitivity analysis, Break even analysis, Scenario analysis and Decision tree analysis, Use of simulation in risk identification, analysis and mitigation. Failure Mode and Effect Analysis (FMEA), Failure Mode Effect and Criticality Analysis (FMECA).	6
4	Introduction to PPP projects and Hybrid Annuity model, Typical risks in road construction projects, Risks in PPP contract. Mitigation of Risks in roads and PPP contract.	3
5	Valuation- Purpose of valuation, factors affecting value of an asset, types of value, concept of freehold and leasehold property, estimation versus	7
6	Value Engineering- Meaning of value, difference between valuation and value engineering, factor contributing to value such as aesthetic, ergonomic, technical, and economic. Reasons for unnecessary costs, basic and secondary functions, FAST diagram, Element of value engineering Job Plan	5

7	Time value of money, different techniques for adjusting time value of money, life cycle costing, different techniques of economic appraisal of projects such as payback period, Rate of return method, NPV, BCR, IRR. Evaluation of Engineering alternatives with Present worth method, Future worth method, equivalent annual worth comparison method and DCF method	5

Recommended Books

1. Project Management, R Panneerselvam, & P. Senthilkumar, PHI Learning Pvt. Ltd. 2013, third edition.
2. Engineering Economics and Costing-by Sasmita Mishra, PHI Learning Pvt. Ltd. 2013, second edition.
3. Managing Risk In construction Projects-By N. J. Smith, T Merna, P Jobling, Blackwell publishing 2006, Second Edition.
4. Value & Risk Management A guide To Best Practice- M. F. Dallas, Blackwell publishing 2006, Second Edition.
5. Sustainable Value Management for Construction Projects- A. E. Oke, C.O. Aigbavboa Springer 2017.
6. Project Risk Analysis And Management Guide By John Bartlett APM Publishing Limited, 2004 2nd Edition
7. RAMP Handbook By Institution Of Civil Engineers And The Faculty And Institute Of Actuaries Thomas Telford Publishing, London.
8. Contemporary Project Management, Timothy J. Kloppenborg | Vittal S. Anantatmula | Kathryn Wells, Cengage Publishers, 2019.
9. An Introduction to Management Science: Quantitative Approaches to Decision Making,
10. Projects Planning Analysis Selection Implementation And Review – Prasanna Chandra.
11. Construction Project Management, K. K. Chitkara, Tata Mcgraw Hill Publ.
12. Projects, Prasanna Chandra, Tata Mcgraw Hill Publ
13. Reliability Principles and practices-Calabro-McGraw Hill Book Company, 1963
14. Shrivastava, Shenoy & Sharma, Quantitative Techniques for Managerial Decisions,Wiley, 1989.
15. Applied Statistics for Civil and Environmental Engineers by Kottegoda.- Stratfor Books
16. IS 15883 (Part 8):2015-Construction Project Management Guidelines- Risk Management.
17. An Introduction to Management Science: Quantitative Approaches to Decision Making, David R. Anderson | Dennis J. Sweeney | Thomas A. Williams | Jeffrey D. Camm | James J Cochran, Cengage Publishers,15th edition 2019.
18. Statistics for Management and Economics, Gerald Keller | Gunjan Malhotra Cengage Publishers,11th edition, 2018.

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

OEII Economic policies of India OE-BTC711

Course Code	Course Name
OE-BTC711	Economic policies of India

Course pre-requisites	

Course Objectives

The objectives of this course are

1. To make Civil Engineering students aware about the economic policy of India to become a good project manager.

Course Outcomes

Upon successful completion of the course, students should be able

1. Civil Engineering students will gain knowledge about the economic policy of India and financial management.
2. Students will be able to understand the role of economics and policies in construction sector.

Course Content

Module No.	*Details*	*Hrs.*
1	Introduction: Brief introduction about RBI, NITI Aayog, Economic planning, Ministry of Finance, Indian federal system.	03
2	Economic policies of India: Industrial Policy, Trade Policy, Monetary Policy, Fiscal Policy, Indian Agricultural Policy, National Agricultural Policy, Industrial Policies, International Trade Policy, Exchange Rate Management Policy, and EXIM Policy.	06
3	Policies designed to create economic growth: Policies related to development economics, Government policies on water conservation and water resources planning and management, Disaster management.	06
4	Policies dealing with the redistribution of income, property and/or wealth.	05
5	Regulatory policy, anti-trust policy, industrial policy and technology-based economic development policy.	06
6	Macroeconomic stabilization policy: Stabilization policy,money supply, inflation, Monitory policies, Money in circulation, interest rates.	06
7	Case studies: Economic policies of India and Construction sector.	04

Text Books

1. https://www.rbi.org.in/
2. http://www.niti.gov.in/
3. https://dea.gov.in/

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

OEII Entrepreneurship, Innovation and Design thinking

Course Code	Course Name
OE-BTC712	Entrepreneurship, Innovation and Design thinking

Course pre-requisites	

Course Objectives

Enable graduates to:
1. Innovate based on needs.
2. Write and execute a business plan.
3. Pitch for a start up.

Course Outcomes

At the end of the course the student will be able to:
1. Appreciate the community nature of many basic needs, user and market characteristics, delivery and scaling up considerations, and the role of partnerships and policies.
2. Understand the implications of different social, economic & cultural contexts for innovation and design of products, businesses and services
3. Familiarize with key concepts in design and innovation for impact, including various elements of the innovation cycle going all the way from need identification to deployment.

Course Content

Module No.	*Details*	*No of lectures*
SECTION 1. - Innovation		
1	Understanding Innovation Curve Identifying opportunities for innovation	04
2	Understanding concepts – Prototyping, Minimum Viable Product (MVP), validating with early adopters Bring forth ideas to life using prototypes to test with real users and identify promising solutions to implement	06
SECTION 2. - Design Thinking		
3	Introduction to human-centered Design - Create innovative solutions to real-world challenges, Appreciating User Needs & Social Context Conduct user interviews and synthesize learning to uncover insights	04
4	Design thinking models;Integration of design and technology for impact perspective; Understanding minimum value proposition Case Studies Sanitation, Education, Health, Food, Insurance and finance technology	08
SECTION 3. - Entrepreneurship		
5	Immersive Learning Exercises for an entrepreneurial venture Concepts of ideation and experimentation, problem validation and	06

	hypothesis testing, prototype creation and viability	
6	Quick Introduction to key concepts – Cost, Revenues, Profit, cash flow, funding/investments, Business Model types – B2C, B2B, B2B2BC, and importance of knowing what business you are in.	03
7	Writing a business plan; Making pitch to investors And Launching a start up	06

Quick Mandatory Reads

The Lean Startup: How Today's Entrepreneurs Use Continuous Innovation to Create Radically Successful Businesses, Eric Reis, 2011Crown Business Publishing.

Zero to One: Notes on Startups, or How to Build the Future, Peter Theil with Blake Masters, 2014, Crown Business Publishing.

The McKinsey Way Hardcover – 1999, Ethan Raisel, Mc Graw Hill Publication.

References

1. Innovation and Entrepreneurship by Peter F. Drucker (Special Indian Edition). Routledge.
2. Entrepreneurship Development by S.S. Khanka. S. Chand Publishers.
3. Design Thinking for Strategic Innovation: What They Can't Teach You at Business or Design School, 2013, Wiley Publications.
4. Change by Design: How Design Thinking Transforms Organizations and Inspires Innovation, 2009.

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

OEII Disaster Management and Preparedness

Course Code	Course Name
OE-BTC713	Disaster Management And Preparedness

Course pre-requisites	Environmental Science (mandatory course), Surveying and Geomatics

Course Outcomes
Upon successful completion of the course, students should be able 1. Understanding categories of disasters / hazards 2. Analysing relationship between development and disasters 3. Applying disaster/hazard management concepts and ideas and realization of the responsibilities to society 4. Using various spatial tools and technologies for analysing the disaster/hazard 5. Analysing methods to assess risk, vulnerability and exposure of each disaster / hazard

Course Content

Module No.	*Details*	*Hrs.*
1	**Introduction** Concepts and definitions: disaster, hazard, vulnerability, risk, severity, frequency and details, capacity, impact, prevention, mitigation **Disasters –** Disasters classification; natural disasters (floods, drought, avalanches, cyclones, volcanoes, earthquakes, tsunami, landslides, coastal erosion, soil erosion, forest fires etc.); manmade disasters (industrial pollution, artificial flooding in urban areas, flash floods, cloud burst, nuclear radiation, chemical spills, transportation accidents, terrorist strikes, etc.); Disasters in global context, hazard and vulnerability profile of India, mountain and coastal areas, ecological fragility, recent case studies	08
2	**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
3	**Disaster Risk Reduction (DRR) –** Disaster management cycle – its phases; prevention – significance of preventive action and measures, 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);	10

	Roles and responsibilities of government, community, local institutions, NGOs and other stakeholders; Policies and legislation for disaster risk reduction, DRR programmes in India and the activities of National Disaster Management Authority.	
4	**Disasters, Environment and Development –** Factors affecting vulnerability such as impact of developmental projects and environmental modifications (including of dams, land use changes, urbanization etc.) – case studies, sustainable and environmental friendly recovery; reconstruction and development methods.	08
5	**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 - use of geoinformatics for HVRA	05

Text Books
1. Singh B.K., 2008, Handbook of Disaster Management: Techniques & Guidelines, Rajat Publication. 2. Ghosh G.K., 2006, Disaster Management, APH Publishing Corporation
Reference Books
1. http://ndma.gov.in/ (Home page of National Disaster Management Authority) 2. http://www.ndmindia.nic.in/ (National Disaster management in India, Ministry of Home Affairs). 3. Pradeep Sahni, 2004, Disaster Risk Reduction in South Asia, Prentice Hall.

OEII Engineering System and Development OEBTC714

Course Code	Course Name
OE-BTC714	Engineering System and Development

Course pre-requisites	

Course Objectives

Objectives of the course is:

(i) to introduce the basic principles of engineering for a developing society,
(ii) to develop an ability to formulate problem, analyze, solve and report to the stakeholders, and
(iii) to practice the ability to design, conduct and report field-work in a particular discipline of engineering contributing to the development.

Course Outcomes

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

(i) understand the basic principles of engineering for a developing society,

(ii) formulate problem, analyze, solve and report to the stakeholders, and
(iii) design, conduct and report field-work in engineering contributing to the development of the society.

Course Content

Module No.	*Details*	*Hrs.*
1	Module 1. Engineer and Society: Basics of Engineering Profession, engineering services, understanding the values of equity, efficiency and sustainability.	5
2	Module 2. The Engineer as a change agent: Interdisciplinary, the need for design and synthesis	5
3	Module 3. Development Indices: Human Development Index (HDI) and Organization for Economic Co-operation and Development (OECD) indices, The data needed to compute these, Core values of equity, efficiency and sustainability, Paradigms of development.	7
4	Module 4: Role of Engineer as a change agent: Understanding Rural and Urban divide and its economy, Wholesale vs. Retail markets, the role of knowledge, practices, science and technology.	
5	Module 5: A Sectoral Engineering System. Example: Drinking water, Irrigation, Electricity, Diesel pumps, non-conventional energy, solar system, community services, water pipe networking, education, health services, road networking, road development, drainage system, energy audit, telecommunication, small scale	

	industries, agricultural sector, effect of seasonal variation on development, understanding service and manufacturing sector, understanding local and global scenario, any other as per engineering sector (Civil, Mechanical, Electrical, Computer, Agricultural, Health etc.)	
6	Module 6: Project through case studies (Rural/Urban): Framing the project, Understanding the demand, needs analysis, Studying the options available, measurement of social and economic parameters as inputs, The activities and the analysis, picking case-study, analyzing, solving and reporting solutions to the stakeholders.	

Text Books
References: https://unfoundation.org http://www.undp.org http://hdr.undp.org http://www.oecd.org http://unnatbharatabhiyan.gov.in http://www.ctara.iitb.ac.in https://sustainabledevelopment.un.org

Project Stage I PROJ-BTC751

Course Code	Course Name
PROJ-BTC751	Project Stage-1
Course Pre-Requisites	Course pre-requisites: Recommended – all courses till semester VI

Course Objectives

Objectives of the course is:

1. Apply knowledge of principles of engineering for a developing society,
2. To be able to do literature survey and be able to put it ethically towards solving an engineering prob lem
3. to develop an ability to empathize and formulate problem and analyze it

Course Outcomes

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

1. integrate the knowledge of the fundamentals of subjects to search the related literature and devise sol ution
2. use knowledge for formulation / fabrication of the desired project
3. analyze the available resources and to select most appropriate one
4. apply principles of ethics and standards, skill of presentation and communication techniques

Course Content

Module No.	***Description***	***Hrs.***
1	Student shall study the topic of project work in terms of data collection, ana lysis, and inferencing. The student shall prepare an interim report and shall present a seminar on the work done at the end of semester. There would be one or more evaluation throughout the semester by commit tee of Faculty members	2+6(Self study)

PC-BTC751 – Design of RCC Structures -Lab

Course Code	Course Name
PC-BTC751	Design of RCC Structures -Lab

Course pre-requisites	Design of RCC elements, Design of concrete structures, Engineering drawing

Course Objectives

The objectives of this course are

1. To develop clear understanding of concepts, and practical knowledge of modern Civil Engineering techniques for design of RCC structures and the structural drawings for the same.
2. Use of various relevant IS codes for designing RCC structures.

Course Outcomes

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

1. To design structural members buildings, water tanks and retaining walls
2. To understand the application of loads and design guidelines for RCC design as per relevant IS codes
3. To prepare detailed drawings ready for construction.

Course Content

1.	Group project on design and drawing of G+4 residential/commercial/industrial building : • Developing architectural pan • Use of relevant IS codes (IS 875 – Parts I and II, IS 456-2000) for obtaining dead and live loads • Design of roof and floor slabs • Design of floor level and plinth beams • Design of columns • Design of footings • Design of staircase • Preparing hand sketched GFC drawings for the designs
2.	Design of cantilever retaining wall. Preparing hand sketched GFC drawings for the designs
3.	Design of counterfort retaining wall. Preparing hand sketched GFC drawings for the designs
4.	Design of rectangular water tank resting on ground using IS code co-efficients. Preparing hand sketched GFC drawings for the designs

Text books And References

1. Ashok K. Jain (1993), “Reinforced Concrete: Limit State Design”, Nem Chand & Brothers, ISBN 8185240531, 844 pages
2. Dr. H. J. Shah, (2008),” Reinforced Concrete, Volume 2”, Charotar Publishing

House Pt. Limited, ISBN 8185594732, 424 pages
3. S N Sinha, (2002)," Reinforced Concrete Design, Second Revised Edition", Tata McGraw-Hill Education, ISBN 0070473323, 705 pages
4. Karve & Shah, (2011), "Illustrated Design of Reinforced concrete Buildings", mihailkoprivchin-3758, 502 pages
5. Relevant I.S. codes and design aids
6. P.C. Vargese (2007) Advance reinforced concrete design, PHI Learning.
7. B.C. Punmia, Ashok Kumar Jain and Arunkumar Jain (2009), Limit State Design of Reinforce Concrete.

VA Environmental Impact Assessment and Management VA-BTC772

Course Code	Course Name
VAC-BTC772	Environmental Impact Assessment and Management

Course pre-requisites	EVS

Course Objectives
The objectives of this course are 1. Enable graduates to identify attributes for EIA 2. Enable graduates to prepare EIA reports 3. Enable graduates to formulate Environmental Management Plans
Course Outcomes
Upon successful completion of the course, students should be able 1. Identify environmental attributes for the EIA study 2. Identify methodology and prepare EIA reports 3. Specify methods for prediction of the impacts 4. Formulate environmental management plans
Course Content

Module No.	***Details***	***Hrs.***
1	Introduction: The Need for EIA, Indian Policies Requiring EIA, The EIA Cycle and Procedures, Screening, Scoping, Baseline Data, Impact Prediction, Assessment of Alternatives, Delineation of Mitigation Measure and EIA Report, Public Hearing, Decision Making, Monitoring the Clearance Conditions, Components of EIA, Roles in the EIA Process. Government of India Ministry of Environment and Forest Notification (2000), List of projects requiring Environmental clearance, Application form, Composition of Expert Committee, Ecological sensitive places, International agreements.	04
2	Identifying The Key Issues: Key Elements of an Initial Project Description and Scoping, Project Location(s), Land Use Impacts, Consideration of Alternatives, Process selection: Construction Phase, Input Requirements, Wastes and Emissions, Air Emissions, Liquid Effluents, Solid Wastes, Risks to Environment and Human, Health, Socio-Economic Impacts, Ecological Impacts, Global	04

	Environmental Issues.	
3	EIA Methodologies: Criteria for the selection of EIA methodology, impact identification, impact measurement, impact interpretation & Evaluation, impact communication, Methods-Adhoc methods, Checklists methods, Matrices methods, Networks methods, Overlays methods, Environmental index using factor analysis, Cost/benefit analysis, Predictive or Simulation methods. Rapid assessment of Pollution sources method, predictive models for impact assessment, Applications for RS and GIS.	04
4	Reviewing The EIA Report: Scope, Baseline Conditions, Site and Process alternatives, Public hearing. Construction Stage Impacts, Project Resource Requirements and Related Impacts, Prediction of Environmental Media Quality, Socio-economic Impacts, Ecological Impacts, Occupational Health Impact, Major Hazard/ Risk Assessment, Impact on Transport System, Integrated Impact Assessment.	04
5	Review of EMP And Monitoring: Environmental Management Plan, Identification of Significant or Unacceptable Impacts Requiring Mitigation, Mitigation Plans and Relief & Rehabilitation, Stipulating the Conditions, what should be monitored? Monitoring Methods, who should monitor? Pre-Appraisal and Appraisal.	04
6	Case Studies: Preparation of EIA for developmental projects-Factors to be considered in making assessment decisions, Water Resources Project, Pharmaceutical industry, thermal plant, Nuclear fuel complex, Highway project, Sewage treatment plant, Municipal Solid waste processing plant, Tannery industry.	08
7	ISO 14001	02

Term Work

Term work shall comprise of

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

Audit will be granted on submitting the assignments and case studies

Text Books

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

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

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

VA Conventional and Non-conventional materials in Highway subgrade

VABTC773

Course Code	Course Name
VAC-BTC773	Conventional and non conventional materials in Highway subgrade

Course pre-requisites	Highway Engineering

Course Objectives

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

Course Outcomes

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

1. Learn how to conduct static and cyclic triaxial test & how to use these data in pavement design. How to conduct static & cyclic plate bearing test, CBR test in field & lab.
2. Learn about different ground improvement technique, use of different stabilizers like, lime, fly ash, fibres in highway subgrade

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.	10
2	Test on subgrade soils: Static and cyclic triaxial test on subgrade soils, resilient deformation, Resilient strain, resilient modulus. CBR test, effect of lateral confinement on CBR and E – value of Subgrade soil. Static and cyclic plate load test, estimation of modulus of subgrade reaction, correction for plate size, correction for worst moisture content	06
3	Ground Improvement Technique: Different method of soil stabilization, use of geo- textile, geogrid and fibres, lime, fly ash in 3 highway subgrade. Vertical sand drain: design criteria, construction 08 and uses.	08

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

Bharatiya Vidya Bhavan's

SARDAR PATEL COLLEGE OF ENGINEERING

(Government Aided Autonomous Institute under Mumbai University) Andheri (W), Mumbai – 400058

COURSE CONTENTS

Regulation 18

Sem. VIII

Year 2024-25 B.Tech. (Civil) Engineering

Academic Year 2024-2025

Course Contents for Regulation 18 for Sem-VIII

Engineering Economics Estimation & Costing PC-BTC801

Course Code	**Course Name**
PC-BTC801	Engineering Economics, Estimation & Costing
Course pre-requisites	ES-BTC304, ES-BTC355, PC-BTC307, PC- BTC405 to 407, PC-BTC501 to 506, PC-BTC 602, PC-BTC604

Course Outcomes
Upon successful completion of the course, students should be able to 1. Perform and evaluate present worth, future worth and annual worth of one of more economic alternatives. 2. Carry out and evaluate benefit to cost ratio, perform breakeven and sensitivity analyses on one or more economic alternatives. 3. Apply concepts of depreciation and assess book value of construction equipment 4. Quantify the worth of a structure or road project by evaluating quantities of constituents, derive their cost rates and build up the overall cost of the structure based on technical specifications. 5. Draft a notice inviting tender, understand the bidding process, understand suitability of various contract types, know about major clauses of a contract **https://nptel.ac.in/courses/105104178**

Course Content		
Module No.	***Details***	***Hrs.***
1.	Basic principles and of economics, accounting, finance and economy, basic terminology related to economics and accounting, introduction to micro and macroeconomics, uniqueness of construction economics, role of an engineer, economic decision making, cash flow diagrams, time value of money, equipment cost, equipment life, depreciation, sinking fund, economic management of equipment, present value, future worth, decision making based on economics, private vs. public projects. Benefit to cost ratio, breakeven analysis, sensitivity analysis. **Self-learning:** Demand/Supply – elasticity, insurance requirements for construction projects	12
2.	Specifications-Types, requirements and importance, drafting of general and detailed specifications.	02
3.	Approximate estimates, Detailed estimates, Measurement of various items, use of relevant IS codes, taking out quantities, long wall-short wall method, centre line method, bar bending schedule, use of computers in quantity surveying, introduction to BIM.	10
4.	Estimation of earthwork for roadwork project, mass haul diagram.	03
5.	Material survey, thumb rules for computation of material, market survey of	03

	basic materials, rate analysis using relevant IS codes, purpose, importance and necessity of the same, factors affecting, task work, daily output from different equipment/ productivity.	
6.	Importance of inviting tenders, preparation of tender documents, tendering process, contract types, relative merits, prequalification, general and special conditions, termination of contracts, extra work and changes, penalty and liquidated charges, settlement of disputes.	03
7.	Introduction to Acts pertaining to-Minimum wages, Workman's compensation (WC), Arbitration and conciliation act.	03

Term Work

Term work shall comprise of assignments related to:

1. Deriving an approximate estimate for a multi-storeyed building by approximate methods.
2. Detailed estimate for a multi-storeyed structure with the required material survey
3. Earthwork estimate for road work project with mass haul diagram
4. Preparation of bar bending schedule.
5. Drafting specifications
6. Rate analysis
7. Calculation of present value, future worth, cash flow diagrams
8. Calculation of depreciation and book value of construction equipment
9. Problems related to economic decision making
10. Breakeven analysis and sensitivity analysis

Text books and reference books

1. Chakraborti, M. (2006). Estimating, Costing, Specification and Valuation in Civil Engineering.
2. Dutta, B. N. (2020). Estimating and Costing in Civil Engineering: Theory and Practice: Including Specifications and Valuation. UBS.
3. Mankiw Gregory N. (2002), Principles of Economics, Thompson Asia
4. Jha, K. N. (2011). Construction project management: Theory and practice. Pearson Education India.
5. Acts Related to Minimum Wages, Workmen’s Compensation, Contracts, and Arbitration
6. Typical PWD Rate Analysis documents.
7. Relevant Indian Standard Specifications.
8. FIDIC Contract Conditions

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

PEV Finite Element Analysis PE-BTC824

Course Code	Course Name
PE-BTC824	Finite Element Analysis

Course pre-requisites	Advanced Solid Mechanics

Course Objectives

The objectives of this course are

1. To understand mathematical modelling and numerical formulation of engineering problems.
2. To learn about concepts of elements and their properties.
3. To understand finite element methods and its application for solution of structural mechanics problems.

Course Outcomes

Upon successful completion of the course, students should be able

1. Formulate the numerical models for engineering problems.
2. Use appropriate element for solution of problem by finite element modeling.

Course Content

Module No.	*Details*	*Hrs.*
1	**Introduction** Mathematical Modeling of Engineering Problems, Types of governing equations, Solution methodologies, numerical modeling, approximate method of analysis – method of point collocation, method of collocation by sub region, method of least squares, Galerkin's method, Rayleigh-Ritz method	05
2	**Finite Element Method:** General Steps in FEM, Direct approach, variational approach, energy approach and weighted residual approach.	06
3	**Finite Elements and Interpolation Functions:** Interpolation functions, one two and three dimensional elements – linear, quadratic, Cubic and Lagrangian Interpolation function, Isoparametric elements, Serendipity elements Shape Functions, Sub-Parametric and super parametric elements,Infinite elements	06
4	**One Dimensional Finite Elements:** Linear spring, Truss element, Space truss, Beam Element. Application to analysis of beams, trusses, plane frames and grids	04

	Multilinear springs, compression and tension only springs.	
5	**Two Dimensional Finite Elements:** Two dimensional stress analysis, CST element for plane stress and plane strain, triangular elements for axi-symmetric analysis, rectangular elements, isoparametric formulation	05
6	**Introduction to Non-Linear Analysis:** Geometric Non-Linearity-Geometric Stiffness of an Axial Element. Stability of Bar- Spring System. General Formulation of Geometrically Non Linear Problem. Geometric Stiffness of Beam-Column and Triangular Elements. Non-Linear Material Behavior. Non- Linear Spring- Elasto Plastic Analysis by FEM- Elasto Plastic Analysis of a truss- Two Dimensional Element Formulations- General Formulation of a physically Non-Linear Problem	05
7	**Introduction to Dynamic Analysis by FEM:** Formulation of Inertial Properties- Lumped Mass vs Consistent Mass Matrices –Condensation and Assembly of Mass Matrices- Formulation of Damping Properties- Free Vibration, Steady – State and Transient Response Analysis for Simple Problems.	05

Text Books

1. Desai Y.M, Eldho T.I, Shah A.H (2011) ,"Finite Element Method With Applications in Engineering ", Pearson Education India , ISBN 8131724646 , 492 pages
2. Krishnamoorthy C.S, (1994), "Finite Element Analysis", Tata McGraw Hill, ISBN 0074622102, 710pages
3. William B. Bickford, (1990),"First Course in The Finite Element Method", ISBN 0256079730, 649 pages
4. Rajshekaran S. (2008), "Finite Element Analysis", Wheeler publishing, ISBN 8121923149, 630 pages

Reference Books

1. O. C. Zienkiewicz,K. Morgan (2000), "Finite Elements and Approximation", Dover publications, ISBN 0486453014, 352 Pages
2. J.N. Reddy, (2008), "Non linear Finite Element Analysis", Oxford University Press, ISBN 0195692039,
3. Cook R.D., Malkus D.S. and Plesha,(2001), "Concepts and Applications of Finite Element Analysis", John Wiley & Sons (Asia) PvtLtd.ISBN0471356050, 736 pages.
4. Weaver W and Johnston P.R., "Finite Element for Structural Analysis", Prentice Hall

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

PEV Advanced Structural Mechanics PE-BTC825

Course Code	Course Name
PE-BTC825	Advanced Structural Mechanics

Course pre-requisites	Mechanics of Materials, Structural Mechanics

Course Objectives

The main objectives of the course:

1. To Introduce the advanced topics of structural mechanics

Course Outcomes

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

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

Course Content

Module No.	*Details*	*Hrs.*
1	Shear Centre for symmetrical and non-symmetrical (about both axis) thin walled open sections, Introduction to thin walled beam theory	06
2	Bending of beams with large initial curvature loaded in their plane of curvature. Application to analysis of hooks, circular closed rings, chain links with straight length and semi-circular ends.	06
3	Beams on elastic foundation: Analysis of beams of infinite length subjected to concentrated force/moment and semi-infinite length subjected to concentrated load/moment at one end. Semi-infinite beam hinged at one end (origin)& subjected to UDL throughout.	06
4	Beams curved in plan: Analysis of beams loaded perpendicular to their own plane, simply supported, fixed and continuous beams.	06
5	Theories of Failure: Maximum principal stress theory, Maximum principal strain theory, Maximum shear stress theory, maximum total strain energy theory.	04

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

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

PEV Water Resources Economics Planning and Management PE-BTC832

Course Code	Course Name
PE-BTC832	Water Resources Economics Planning and Management

Course pre-requisites	

Course Objectives

The main objectives of the course are
1.To study the water resources planning processes
2. To acquire the knowledge of system approach and decision making
3. To understand discounting techniques in water resources engineering

Course Outcomes

At the end of the course the students shall be able to
1. Demonstrate the water resources planning processes
2. Apply the knowledge of system approach during project selection
3. Apply discounting techniques in WRE.

Course Content

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

Reference Books

1. Water Resources Project Economics by Kuiper, (1971), Buttersworth, London.
2. Water Resources System Planning and Management by M.C. Chaturvedi, (1987), Tata McGraw Hill Co. New Delhi.
3. Water Resources Planning and Management by O.J. Helweg., (1985), John Wiley and Sons Inc., USA.

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

PEV Environmental Law and Policy PE-BTC842

Course Code	Course Name
PE-BTC842	Environmental Law and Policy

Course pre-requisites	EEI, EEII, EVS

Course Objectives

The objectives of this course are

1. Learn about the significance of developments in international environmental law and the fundamental principles that have emerged.
2. Expose about the human right to environment and constitutional framework governing environment in select countries, including India
3. Understand judicial response to environmental issues in India

Course Outcomes

Upon successful completion of the course, students should be able

1. Comprehend the statutory and regulatory mechanisms pertaining to environment in India and abroad
2. Know about importance of public participation through Right to information, Public Interest Litigation and other remedies in preserving and protecting environment
3. Understand the emerging environmental issues as ozone depletion, climate change, energy crisis, nuclear issues, waste accumulation, marine ecology etc.and the viability of posited solutions
4. Understand the judicial response.

Course Content

Module No.	*Details*	*Hrs.*
1	**Introduction** Principles of Environmental Law and international environmental law Human rights to environment and constitution of the world Sources of Environmental Law	03
2	Law relating to Water pollution, Regulation of wetlands, Dams and the environment, Coastal regulation laws in India, High seas and outer space, Law relating to Air pollution, Ozone depletion, Climate change law, Law relating to Waste management, Law relating to Plastic and bio- medical waste management, Industrial disasters and the environment, Disaster management and environment, Chemicals and impact on environment	07
4	Regulation of Mining sector in India, Forest conservation laws in India, Wildlife protection	04
5	Biodiversity, Access and benefit sharing, Bio safety and legal issues, Procedural environmental rights, Role of NGO in environmental protection	04

6	Judicial remedies in environmental cases, Responsibility and Liability for environmental harm	04
7	Nuclear energy and law, Armed conflict and the environment, Regional environmental Cooperative framework	04

Reference Books
1. Environmental Law in India: P Leelakrishnan **2.** Environmental Law and Policy in India: Shyam Divan: Armin Rosencranz **3.** Further important articles will be shared as and when the course progresses

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

PEV Valuation and Value Engineering PE-BTC853

Course Code	Course Name
PE-BTC853	Valuation and Value Engineering

Course pre-requisites	Construction Engineering and Management

Course Objectives

The objectives of this course are
1. To describe purpose of valuation and different methods of valuation.
2. To describe concept and importance of Value analysis and management.
3. To summarize life cycle costing for the construction project.

Course Outcomes

Upon successful completion of the course, students should be able
To carry out valuation of building and other structures
2. Demonstrate their capability for Value analysis and management for construction project.
3. Use of Life cycle costing for the construction project.

Course Content

Module No.	*Details*	*Hrs.*
1	Valuation: Purpose of valuation. Meaning of price, cost and value. Factors affecting 'value'. Types of value: only Fair Market Value, Book Value, Salvage/ Scrap Value, Distressed Value and Sentimental Value. Concept of free hold and lease hold property. Estimation versus valuation. Estimation versus valuation, Methods of depreciation & obsolescence, Sinking Fund, Years Purchase.	6
2	Different methods for valuation of assets such as land and building, horticulture, historical places. Methods of Valuation of Building: Rental Basis, Land & Building basis, Direct Comparison Method, Profit based method, Belting of Land, Development method.	6
3	Value: Meaning of value, value analysis, value engineering and value management, basic and secondary functions, factor contributing to value such as aesthetic, ergonomic, technical, economic value. Identifying reasons for unnecessary costs, FAST diagram and its importance.	6
4	Value Analysis: value analysis team; principles of value analysis, elements of a job plan such as orientation, Information, presentation. Implementation, follow up action, benefits of value analysis, various applications; assessing effectiveness of value analysis. Value management for building and other construction works.	6
5	Life cycle costing – Forecasting of Capital as well as operating & maintenance costs, time value, present worth analysis, DCF methods, ROR analysis.	5
6	Valuation Report: Valuation Report, contents, standard formats, Case study of any one Report	2

7	Case study in Value Engineering in building construction sector and Infrastructure sector.	5

Text Books
1. Value Engineering: Analysis And Methodology By Del Younke 2. Industrial Engg. & Mgt., O.P.Khanna, Dhanpat Rai Publ. 3. Industrial Organization & Engg. Economics, T.R.Banga, S.C.Sharma, Khanna Publ. 4. Estimating and Costing in Civil Engineering: Theory and Practice B.N Dutta Published S. Dutta & Company, Lucknow. 5. Estimating, Costing Specifications & valuation in Civil EngineeringBy: M.Chakraborty 6. Estimating and Costing By: Rangwala Published By: Charotar Publishing House, 7. Practical Information for Quantity Surveyors, Property valuers, Architects Engineers and Builders, P.T.Joglekar, Pune Vidyarthi Griha Prakashan, 2008 reprint. 8. Value Management of Construction Projects by John Kelly,Steven Male and Drummond Graham

Sr. No.	Examination	Module
1	T-I	1, 2
2	T-II	3, 4
3	End Sem	1 to 6

PEV Risk & Disaster Management PEBTC854

Course Code	Course Name
PE-BTC854	Risk & Disaster Management

Course pre-requisites	Construction Engineering and Management

Course Objectives

The objectives of this course are

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

Course Outcomes

Upon successful completion of the course, students should be able

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

Course Content

Module No.	*Details*	*Hrs.*
1	Basic concept of Risk, Definition of Risk, Types of risk, Risk &Uncertainty, Failure Mode Effect analysis, Performance Measures, Scope of risk control during project life cycle.	04
2	Decision analysis determination of risk value, formalization of quantitative risk assessment, probabilistic risk assessment	06
3	Risk registers, risk priority number, risk identification analysis and response measures, probability matrix measures	06
4	Risk analysis in construction projects, Sensitivity analysis, Break even analysis, Scenario analysis, Decision trees, Monte-Carlo simulation, Spider diagram, Probability contours	06

5	Nature & Extent of disasters, Industrial Hazards, Development of Disaster Management Plant.	06
6	Role of Organizations in disaster management, Financing relief operations, Legal aspects.	04
7	Hazard Analysis, personnel training, Information management, Emergency operations and facilities, creating awareness, Effective implementation of Disaster Management system.	04

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

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

PEV Transportation Planning and Economics PEBTC863

Course Code	Course Name
PEC-BTC863	Transportation Planning and Economics

Course pre-requisites	Transportation Engineering

Course Objectives

The objectives of this course are

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

Course Outcomes

Upon successful completion of the course, students should be able

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

Course Content

Module No.	***Details***	***Hrs.***
1	Transportation Planning and management: General Travel Forecasting Principles and techniques, Generalized demand, price and capacity relationship applied to travel forecasting, Practical problems of forecasting travel. Introduction to the process of urban transport planning.	06
2	Travel demand forecasting: Trip generation analysis, trip classification, multiple regression analysis, category analysis, trip distribution analysis: introduction, methods of trip distribution,	06

	uniform and average factor method, Frater method, Furness method, the gravity model and its calibration, Intervening and competing opportunities model, linear programming approach to trip distribution. Modal split analysis: introduction, Modal split analysis: Probity analysis, Logit analysis and Discriminant analysis, modal split models with behavioral basis. Traffic Assignment: purpose of traffic assignment, traffic flow characteristics, Assignment techniques: All or nothing assignment, Multiple route assignment, Capacity restraint assignment, Diversion curves. Rout building algorithms.
3	Land-use transport models: Introduction, selection of Land-use transport models, The Lowry model, Grain – Lowry model, Applications of Lowry model.
4	Introduction to advanced/soft computational techniques for transportation planning like Expert Systems, Neural Networks, Fuzzy Logic, Genetic Algorithm, Simulated Annealing, Hybrid systems etc.
5	Transport Economics: Economic evaluation of highway schemes, need for economic evaluation, cost and benefits of transportation projects, basic principles of economic evaluation, Net present value method, benefit/cost ratio method, internal rate of return method. Vehicle operating costs, Value of travel time saving, Accident costs and road pricing.
6	Public Transportation Introduction to various mass transportation systems, Classification of mass transit modes: Street transit or surface transit, Semi rapid transit, Rapid transit or mass rapid transit System, Special transit systems: magnetic levitation, monorails, water borne transport, Automated Guided Transit, Detailed capacity assessment of some selected technologies: Conventional bus on bus bays, Light rail transit, Rail Rapid Transit, Regional rail Transit or Suburban Railway, Suitability of Transit Systems for different travel demand for Indian Cities,
7	Suitability of Transit Systems for Indian Cities of Different Population sizes and forms, Influence of other factors in selection of Mass Transit Systems, Transit System Operations: Introduction, Route Development, stop location and stopping policy, Schedule development, Capacity of transit systems. Future of Public transportation.

Term Work
Term work shall comprise of Mini Project work based on transportation planning or on Public transportation system / Application of transport planning or transport economics software, assignment consisting of at least 15 problems.

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

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

PEVI Earthquake Engineering PE-BTC851

Course Code	Course Name
PE-BTC821	Earthquake Engineering

Course pre-requisites	Engg. Mathematics II, Structural Dynamics

Course Objectives

The objectives of this course are

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

Course Outcomes

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

elements of single degrees of freedom system, concept of damping.

ground motion.

motion characteristics and construct response spectrum for ground motions.

including earthquakes.

13920- 2016

Course Content

Module No.	*Details*	*Hrs.*
1	**Introduction:** Introduction to structural dynamics, definition of basic problem in dynamics, static v/s dynamic loads, different types of dynamic	02

	loads.	
2	**Single degree of Freedom (SDOF) systems:** Undamped vibration of SDOF system, natural frequency and period of vibration, damping in structures, viscous damping and Coulomb damping, effect of damping on frequency of vibration and amplitude of vibration, logarithmic decrement. Forced vibration, response to harmonic forces, periodic loading, dynamic load factors, response of structure subjected to general dynamic load, Duhamel's integral, numerical evaluation of dynamic response of SDOF systems subjected to different types of dynamic loads. Use of Fourier Series for periodic forces, introduction to vibration isolation.	08
3	**MDOF systems:** Direct determination of frequencies and mode shapes, orthogonality principle, approximate methods for determination of frequencies and mode shapes. Forced vibration of MDOF system, modal analysis, applications to beams and multistoried frames with rigid girders subject to lateral dynamic loads including ground motion.	06
4	**Seismological background:** Seismicity of a region, earthquake faults and waves, structure of earth, plate tectonics, elastic-rebound theory of earthquake, intensity and magnitude of earthquake, measurement of ground motion, seismogram, earthquake frequency, local site effects, seismotectonic and Seismicity of India. Effect of near-field and far-field earthquake ground motions.	04
5	**Characterization of ground motion:** Earthquake response spectra, factors influencing response spectra, design response spectra for elastic systems, peak ground acceleration, response spectrum shapes, deformation, pseudo-velocity, pseudo-acceleration response spectra, peak structural response from the response spectrum, response spectrum characteristics, construction site specific response spectra.	05
6	**Deterministic earthquake response:** Types of earthquake excitation, lumped SDOF elastic systems.	04

	translational excitation, lumped MDOF elastic systems, translational excitation, time history analysis, multistoried buildings with symmetric plans, multi storied buildings with un symmetric plans, torsional response of symmetric plan building, distributed - parameter elastic systems, translational excitation, combining maximum modal responses using mean square response of a single mode, SRSS and CQC combination of modal responses.	
7	**I. S. code method of seismic analysis:** Equivalent static method and its limitation, response spectrum method, IS 1893-2016 provisions for seismic analysis of buildings and water towers, seismic evaluation and retrofitting, types of structural systems used in building to resist earthquake loads. Review of damages during past earthquakes and remedial measures, seismic design considerations, allowable ductility demand, ductility capacity, reinforcement detailing for members and joints as per IS 13920-2016.	06 03

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

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

Reference Books

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

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

PEVI Bridge Engineering PE-BTC822

Course Code	Course Name
PE-BTC822	Bridge Engineering

Course pre-requisites	Design of Prestressed concrete structures

Course Objectives

The objectives of this course are

1. To understand Bridge types
2. To learn IRC Loading criteria
3. To understand fundamentals of Bridge design
4. To understand fundamentals of Bridge design
5. To understand the principles of long span bridge design

Course Outcomes

Upon successful completion of the course, students should be able

1. Understand the different loadings on Bridges
2. Understand the components of different types of Bridges
3. Understand the behaviour and suitability of various bridge types
4. Design the various components of bridges

Course Content

Module No.	*Details*	*Hrs.*
1	**Introduction:** Classification and components of bridges, historical perspective, layout and planning, investigations for bridges, choice of type of the bridges, conceptual bridge design, bridge aesthetics. Bridge appurtenances.	05
2	**Loads on bridges:** Loading standards for highway and railway bridges (IRC, IRS)	05
3	**Analysis and design of RC and PSC bridge decks:** Slab culvert bridges, slab-and-beam bridges, load distribution in slabs and beams, bow-string girder bridges, behavior of skew bridge decks	05
4	Behavior, analysis and design of RC and PSC box-girder bridge decks.	05
5	Behavior, analysis and design of steel bridge decks: girder bridges, truss bridges, arch bridges, composite construction	05
6	Design of bearings, substructure and foundations – piers and abutments of different types, shallow and deep foundations –design and constructional a spects	05

7	Modern methods of construction of concrete, steel and composite bridges, their impact on analysis and design, construction stage analysis. Introduction to analysis and design of long span bridges: suspension and cable stayed bridges, balanced cantilever construction, segmental construction.	06

Text Books

1. Raju N. K (1988), "Design of Bridges", Oxford and IBH Publishing, ISBN 8120417410.
2. Victor D. J (2007), "Essentials of Bridge Engineering" , Oxford & IDH, ISBN 8120417178, 495 pages.
3. T.R Jagdeesh& M.A Jayaram,(2009), " Design of Bridge Structures", Prentice Hall India Private Ltd. New Delhi, 360 pages

Reference Books

1. Ponnuswamy S (2008), "Bridge engineering", Tata McGraw-Hill Education, ISBN 0070656959, 747 pages
2. Raina V.K(1994), " ConcreteBridge Practice", Tata McGraw Hill, ISBN 0074623621, 756 pages
3. Tomlinson M.J (2001), "Foundation Design And Construction " , Prentice Hall , ISBN 0130311801, 584 pages
4. FIB recommendations.

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

PEVI Decision and Risk Analysis PE-BTC823

Course Code	Course Name
PE-BTC823	Decision And Risk Analysis

Course pre-requisites	Probability and Statistics

Course Outcomes

Upon successful completion of the course, students should be able

1. Describe and handle different risk and decision theoretic concepts and models
2. Model and evaluate simple decision problems
3. Handle problems with multiple criteria
4. Elicit and handle model parameters

Course Content

Module No.	*Details*	*Hrs.*
1	Science of systems and concept of risk; introduction, systems engineering, concepts of risk assessment and management, applications to Civil Engineering Steps of risk characterization; hazard identification, exposure assessment, vulnerability analysis, risk mapping, example of risk characterization to natural hazards, risk assessment as a distributed process: example of Monte-Carlo techniques in human health and ecological risk assessments	10
2	Uncertainty analysis; introduction, uncertainty taxonomy, sensitivity analysis, probabilistic uncertainty, fuzzy systems, interval analysis, risk-based decision making	07
3	Risk filtering and ranking; introduction, past efforts in risk filtering, methodological framework of filtering and ranking, different ranking methods, case studies	07
4	Multi-objective trade-off analysis; introduction, examples of multiple environmental objectives, surrogate worth trade-off, characterizing a proper non-inferior solution	05
5	Decision-tree analysis; introduction, methodological approach, differences between single and multiple objective decision trees	07

Text Books

1. Robert T. Clemen: Making Hard Decisions: An Introduction to Decision Analysis (Upplaga: 2nd edition), Duxbury,
2. Vijay P. Singh, Sharad K. Jain, and Aditya Tyagi, : Risk and Reliability Analysis: A Handbook for Civil and Environmental Engineers, ASCE Press

Reference Books

1. Griffiths, D.V.: Risk assessment in geotechnical engineering, Colorado School of Mines, USA
2. National Research Council (2009). Science and Decisions: Advancing Risk Assessment, NAS Press
3. Melvin W. Lifson , Edward F. Shaifer: Decision and Risk Analysis for Construction Management (Construction Management and Engineering), John Wiley & Sons Inc (June 1982)

Sr. No.	Examination	Module
1	T-I	1, 2 part
2	T-II	2 part, 3
3	End Sem	1 to 5

PEIV Introduction to Offshore Engineering PE-BTC831

Course Code	Course Name
PE-BTC831	Introduction to Offshore Engineering

Course pre-requisites	

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

Module No.	*Details*	*Hrs.*
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 l GB, 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).

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

PEVI Construction Productivity and Cost Analysis PE-BTC851

Course Code	Course Name
PE-BTC851	Construction Productivity and Cost Analysis

Course pre-requisites	

Course Objectives

The objectives of this course are

1. To describe the Construction productivity
2. To understand basics of construction cost analysis
3. To summarize the students about various techniques of construction productivity and cost analysis.

Course Outcomes

Upon successful completion of the course, students should be able

1. Carry out construction labour and equipment productivity with help of various techniques.
2. Apply the statistical measurements for the analysis of construction cost.

Course Content

Module No.	*Details*	*Hrs.*
1	Definition of Productivity, Impact of productivities on construction duration and costs; Measuring productivities of construction equipment, Staff and Labour and typical benchmarks for the same. Material logistics	06
2	Productivity analysis from Daily Progress Reports; Lean Construction concepts of Value Adding activities, Non-Value Adding Activities and Non-Value Adding but Necessary Activities; Productivity measurements by special Lean Construction-oriented field methods such as Work Sampling, Tact time analysis, Foreman Delay Surveys. Leads-Mass Haul Diagram	06
3	Productivity improvement measures such as Value Stream Mapping, Location-Based management Systems, 5S, good Housekeeping, etc.; use of specialist software for productivity studies.	06
4	Construction Cost Analysis: Introduction to the application of scientific principles to costs and estimates of costs in construction engineering; DSR and Market rates for cost analysis	06
5	Concepts and statistical measurements of the factors involved in direct costs, general overhead costs, cost mark-ups and profits	06
6	Fundamentals of cost recording for construction cost accounts and cost controls. Extension of EVM, Progress review & cost adjustment, Additional cost such as Contingencies, utilities, Land acquisition, Environment and forest clearance.	06

Text Books
1. Construction productivity A Practical Guide for Building and Electrical Contractors Edited by Eddy M. Rojas in Co-operation with ELECTRI International A Title in J. Ross Publishing's Strategic Issues in Construction Series. 2. Construction Productivity Management , Paul O. Olomalaiye ,Ananda K.W. Jayawardane ,Frank C. Harris, November 11, 1998, Prentice Hall. 3. Construction Management & PWD Accounts --- D Lal, S. K. Kataria & Sons, 2012 4. Construction Management and Accounts -- Singh H. Tata McGraw Hill, New Delhi, 1988 5. Construction Management: Planning and finance-- Cormican D. Construction press, London, Feb 2002. 6. Principles of Corporate Finance, Brealey R.A. Tata McGraw Hill, New Delhi, 2003.

Sr. No.	Examination	Module
1	T-I	1, 2
2	T-II	3, 4
3	End Sem	1 to 6

PEVI Contracts Management PE-BTC852

Course Code	Course Name
PE-BTC852	Contracts Management

Course pre-requisites	Construction Engineering and Managemetn

Course Objectives

The objectives of this course are

1. To describe the Overview of Contract Management
2. To understand Performance parameters; Delays, penalties in contract
3. To summarize the students about Contract Administration and Legal Aspects in Contract Management.

Course Outcomes

Upon successful completion of the course, students should be able

1. An idea of Management of Construction Contract
2. A basic ability to measures performance construction contract.
3. An idea how construction projects are administered with respect to contract structures and issues

Course Content

Module No.	*Details*	*Hrs.*
1	Introduction, Importance of Contracts, Overview of Contract Management, Overview of Activities in Contract Management; Planning and People- Resource Management; Types of Contracts. EPC, BOT, BOOT, BOLT,HAM,DBFOT & PPP	06
2	Parties to a Contract; Common contract clauses, Notice to proceed, rights and duties of various parties, notices to be given, Contract Duration and Price.	06
3	Performance parameters; Delays, penalties and liquidated damages; Force Majeure, Suspension and Termination. Changes & variations. Defect liability period. Construction Claims: Extra items and causes of claims. Types of construction claims, documentation. Settlement of claims, extension of time. Notices under contracts; Conventional and Alternative Dispute Resolution methods. Various Acts governing Contracts, Indian Contract Act (1872), Indian Arbitration and Conciliation Act 1996	06
4	Contract Administration, Payments; Contract Management in Various Situations- Contract Management in NCB Works, Contract Management in ICB Works Contracts, Contract of Supply of Goods- Design, Supply and Installation Contracts, FIDIC conditions,	06

5	Contract Management in Consultancy,; Managing Risks and Change; Contract Closure, Post-Implementation Review; Change	06
6	Legal Aspects in Contract Management- Contract Management Legal View, Dispute Resolution, Arbitration, Integrity in Contract Management; Managing Performance- Introduction, Monitoring and Measurement Injunctions and Bailment.	06

Text Books

1. Civil Engineering Contracts and Estimates - B. S. Patil – Universities Press- 2006 Edition, reprinted in 2009.
2. The Indian Contract Act (9 of 1872), 1872- Bare Act- 2006 edition, Professional Book Publishers.
3. The Arbitration and Conciliation Act,(1996), 1996 (26 of 1996)- 2006 Edition, Professional Book Publisher.
4. Law of contract Part I and Part II, Dr. R.K. Bangia- 2005 Edition, Allahabad Law Agency.
5. Arbitration, Conciliation and Alternative Dispute Resolution Systems- Dr. S.R. Myneni- 2004 Edition, reprinted in 2005- Asia Law House Publishers.
6. The Workmen's Compensation Act, 1923 (8 of 1923) Bare Act- 2005- Professional Book Publishers.
7. Standard General Conditions for Domestic Contracts- 2001 Edition- Published by Ministry Of Statistics and Program Implementation, Government of India.
8. FIDIC Document (1999).
9. Dispute Resolution Board foundation manual-www.drbf.org.
10. Law for Engineers, Vandana Bhatt (2018), Procare India.

Sr. No.	Examination	Module
1	T-I	1, 2
2	T-II	3, 4
3	End Sem	1 to 6

PEVI Conventional & Nonconventional Materials in Highway PE-BTC861

Course Code	Course Name
PE-BTC861	Conventional & Nonconventional Materials in Highway

Course pre-requisites	Highway Engineering

Course Objectives

The objectives of this course are

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

Course Outcomes

Upon successful completion of the course, students should be able

1. Learn how to conduct static and cyclic triaxial test & how to use these data in pavement design. How to conduct static & cyclic plate bearing test, CBR test in field & lab.
2. Learn about different ground improvement technique, use of different stabilizers like, lime, fly ash, fibers in highway sub grade

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.	10
2	Test on subgrade soils: Static and cyclic triaxial test on subgrade soils, resilient deformation, Resilient strain, resilient modulus. CBR test, effect of lateral confinement on CBR and E – value of Subgrade soil. Static and cyclic plate load test, estimation of modulus of subgrade reaction, correction for plate size, correction for worst moisturec content.	06

3	Ground Improvement Technique: Different method of soil stabilization, use of geo- textile, geogrid and fibres, lime, fly ash in highway subgrade. Vertical sand drain: design criteria, construction and uses.	08

Text Books

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

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

PEVI Soil Dynamics PE-BTC862

Course Code	Course Name
PE-BTC862	Soil Dynamics

Course pre-requisites	Engineering Mechanics, Soil Mechanics

Course Objectives

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

The objectives of this course are

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

Course Outcomes

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

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

Course Content

Module No.	*Details*	*Hrs.*
1	Vibration of elementary system, Degree of freedom, Analysis of system with one degree of freedom , Spring- mass system, Harmonic vibration, uniform circular motion, natural frequency, free and forced vibrations with and without damping. Types of damping. Importance of resonance	08
2	Wave propagation in elastic rods, in an elastic infinite medium, and in elastic half space, wave generated by surface footing.	04

3	Liquefaction of soils , criterion and factors affecting liquefaction of soil, laboratory and field studies on liquefaction, evaluation of liquefaction potentials, liquefaction of clay	08
4	Field and laboratory tests for evaluation of dynamic properties of soil under vertical vibration coefficient of elastic uniform compression, coefficient of elastic uniform shear, spring constant damping modulus of elasticity typical values of soils	05
5	Principles of machine foundation design, criteria for satisfactory machine foundation, degree of freedom of a block foundation analysis of vertical and sliding vibration of a machine foundation, mass of soil participating in vibration	05
6	Vibration isolation and screening methods, improvement of distressed machine foundation.	03
7	Basics of pseudo-static earth pressure on retaining walls: distribution of pressure, point of application of the resultant. Introduction to pseudo-dynamic and modified pseudo-dynamic theories	03

Term Work

Term work shall comprise of

1. Examination (MCQ) based on above topics
2. Site visit for better understanding various aspects of foundation engineering
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. Prakash, S. Soil Dynamics. McGraw-Hill, USA, 1981.
2. Kramer, S. L. Geotechnical Earthquake Engineering. Pearson-India, India, 2007.
3. Das, B. Principles of Soil Dynamics. 2nd Edition, Cengage, USA, 2014.
4. Barkan, D. D. Dynamics of Bases and Foundations. McGraw-Hill, USA, 1962.
5. Relevant journal and conference papers for case studies.
6. Relevant IS codes

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

PEVI Ground Improvement Techniques PEBTC864

Course Code	Course Name
PE-BTC864	Ground Improvement Techniques

Course pre-requisites	Soil Mechanics

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

Module No.	*Details*	*Hrs.*
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. Foudnation Design Manual. 7th Edition, Dhanpat Rai Publications, India, 2018.
4. Relevant journal and conference papers for case studies.
5. Relevant IS codes.

OEIII Mechanics of Water Waves OE-BTC811

Course Code	Course Name
OE-BTC811	Mechanics of Water Waves

Course pre-requisites	

Course Objectives

The main objectives of the course are

1. To develop an understanding of basic concepts in coastal engineering
2. To help the student develop design concepts in coastal engineering
3. To discuss basic principles of water wave mechanics regarding wave energy and momentum

Course Outcomes

Upon successful completion of the course, students should be able

1. Basic concepts in coastal engineering and construction environment
2. Design concepts in coastal engineering
3. Basic principles of water wave mechanics in analyzing ocean and coastal structures and environment

Course Content

Module No.	*Details*	*Hrs.*
1	**Phenomena, Definitions and Symbols:** Wave Classification, Description of Waves, Definitions and Symbols	04
2	**Governing Equations and Boundary Conditions:** Bottom Boundary Layer, Governing Hydrodynamic Equations, Boundary Conditions, Kinematic Boundary Condition at Bottom, Boundary Conditions at the Free Surface, Boundary Condition Reflecting Constant Wave Form (Periodicity Condition), Summary of Mathematical Problem	06
3	**Wave Theory:** Linear or Airy's (or sinusoidal or small amplitude) wave theory, Non-linear (or finite amplitude) wave theories.	05
4	**Random Waves:** Basic definitions in random data analysis, Wave Spectrum Analysis, Short term and long term Wave Statistics,	05
5	**Wave propagation:** Wave Shoaling, Wave Refraction, Wave Diffraction, Wave Reflection, Effect of Currents, Wave Breaking, Wave Set up and Set down, Wave Runup, Design water depth.	05
6	**Wave Forces:** Wave forces on Shore-Based Structures, wave forces on small diameter and large diameter members, wave forces on entire structures, Spectral and Statistical Analysis of Wave Forces	05
7	Various case studies in ocean and coastal engineering	06

Text Books
1. Deo M C (2013): Waves and Structures http://www.civil.iitb.ac.in/~mcdeo/waves.html 2. Brebbia C.A. and Walker (1978): Dynamic Analysis of offshore structures", Newness butterworth, London, 1978. 3. Sarpakaya T. and Isaacson M.(1981): Mechanics of Wave Forces on Offshore Structures", Van NostrandRainhold, NewYork, 1981. 4. Hallam M.G., Heaf N.J. and Wootton, L.R. (1978): "Dynamics of Marine Structures", CIRIA Publications, Underwater Engg. Group, London, 1978. 5. Graff W.J. (1981): "Introduction to Offshore Structures", Gulf Publishing Co., Houston, Texas, 1981. 6. Clough R.W. and Penzien J. (1992): "Dynamics of Structures", IInd Edition, McGraw hill, 1992. 7. Simiu E. and Scanlan R.H. (1978): wind effects on Structures", Wiley, New York, 1978. 8. Codes of Practices (latest versions) such as API R-2A, bureau Veritas etc. US Army Corps of Engineers (1984) “Shore Protection Manual, v.1,2

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

OE III Human Resources Development and Organizational Behavior
OE-BTC812

Course Code	Course Name
OE-BTC812	Human Resources Development and Organizational behavior

Course pre-requisites	NA

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

Module No.	***Details***	***Hrs.***
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:** 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.	05
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

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.

OEIII Disaster Management and Preparedness OE-BTC814

Course Code	Course Name
OE-BTC814	Disaster Management And Preparedness

Course pre-requisites	Environmental Science (mandatory course), Surveying and Geomatics

Course Outcomes

Upon successful completion of the course, students should be able

1. Understanding categories of disasters / hazards
2. Analysing relationship between development and disasters
3. Applying disaster/hazard management concepts and ideas and realization of the responsibilities to society
4. Using various spatial tools and technologies for analysing the disaster/hazard
5. Analysing methods to assess risk, vulnerability and exposure of each disaster / hazard

Course Content

Module No.	*Details*	*Hrs.*
1	**Introduction** Concepts and definitions: disaster, hazard, vulnerability, risk, severity, frequency and details, capacity, impact, prevention, mitigation **Disasters –** Disasters classification; natural disasters (floods, drought, avalanches, cyclones, volcanoes, earthquakes, tsunami, landslides, coastal erosion, soil erosion, forest fires etc.); manmade disasters (industrial pollution, artificial flooding in urban areas, flash floods, cloud burst, nuclear radiation, chemical spills, transportation accidents, terrorist strikes, etc.); Disasters in global context, hazard and vulnerability profile of India, mountain and coastal areas, ecological fragility, recent case studies	08
2	**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
3	**Disaster Risk Reduction (DRR) –** Disaster management cycle – its phases; prevention – significance of preventive action and measures, 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);	10

	Roles and responsibilities of government, community, local institutions, NGOs and other stakeholders; Policies and legislation for disaster risk reduction, DRR programmes in India and the activities of National Disaster Management Authority.	
4	**Disasters, Environment and Development –** Factors affecting vulnerability such as impact of developmental projects and environmental modifications (including of dams, land use changes, urbanization etc.) – case studies, sustainable and environmental friendly recovery; reconstruction and development methods.	08
5	**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 - use of geoinformatics for HVRA	05

Text Books
1. Singh B.K., 2008, Handbook of Disaster Management: Techniques & Guidelines, Rajat Publication. 2. Ghosh G.K., 2006, Disaster Management, APH Publishing Corporation
Reference Books
1. http://ndma.gov.in/ (Home page of National Disaster Management Authority) 2. http://www.ndmindia.nic.in/ (National Disaster management in India, Ministry of Home Affairs). 3. Pradeep Sahni, 2004, Disaster Risk Reduction in South Asia, Prentice Hall.

OEIII Environmental Impact Assessment OE-BTC815

Course Code	Course Name
OE-BTC815	Environmental Impact Assessment

Course pre-requisites	Environment related course in respective branch

Course Objectives

The objectives of this course are

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

Course Outcomes

Upon successful completion of the course, students should be able

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

Course Content

Module No.	*Details*	*Hrs.*
1	Introduction: The Need for EIA, EIA notification and its emergence ; EIA notification 2006 and its subsequent amendments The EIA Cycle and Procedures, Screening, Scoping, Baseline Data, Impact Prediction, Assessment of Alternatives, Delineation of Mitigation Measure and EIA Report, Public Hearing, Decision Making, Monitoring the Clearance Conditions, Components of EIA, Roles in the List of projects requiring Environmental clearance, Application form, Composition of Expert Committee, Ecological sensitive places, International agreements. , Consent to establish and operate	6
2	Identifying The Key Issues: Key Elements of an Initial Project Description and Scoping, Project Location(s), Land Use Impacts, Consideration of Alternatives, Process selection: Construction Phase, Input Requirements, Wastes and Emissions, Air Emissions, Liquid Effluents, Solid Wastes, Risks to Environment and Human, Health, Socio-Economic Issues and Management, Ecological Impacts including biodiversity, Global Environmental Issues.	6
3	EIA Methodologies: EIA methodology (as per EIA 2006 notification_ impact identification, impact measurement, impact interpretation & Evaluation, impact communication, development of Leopold Matrix, predictive models for impact assessment, Applications for RS and GIS. Role of consultants, NABET, QCI	8

4	Reviewing Contents of EIA Report: Scope, Baseline Conditions, Site and Process alternatives, Public hearing. Construction Stage Impacts, Project Resource Requirements and Related Impacts, Prediction of Environmental Media Quality, Socio-economic Impacts, Ecological Impacts, Occupational Health Impact, Major Hazard/ Risk Assessment, Impact on Transport System, Integrated	6
6	Case Studies: Preparation of EIA for developmental projects-Factors to be considered in making assessment decisions, Water Resources Project, Pharmaceutical industry, thermal plant,.	5
7	Case Studies :Nuclear fuel complex, Highway project, Sewage treatment plant, Municipal Solid waste processing plant, Tannery industry, Construction Projects	5

Text Books

1. Canter, L.W., Environmental Impact Assessment, McGraw Hill Pub. Co., 1997
2. David P. Lawrence, Environmental Impact Assessment: Practical Solutions to Recurrent Problems, John Wiley & Sons, 2003
3. Hosetti, B. B., Kumar A, Eds, Environmental Impact Assessment & Management, Daya Publishing House, 1998
4. UNESCO, Methodological Guidelines for the Integrated Environmental Evaluation of Water Resources Development, UNESCO/UNEP, Paris, 1987
5. Anjaneyulu.Y., and Manickam. V., Environmental Impact Assessment Methodologies, B.S. Publications, Hyderabad, 2007
6. Wathern.P., Environmental Impact Assessment- Theory and Practice, Routledge Publishers, London, 2004
7. EIA notification (2006)
8. EIA manuals of different sectors (available online)

Sr. No.	Examination	Module
1	T-I	1, 2, 3
2	T-II	4, 5, 6 (2 Industries)
3	End Sem	1 to 6

Project Stage II PROJ-BTC851

Course Code	Course Name
PROJ-BTC851	Project Stage-II
Course Pre-Requisites	Course pre-requisites: Recommended – all courses till semester VII

Course Objectives
Objectives of the course is: 4. Apply knowledge of principles of engineering for a developing society, 5. To be able to do literature survey and be able to put it ethically towards solving an engineering problem 6. To develop an ability to empathize and formulate problem and analyze it 7. Apply engineering knowledge to develop a working solution to the empathized problem
Course Outcomes
At the end of the course the student will be able to: 1. Identify and formulate research problem 2. **Design** and develop solution to the problem 3. plan, implement and execute the project 4. Write effective technical report and demonstrate through presentation ethically

Course Content

Module No.	***Description***	***Hrs.***
1	Student shall study the topic of project work in terms of data collection, analysis, and inferencing. The student shall prepare an interim report and shall present a seminar on the work done at the end of semester. There would be one or more evaluation in the form of presentation and report throughout the semester by committee of Faculty members	2+12(Self study)

VA Low Cost Roads (Rural Roads) VABTC873

Course Code	Course Name
VA-BTC873	Low Cost Roads (Rural Roads)

Course pre-requisites	

Course Objectives
1. To acquire the knowledge about the selection of materials for construction and maintenance of Rural Roads. 2. To discuss the Geometric standard of rural roads and utilize the knowledge for implementation. 3. To identify and Implement the suitable technique for construction of rural roads
Course Outcomes
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	06
3	Pavement Materials subgrade soil classification for highway engineering purpose soils as per PRA system, revised PRA system, Grading requirements for aggregate, Grading of aggregate for WBM type bases and subbase construction, material selection for Bituminous Course of Rural Roads. Suitability of aggregate and binding material for construction of rural roads. CBR test, triaxial test on subgrade soils, plate bearing test, modulus of subgrade reaction, E – Value of subgrase soils	05
4	Design and construction of Rural Roads: Flexible pavement, semi rigid pavements, roller compacted concrete pavements; equipment's used	06

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

Text Books

1. Yoder, E.J., John (1975); "Principle of pavement Design" Wiley & sons, Inc., New York.
2. S.K. Khanna, C.E.G. Justo & A. Veeraragavan (2014); "Highway Engineering",10th Edition new Chand & Brothers, Roorkee.
3. Guide lines for the design of flexiable pavement, IRC: 37-2012.
4. Guide lines for strengthening of flexible road pavements using Benkelman beam Deflection Technique. IRC: 81:1997.
5. Concrete Roads: HMSO, Road Research Laboratory, London.

Specification of Rural Roads – 2014, Ministry of Rural Development

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