INVERTIS
UNIVERSITY BAREILLY
Established by Govt. of U.P. u/s 2F of UGC Act, 1956 vide U.P. Act 22 of 2010.

Scheme of Instructions & Syllabi of

Bachelor of Technology

3rd Year

(Civil Engineering)

(With effective from session 2021-22)

[Revised after the inclusion of Skill and Entrepreneurship courseseffective from the session 2022-23]

(Arvind Kumar)

HOD CE

(Dr. R.K.Shukla)

Dean Engineering

(Dr. Y.D.S Arya)

Vice Chancellor

Invertis Institute of Engineering &Technology

INVERTIS UNIVERSITY

Invertis Village, Bareilly-Lucknow NH-24, Bareilly

243123, Uttar Pradesh

INVERTIS UNIVERSITY BAREILLY

Established by Govt. of U.P. u/s 2F of UGC Act, 1956 vide U.P. Act 22 of 2010.

STUDY & EVALUATION SCHEME

B. Tech. Civil Engineering

(w.e.f. academic Session 2022-23)

YEAR III, SEMESTER-V

Sl. No.	Category	Course Code	Course Title / Subject	Hours per week			Evaluation Scheme		Total	Credits
				L	T	P	CA	EE		
THEORY										
1	Professional Core Course	BCE501	Geotechnical Engineering	2	0	0	15	35	50	2
2	Professional Core Course	BCE502	Structural Engineering	2	1	0	25	50	75	3
3	Professional Core Course	BCE503	Transportation Engineering	2	0	0	15	35	50	2
4	Professional Core Course	BCE504	Hydrology & Water Resources Engineering	2	1	0	25	50	75	3
5	Professional Core Course	BCE505	Environmental Engineering	2	0	0	15	35	50	2
6	Professional Core Course	BCE506	Hydraulic Engineering	2	0	0	15	35	50	2
7	Professional Core Course	BCE507	Reinforced Cement Concrete	3	1	0	30	70	100	4
8	Humanities & Social Science including Management Course	HAS501	Professional Practice, Law & Ethics	2	0	0	15	35	50	2
PRACTICAL/DESIGN/DRAWING										
10	Professional Core Course	BCE551	Geotechnical Engineering lab	0	0	2	10	15	25	1
11	Professional Core Course	BCE556	Hydraulic Engineering lab	0	0	2	10	15	25	1
12	Professional Core Course	BCE553	Transportation Engineering Lab	0	0	2	10	15	25	1
13	Professional Core Course	BCE555	Environmental Engineering lab	0	0	2	10	15	25	1
Total				**17**	**3**	**8**	**195**	**405**	**600**	**24**

INVERTIS UNIVERSITY, BAREILLY

STUDY & EVALUATION SCHEME
B. Tech. Civil Engineering
(w.e.f. academic Session 2022-23)
YEAR III, SEMESTER-VI

SI. No.	Credits	Course Code	Course Title / Subject	Hours per week			Evaluation Scheme		Total	Credits
				L	T	P	CA	EE		
THEORY										
1	Professional Core courses	BCE-601	Construction Engineering & Management	2	1	0	25	50	75	3
2	Professional Core courses	BCE-602	Engineering Economics, Estimation & Costing	2	1	0	25	50	75	3
3	Professional Elective Courses	BCE-011 to BCE-014	CE Elective-I	3	0	0	25	50	75	3
4	Professional Elective courses	BCE-021 to BCE-024	CE Elective-II	3	0	0	25	50	75	3
5	Professional Elective courses	BCE-031 to BCE-034	CE Elective-III	3	0	0	25	50	75	3
6	Professional Elective courses	BCE-041 to BCE-044	CE Elective-IV	3	0	0	25	50	75	3
7	Open Elective Course	BOE-011 to BOE-015	Open Elective-I	3	0	0	25	50	75	3
PRACTICAL/DESIGN/DRAWING										
8	Professional Core courses	BCE-651	Engineering Economics, Estimation & Costing lab	0	0	4	20	30	50	2
9	Professional Core courses	BCE-652	Seminar	0	0	2	25	0	25	1
Total				**19**	**2**	**6**	**220**	**380**	**600**	**24**

L-Lecture, T- Tutorial , P- Practical , CA– Continuous Assessment , EE- End Semester Examination

BCE-501	Geotechnical Engineering	2L:0T:0P	2 credits

Pre-requisites: The study of the geological material properties on a construction site are important to allow design and construction of stable structures that: do not settle, deform or crack and. do not fall down due to foundation failure.

Course Objectives:

CO1	To provide a coherent development to the students for the courses in sector of Geotechnical Engineering & Soil Improvement Techniques etc
CO2	To present the foundations of many basic Engineering tools and concepts related Geotechnical Engineering.
CO3	To give an experience in the implementation of Engineering concepts which are applied in field of Geotechnical Engineering
CO4	To involve the application of scientific and technical principles of planning, analysis, design of foundation along with soil improvement techniques.

Module 1:

Introduction–Types of soils, their formation and deposition, Definitions: soil mechanics, soil engineering,Basic Definitions and Relationships-Soil as three-phase system in terms of weight, volume, voids ratio, and porosity. Definitions: moisture content, unit weights, degree of saturation, voids ratio, porosity, specific gravity, mass specific gravity, etc. Relationship between volume weight, voids ratio- moisture content, unit weight- percent air voids, saturation- moisture content, moisture content- specific gravity etc.

Plasticity Characteristics of Soil - Introduction to definitions of: plasticity of soil,consistency limits-liquid limit, plastic limit, shrinkage limit, plasticity, liquidity and consistency indices, flow & toughness indices, definitions of activity and sensitivity. Classification of Soils-Introduction of soil classification: particle size classification, textural classification, unified soil classification system, Indian standard soil classification system. Identification: field identification of soils, general characteristics of soil in different groups.

Module 2:

Permeability of Soil - Darcy's law, validity of Darcy's law. Determination of coefficient of permeability: Laboratory method: constant-head method, falling-head method. Field method: pumping- in test, pumping- out test. Permeability aspects: permeability of stratified soils, factors affecting permeability of soil. Seepage Analysis- Introduction, stream and potential functions, characteristics of flow nets, graphical method to plot flow nets.

Effective Stress Principle - Introduction, effective stress principle, nature of effective stress, effect of water table. Fluctuations of effective stress, effective stress in soils saturated by capillary action, seepage pressure, quick sand condition. Stresses in soils – Introduction, stresses due to point load, line load, strip load, uniformly loaded circular area, rectangular loaded area. Influence factors, Isobars, Boussinesq's equation, Newmark's Influence Chart. Contact pressure under rigid and flexible area, computation of displacements from elastic theory

Module 3:

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

Compaction of Soil- Introduction, theory of compaction, laboratory determination of optimum moisture content and maximum dry density. Compaction in field, compaction specifications and field control

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

Module 4:

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

Soil Exploration- Introduction, methods of site exploration and soil investigation,methods of boring, soil samplers, sampling procedures, trail pits, borings, penetrometer tests,analysis of borehole logs, geophysical and advance soil exploration methods.

report based on borehole log data and various in-situ tests

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

CO1	Students are able to classify soils
CO2	Students are able to know how water affect the soil parameters
CO3	Students are able to understand the compaction, consolidation and shear strength parameters of soil
CO4	Students are able to calculate the compaction, consolidation and shear strength of soil
CO5	Student will solve actual problems of stability with various material
CO6	Studnets are able to apply various theories and predict the risk factor.

Text/Reference Books:

1. Soil Mechanics by Craig R.F., Chapman &Hall
2. Fundamentals of Soil Engineering by Taylor, John Wiley &Sons

3. An Introduction to Geotechnical Engineering, by Holtz R.D. and Kovacs, W.D., PrenticeHall, NJ
4. Principles of Geotechnical Engineering, by Braja M. Das, Cengage Learning
5. Principles of Foundation Engineering, by Braja M. Das, Cengage Learning
6. Essentials of Soil Mechanics and Foundations: Basic Geotechnics by David F.Mc Carthy
7. Soil Mechanics in Engineering Practice by Karl Terzaghi, Ralph B. Peck, andGholamrezaMesri.
8. Geotechnical Engineering: Principles and Practices of Soil Mechanics and FoundationEngineering (Civil and Environmental Engineering) by V.N.S.Murthy.

BCE-502	Structural Engineering	2L:1T:0P	3 credits

Pre-requisites: A broad specialization of civil engineering, structural engineering is all about analyzing, planning, designing and overlooking the construction of large structures.

Course Objectives:

CO1	To impart the principles of elastic structural analysis and behaviour of indeterminate structures.
CO2	To impart knowledge about various methods involved in the analysis of indeterminate structures.
CO3	To apply these methods for analyzing the indeterminate structures to evaluate the response of structures
CO4	To enable the student get a feeling of how real-life structures behave.

Module 1

Introduction- Classification of Structures, stress resultants, degrees of freedom per node, static and Kinematic determinacy. Classification of Pin jointed determinate trusses, analysis of determinate plane and space trusses (compound and complex)..

Planning and Design Process; Materials, Loads, and Design Safety; Behavior and Properties of Concrete and Steel; Wind and Earthquake Loads.

Module 2:

Materials and Structural Design Criteria: Analysis of fixed beams, Continuous beams and simple frames with and without translation of joint, , Slope-Deflection method, Moment Distribution method, Strain Energy method.

Module 3:

Strain Energy of deformable systems, Maxwell's reciprocal & Betti's theorem, Castigliano's first theorem, unit load & Conjugate beam methods.

Analysis of Arches, Linear arch, Eddy's theorem, three hinged parabolic arch, spandrel braced arch, moving load & influence lines. Analysis of cables with concentrated and continuous loadings, Basics of two and three hinged stiffening girders.

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

CO1	Student will be able to analyze Fixed and continuous beams.
CO2	Student will be able to analyze moving loads and will be able to draw influence line diagrams for simply supported beams.
CO3	Student will also be able to analyze columns.
CO4	Student will also be able to analyze three hinge arches and three hinge suspension bridges.

CO5	Students are able to do the analysis of beam by using advance method of analysis.
CO6	Students are able to do analysis of portal frame.

Text/Reference Books:

1. Nilson, A. H. Design of Concrete Structures. 13th edition. McGraw Hill,2004
2.Mc Cormac, J.C., Nelson, J.K. Jr., Structural Steel Design. 3rd edition. PrenticeHall,N.J.,2003.
3. Galambos, T.V., Lin, F.J., Johnston, B.G., Basic Steel Design with LRFD, PrenticeHall,1996
4. Segui, W. T., LRFD Steel Design, 2nd Ed., PWS Publishing,Boston.
5. Salmon, C.G. and Johnson, J.E., Steel Structures: Design and Behavior, 3rd Edition, Harper & Row, Publishers, New York,1990.
6. MacGregor, J. G., Reinforced Concrete: Mechanics and Design, 3rd Edition, PrenticeHall, New Jersey,1997.
7. Nawy, E. G., Reinforced Concrete: A Fundamental Approach, 5th Edition, PrenticeHall, New Jersey.
8. Wang C-K. and Salmon, C. G., Reinforced Concrete Design, 6th Edition, Addison Wesley, NewYork.
9. Nawy, E. G. Prestressed Concrete: A Fundamental Approach, Prentice Hall, NJ,(2003).
10. Related Codes of Practice ofBIS
11. Smith, J. C., Structural Analysis, Harpor and Row, Publishers, NewYork.

BCE-503	Transportation Engineering	2L:0T:0P	2credits

Pre-requisites: It is the transportation engineer's responsibility to plan, design, build, operate and maintain these systems of transport, in such a way as to provide for the safe.

Course Objectives:

CO1	To introduce principles and practice of transportation engineering
CO2	To impart analytical knowledge of highway cross section elements, alignment and intersections.
CO3	To know the principles of geometric design for various transportation facilities.
CO4	To learn about various characteristics, testing methods, and standard specification of different highway materials considering the serviceability requirements of pavements.

Module 1:

Highway development and planning- Classification of roads, road development in India, Current road projects in India; highway alignment and project preparation.

Module 2:

Geometric design of highways-: Introduction; highway cross section elements; sight distance, design of horizontal alignment; design of vertical alignment; design of intersections, problems.

Traffic engineering & control- Traffic Characteristics, traffic engineering studies, traffic flow and capacity, traffic regulation and control; design of road intersections

Module 3:

Pavement materials- Materials used in Highway Construction- Soils, Stone aggregates, bituminous binders, bituminous paving mixes; Portland cement and cement concrete: desirable properties, tests, requirements for different types of pavements. Problems

Module 4:

Design of pavements- Introduction; flexible pavements, factors affecting design and performance; stresses in flexible pavements; design of flexible pavements as per IRC rigid pavements- components and functions; factors affecting design and performance of CC pavements; stresses in rigid pavements; design of concrete pavements as per IRC; problems

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

CO1	To understand the principles of Highway geometrics design as per IRC standards
CO2	To understand Types of pavements & Materials required for highway construction.
CO3	Perform geometric design for the Highway& Basic concept of Pavement design
CO4	Understand basics of alignment, curves and sight distance.
CO5	Apply the construction and maintenance aspects of roads
CO6	To understand the Traffic engineering& different types of traffic control device.

Text/Reference Books:

1. Khanna, S.K., Justo, C.E.G and Veeraragavan, A, 'Highway Engineering', Revised 10th Edition, Nem Chand & Bros,2017

2. Kadiyalai, L.R., ' Traffic Engineering and Transport Planning', Khanna Publishers.

3. Partha Chakraborty, ' Principles Of Transportation Engineering, PHI Learning, AICTE Model Curriculum for Undergraduate degree in Civil Engineering (Engineering & Technology)

4. Fred L. Mannering, Scott S. Washburn, Walter P. Kilareski,' Principles of Highway Engineering and Traffic Analysis', 4th Edition, John Wiley

5. Srinivasa Kumar, R, Textbook of Highway Engineering, Universities Press,2011.

6. Paul H. Wright and Karen K. Dixon, Highway Engineering, 7th Edition, Wiley Student Edition, 2009.

BCE-504	Hydrology and Water Resources Engineering	2L:1T:0P	3 credits

Pre-requisites: Water Resource Engineering is a specific kind of civil engineering that involves the design of new systems and equipment that help manage human water resources.

Course Objectives:

CO1	The knowledge of hydrology is prerequisite for the irrigation engineering and also for design of hydraulic structure. So one of the objective of this course is to impart the knowledge of hydrology that deals with the occurrence, distribution, movement and properties of water on the earth
CO2	To impart the knowledge of various irrigation techniques , requirements of the crops.
CO3	To learn about distribution systems for canal irrigation, design of unlined and lined irrigation canals design sediment problems associated with canal.

Module 1:

Introduction - hydrologic cycle, water-budget equation, history of hydrology, world water balance.

Precipitation - forms of precipitation, characteristics of precipitation in India, measurement of precipitation, rain gauge network, mean precipitation over an area, depth area-duration relationships, maximum intensity/depth-duration-frequency relationship, Probable Maximum Precipitation (PMP).

Module 2:

Abstractions from precipitation - evaporation process, evaporimeters, analytical methods of evaporation estimation, reservoir evaporation and methods for its reduction, evapotranspiration, measurement of evapotranspiration, evapotranspiration equations, potential evapotranspiration over India, actual evapotranspiration, interception, depression storage, infiltration, infiltration capacity, classification of infiltration capacities, infiltration indices.

Module 3:

Runoff - runoff volume, flow duration curve, flow-mass curve, hydrograph, factors affecting runoff hydrograph, components of hydrograph, base flow separation, effective rainfall, unit hydrograph.

Water requirement of crops- Crops and crop seasons in India, cropping pattern, duty and delta; Soil-water relationships, root zone soil water, infiltration, consumptive use, irrigation requirement, frequency of irrigation; Methods of irrigation.

Distribution systems - canal losses. Design of channels-alluvial channels, Kennedy's and Lacey's theory of regime channels. Water logging: causes, effects and remedial measures. Lining of canals, types of lining.

Module 4:

Dams and spillways - embankment dams: Classification, design considerations,estimation and control of seepage, slope protection. Gravity dams: forces on gravity dams,causes of failure, stress analysis, elementary and practical profile.Spillways: components of spillways, types of gates for spillway crests.

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

CO1	Apply the knowledge of hydrology in day to day life and utilize its basics for the measurement of precipitation.
CO2	Define and explain Infiltration, Evaporation and Transpiration and apply its knowledge to measure Infiltration and Interception.
CO3	Utilize the Technique of the Hydrograph to forecast Flood discharge at various duration.
CO4	Apply the statistical technique to analyze the flood occurrence and frequency.
CO5	Discuss Geo- Hydrology term in exploration of ground water potential and to assess it using various techniques.
CO6	Explain the concept of ground water recharge and multipurpose project for water resources.

Text/Reference Books:

1. K Subramanya, Engineering Hydrology, Mc-GrawHill.
2. K N Muthreja, Applied Hydrology, Tata Mc-GrawHill.
3. K Subramanya, Water Resources Engineering through Objective Questions, Tata Mc-GrawHill.
4. G L Asawa, Irrigation Engineering, WileyEastern
5. L W Mays, Water Resources Engineering,Wiley.

BCE-505	Environmental Engineering	2L:0T:0P	2 credits

Pre-requisites: Nil

Course Objectives:

CO1	To impart knowledge of drinking water treatment and distribution in an integrated way, paying attention to the choice of technologies and tools, ranging from low-cost to advanced options.
CO2	To understand principles involved in the design and selection of appropriate unit processes.

Module 1:

Water -Sources of Water, Water quality standards, Water Supply systems, Need for planned water supply schemes; Transmission of water, Distribution system, Various valves used in W/S systems. Building Plumbing-System of plumbing, Pressure reducing valves, various kinds of fixtures and fittings used.

Water Treatment: aeration, sedimentation, coagulation flocculation, filtration, disinfection, advanced treatments like adsorption, ion exchange, membrane processes

Module 2:

Sewage- Domestic and Storm water, Sewage flow variations. Conveyance of sewage- Sewer appurtenances, Sewage and Sullage, Pollution due to improper disposal of sewage, Wastewater treatment, aerobic and anaerobic treatment systems, suspended and attached growth systems, recycling of sewage – quality requirements for various purposes.

Module 3:

Air - Composition and properties of air, Types of air pollutants, Monitoring of air pollutants, Air pollution- Occupational hazards, Urban air pollution automobile pollution, Chemistry of combustion, Automobile engines. Air quality standards, Control measures for Air pollution, construction and limitations

Noise- Basic concept, measurement and various control methods.

Module4:

Solid waste management- Municipal solid waste, Collection, transport, treatment and disposal of MSW. Solid waste from construction activities, biomedical wastes, Effects of solid waste on environment: effects on air, soil, water surface and ground health hazards. Disposal of solid waste-segregation, reduction at source, recovery and recycle. Hazardous waste: Types and nature of hazardous waste.

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

CO1	Explain the concept related to water & its quality, sewage, sewer, storm water, etc in its hydraulic design.
CO2	Classify and Compare the different components of sewer in construction, testing & maintenance of sewers.
CO3	Distinguish the various characteristics of domestic waste water as well as industrial waste water and units of STP .
CO4	Design various units of conventional sewage treatment plant and the regulation of functional planning.
CO5	Examine provisions for rural sanitation and perform functional design of septic tank
CO6	Compare knowledge & effect of air pollution, solid waste in planning for its prevention and control

Text/Reference Books:

1. Introduction to Environmental Engineering and Science by Gilbert Masters, Prentice Hall, New Jersey.

2. Introduction to Environmental Engineering by P. Aarne Vesilind, Susan M. Morgan, Thompson /Brooks/Cole; Second Edition2008.
3. Peavy, H.s, Rowe, D.R, Tchobanoglous, G. Environmental Engineering, Mc-Graw -Hill International Editions, New York1985. 4. Met Calf and Eddy. Wastewater Engineering, Treatment, Disposal and Reuse, Tata McGraw-Hill, New Delhi.
5. Manual on Water Supply and Treatment. Ministry of Urban Development, NewDelhi.
6. Plumbing Engineering. Theory, Design and Practice, S.M. Patil,1999
7. Integrated Solid Waste Management, Tchobanoglous, Theissen& Vigil. McGraw Hill Publication

BCE-506	Hydraulic Engineering	2L:0T:0P	2 credits

Pre-requisites: Fluid Mechanics.

Course Objectives:

CO1	Define the nature of a fluid.
CO2	Show where fluid mechanics concepts are common with those of solid mechanics and indicate some fundamental areas of difference
CO3	Introduce viscosity and show what are Newtonian and non-Newtonian fluids
CO4	The purpose of this course is to learn the Fluid properties and fundamentals of Fluid statics and fluid flow

Module 1:

Laminar Flow- Laminar flow through: plates and circular pipes. Stoke's law.

Turbulent Flow- Definition of turbulence, Causes of turbulence, instability, mechanism of turbulence and effect of turbulent flow in pipes. Prandtl's mixing length theory,**:**

Boundary Layer Analysis-Assumption and concept of boundary layer theory. Boundary-layer thickness, displacement, momentum & energy thickness, laminar and Turbulent boundary layers on a flat plate; Laminar sub-layer, smooth and rough boundaries. Local and average friction coefficients. Separation and Control.

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Module 2:

Introduction to Open Channel Flow- Comparison between open channel flow and pipe flow, geometrical parameters of a channel, classification of open channels, classification of open channel flow,

Uniform Flow- Continuity Equation, Energy Equation and Momentum Equation, Characteristics of uniform flow, Chezy's formula, Manning's formula. Most economical section of channel. Computation of Uniform flow, Normal depth.

Module 3:

Non-Uniform Flow- Specific energy, Specific energy curve, critical flow, discharge curve Specific force Specific depth, and Critical depth. Gradually Varied Flow-Dynamic Equation of Gradually Varied Flow,

Hydraulic Jump- Theory of hydraulic jump, Elements and characteristics of hydraulic jump in a rectangular Channel, length and height of jump, location of jump, Types, applications and location of hydraulic jump. Energy dissipation and other uses, surge as a moving hydraulic jump. Positive and negative surges

Module 4:

Flow through Pipes: Loss of head through pipes, Darcy-Wiesbatch equation, minor losses, total energy equation, hydraulic gradient line, Pipes in series, equivalent pipes, pipes in parallel. Analysis of pipe networks: Hardy Cross method, water hammer in pipes and control measures**.**

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

CO1	Define the concepts related to boundary layer theory and drag and lift forces.
CO2	Apply the knowledge of theories and equations of pipe flow in analyzing and designing the pipe network systems and its components including water hammer pressures.
CO3	Utilize the concepts of uniform and critical flow through open channels including design of efficient channel sections. Also apply specific energy concepts in the analysis of open channel flow.
CO4	Demonstrate Gradually Varied Flow & Rapidly Varied Flow analysis and its computation.
CO5	Explain the different techniques of dimensional analysis in model testing.
CO6	Demonstrate and apply basic concepts related to Turbines & Pumps in Water Resources planning.

Text/Reference Books:

1. Hydraulics and Fluid Mechanics, P.M. Modi and S.M. Seth, Standard BookHouse
2. Theory and Applications of Fluid Mechanics, K. Subramanya, Tata McGrawHill.
3. Open channel Flow, K. Subramanya, TataMcGrawHill.
4. Open Channel Hydraulics, VenTe Chow, Tata McGraw Hill.

BCE-507	Reinforced Cement Concrete	3L:0T:0P	3 credits

Pre-requisites: Concrete Technology and Mechanics of Materials.

Course Objectives:

CO1	To introduce the students to the fundamentals of reinforced concrete design with emphasis on the design of rectangular and T beams, short and slender columns, slabs, and footings and foundations.
CO2	Student will learn how to analyze and design reinforced concrete structural members under bending, shear, and/or axial loads according to the ACI building code requirements (including computer applications).

Module 1:

Introduction to Various Design Philosophies, Design of Rectangular Singly and Doubly Reinforced Sections by Working Stress Method.

Assumptions in Limit State Design Method, Design of Rectangular Singly and Doubly Reinforced beams, T-beams, L-beams by Limit State Design Method.

Module 2:

Behaviour of RC beams in Shear, Shear Strength of beams with and without shear reinforcement, Minimum and Maximum shear reinforcement, design of beam in shear.

Introduction to development length, Anchorage bond, flexural bond. (Detailed Examples by Limit State Design Method), Failure of beam under shear, Concept of Equivalent Shear and Moments.

Module 3:

Design of one way and two way solid slabs by Limit State Design Method, Serviceability Limit States, Control of deflection, cracking and vibrations.

Design of Columns by Limit State Design Method- Effective height of columns, Assumptions, Minimum eccentricity, Short column under axial compression, requirements for reinforcement, Column with helical reinforcement, Short column under axial load and uni-axial bending, Design of columns under bi-axial loading by Design Charts.

Note : All designs shall be conforming to IS : 456 – 2000.

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

CO1	Explain the basic concepts of structural design Methods of RCC to the practical problem
CO2	Apply the concepts of pre stressed concrete in real problems.
CO3	Use the knowledge of the structural properties of materials i.e. steel and concrete in assessing the strength

CO4	Use the knowledge in structural planning and design of various components of buildings
CO5	Explain the composite action of reinforced steel and concrete in reinforced concrete structural members
CO6	Explain and design the slabs.

Text/Reference Books:

1. IS : 456 – 2000.

2. Reinforced Concrete – Limit State Design by A. K. Jain, Nem Chand & Bros.,Roorkee.

3. Reinforced Concrete Design by P. Dayaratnam.

4. Plain and Reinforced Concrete Vol. I & II by O. P. Jain & Jai Krishna, Nem Chand & Bros.

5. Reinforced Concrete Structures by R. Park and Pauley.

6. Reinforced Concrete Design by S. Unnikrishna Pillai & D. Menon, Tata Mc-Graw

Hill Book Publishing Company Limited, New Delhi.

HAS-501	Professional Practice, Law &Ethics	2L:0T:0P	2 credits

Pre-requisites: None

Course Objectives:

CO1	To create an awareness on Engineering Ethics and Human Values.
CO2	To study the moral issues and decisions confronting individuals and organizations engaged in engineering profession.
CO3	To study the related issues about the moral ideals, character, policies, and relationships of people and corporations involved in technological activity.

Module 1

Professional Practice – Respective roles of various stakeholders: Government(constituting regulatory bodies and standardization organizations, prescribing norms to ensure safety of the citizens); Standardization Bodies (ex. BIS, IRC)(formulating standards of practice); professional bodies (ex. Institution of Engineers(India), Indian Roads Congress, IIA/ COA, ECI, Local Bodies/ Planning Authorities) (certifying professionals and offering platforms for interaction); Clients/ owners (role governed by contracts); Developers (role governed by regulations such as RERA); Consultants (role governed by bodies such as CEAI); Contractors (role governed by contracts and regulatory Acts and Standards);Manufacturers/ Vendors/ Service agencies (role governed by contracts and regulatory Acts and Standards)

Professional Ethics – Definition of Ethics, Professional Ethics, Business Ethics, Corporate Ethics, Engineering Ethics, Personal Ethics; Code of Ethics as defined in the website of Institution of Engineers (India); Profession, Professionalism, Professional Responsibility, Professional Ethics; Conflict of Interest, Gift Vs Bribery, Environmental breaches, Negligence, Deficiencies in state-of-the-art; Vigil Mechanism, Whistle blowing, protected disclosures.

Module 2:

General Principles of Contracts Management: Indian Contract Act, 1972 and amendments covering General principles of contracting; Contract Formation & Law; Privacy of contract; Various types of contract and their features; Valid & Voidable Contracts; Prime and sub-contracts; Joint Ventures & Consortium; Complex contract terminology; Tenders, Request For Proposals, Bids & Proposals; Bid Evaluation; Contract Conditions &Specifications; Critical /" Red Flag"conditions; Contract award & Notice To Proceed; Variations & Changes in Contracts; Differing site conditions; Cost escalation; Delays, Suspensions & Terminations; Time extensions & Force Majeure; Delay Analysis; Liquidated damages & Penalties; Insurance & Taxation; Performance and Excusable Non-performance; Contract documentation; Contract Notices; Wrong practices in contracting (Bid shopping, Bid fixing, Cartels); Reverse auction; Case Studies; Build-Own-Operate & variations; Public-Private Partnerships; International Commercial Terms;

Module 3:

Arbitration, Conciliation and ADR (Alternative Dispute Resolution) system: Arbitration – meaning, scope and types – distinction between laws of 1940 and 1996;UNCITRAL model law – Arbitration and expert determination; Extent of judicial intervention; International commercial arbitration; Arbitration agreements – essential and kinds, validity, reference and interim measures by court; Arbitration tribunal – appointment, challenge, jurisdiction of arbitral tribunal, powers, grounds of challenge, procedure and court assistance; Award including Form and content, Grounds for setting aside an award, Enforcement, Appeal and Revision; Enforcement of foreign awards – New York and Geneva Convention Awards; Distinction between conciliation, negotiation, mediation and arbitration, confidentiality, resort to judicial proceedings, costs; Dispute Resolution Boards; Lok Adalats.

Module 4 :

Engagement of Labour and Labour & other construction-related Laws: Role of Labour in Civil Engineering; Methods of engaging labour- on rolls, labour sub-contract, pieces rate work; Industrial Disputes Act, 1947; Collective bargaining; Industrial Employment (Standing Orders) Act, 1946; Workmen's Compensation Act, 1923; Building & Other Construction Workers (regulation of employment and conditions of service) Act (1996) and Rules (1998); RERA Act 2017, NBC 2017

Law relating to Intellectual property: Introduction – meaning of intellectual property, main forms of IP, Copyright, Trademarks, Patents and Designs, Secrets; Law relating to Copyright in India including Historical evolution of Copy Rights Act, 1957,Meaning of copyright – computer programs, Ownership of copyrights and assignment, Criteria of infringement, Piracy in Internet – Remedies and procedures in India; Law relating to Patents under Patents Act, 1970 including Concept and historical perspective of patent slaw in India, Patentable inventions with special reference to biotechnology products, Patent protection for computer programs, Process of obtaining patent – application, examination, opposition and sealing of patents, Patent cooperation treaty and grounds for opposition, Rights and obligations of patentee, Duration of patents – law and policy considerations, Infringement and related remedies;

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

CO1	Learn the moral issues and problems in engineering; find the solution to those problems.
CO2	Learn the need for professional ethics, codes of ethics and roles, concept of safety, risk assessment.
CO3	Gain exposure to Environment Ethics & computer ethics; know their responsibilities and rights

Text/Reference Books:

1. B.S. Patil, Legal Aspects of Building and Engineering Contracts,1974.
2. The National Building Code, BIS,2017
3. RERA Act,2017
4. Meena Rao (2006), Fundamental concepts in Law of Contract, 3rd Edn. Professional Offset

5.Neelima Chandiramani (2000), The Law of Contract: An Outline, 2nd Edn. Avinash Publications Mumbai
6. Avtarsingh (2002), Law of Contract, Eastern Book Co.
7. Dutt (1994), Indian Contract Act, Eastern Law House
8. Anson W.R. (1979), Law of Contract, Oxford University Press.
9. Kwatra G.K. (2005), The Arbitration & Conciliation of Law in India with case law on UNCITRAL Model Law on Arbitration, Indian Council of Arbitration
10. Wadhera (2004), Intellectual Property Rights, Universal Law Publishing Co.
11. T. Ramappa (2010), Intellectual Property Rights Law in India, Asia Law House
12. Bare text (2005), Right to Information Act
13. O.P. Malhotra, Law of Industrial Disputes, N.M. Tripathi Publishers
14. K.M. Desai(1946), The Industrial Employment (Standing Orders)Act
15. Rustamji R.F., Introduction to the Law of Industrial Disputes, Asia Publishing House
16. Vee, Charles & Skitmore, Martin (2003) Professional Ethics in the Construction Industry, Engineering Construction and Architectural management, Vol.10, Iss2,pp117-127, MCB UP Ltd
17. American Society of Civil Engineers (2011) ASCE Code of Ethics – Principles Study and Application
18. Ethics in Engineering- M.W.Martin & R.Schinzinger, McGraw-Hill
19. Engineering Ethics, National Institute for Engineering Ethics, USA
20. www.ieindia.org
21. Engineering ethics: concepts and cases – C. E. Harris, M.S. Pritchard, M.J.Rabins
22. CONSTRUCTION CONTRACTS, http://www.jnormanstark.com/contract.htm
23. Internet and Business Handbook, Chap 4, CONTRACTSLAW,http://www.laderapress.com/laderapress/contractslaw1.html
24.Contract&Agreementshttp://www.tco.ac.ir/law/English/agreements/General/Contract%20Law/C.htm
25. Contracts, http://206.127.69.152/jgretch/crj/211/ch7.ppt
26. Business & Personal Law. Chapter 7. "How ContractsArise",http://yucaipahigh.com/schristensen/lawweb/lawch7.ppt
27. Types of Contracts,http://cmsu2.cmsu.edu/public/classes/rahm/meiners.con.ppt
28. IV. TYPES OF CONTRACTS AND IMPORTANT PROVISIONS,http://www.worldbank.org/html/opr/consult/guidetxt/types.html
29. Contract Types/Pricing Arrangements Guideline- 1.4.G (11/04/02), http://www.sandia.gov/policy/14g.pdf

BMC-003	Constitution of India	2L:0T:0P	0 credits

Pre-requisites: None

Course Objectives:

CO1	Define a constitution
CO2	Describe the salient features of the Indian Constitution
CO3	Explain different ways of acquiring Indian Citizenship
CO4	List the Fundamental Rights and Fundamental Duties of Indian citizens
CO5	Describe the Directive Principles of State Policy and their significance

Module 1:

Introduction and History of Indian constitution.

Meaning of the constitution law and constitutionalism, Historical Background of the Constituent. Assembly, Government of India Act of 1935 and Indian Independence Act of 1947, Enforcement of the Constitution, Indian Constitution and its Salient Features.

Module 2

Basic Information about Indian Constitution

The Preamble of the Constitution, Fundamental Rights, Fundamental Duties, Directive Principles of State Policy, Parliamentary System, Centre-State Relations, Amendment of the Constitutional Powers and Procedure, Emergency Provisions: National Emergency, President Rule, Financial Emergency, and Local Self Government – Constitutional Scheme in India.

Module 3

Union Executive and State Executive

Powers of Indian Parliament Functions of Rajya Sabha, Functions of Lok Sabha, Powers and Functions of the President, powers of Indian President, Powers and

Functions of the Prime Minister, Judiciary – Supreme Court, Judicial Review, Public Interest Litigation, Judicial Activism, LokPal, LokAyukta, The Lokpaland Lokayuktas Act 2013, State Executives – Powers and Functions of the Governor, Powers and Functions of the Chief Minister, Functions of State Cabinet, Functions of State Legislature, Functions of High Court and Subordinate Courts.

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

CO1	Understand the meaning and importance of Constitution.
CO2	Explain about making of Indian Constitution - contribution of Constituent assembly on it.
CO3	Describe the Salient (Outstanding) features of Indian Constitution.
CO4	Describe the importance of Preamble of the Indian Constitution and its significance.

Reference book:

1. Brij Kishore Sharma: Introduction to the Indian Constitution, PHI, New Delhi, latest edition.

2. Granville Austin: The Indian Constitution: Cornerstone of a Nation. 1966, Oxford

Clarendon Press.
3. Subhash C. Kashyap: Our Constitution: An Introduction to India's Constitution and constitutional Law, NBT, 2018.
4. PM Bakshi: The Constitution of India, Latest Edition, Universal Law Publishing.
5. V.K. Ahuja: Law Relating to Intellectual Property Rights (2007)
6. Suresh T. Viswanathan: The Indian Cyber Laws, Bharat Law House, New Delhi-88
7. P. Narayan: Intellectual Property Law, Eastern Law House, New Delhi
8. Prabudh Ganguli: Gearing up for Patents: The Indian Scenario, Orient Longman.
9. BL Wadehra: Patents, Trademarks, Designs and Geological Indications.Universal Law Publishing - LexisNexis.

PRACTICAL/DESIGN/DRAWING			
BCE-551	**Geotechnical Engineering lab**	**0L:0T:2P**	**1 credits**

1. Field Density using Core Cutter method.
2. Field Density using Sand replacement method.
3. Natural moisture content using Oven Drying method.
4. Field identification of Fine Grained soils.
5. Specific gravity of Soils.
6. Grain size distribution by Sieve Analysis.
7. Grain size distribution by Hydrometer Analysis.
8. Consistency limits by Liquid limit
9. Consistency limits by Plastic limit
10. Consistency limits by Shrinkage limit.
11. Permeability test using Constant-head test method.
12. Permeability test using Falling-head method.
13. Compaction test: Standard Proctor test.
14. Compaction test: Modified Proctor test.
15. Relative density.
16. Consolidation Test.
17. Triaxial Test(UU)
18. Vane shear test
19. Direct Shear Test
20. Unconfined Compression Strength Test.

BCE-556	**Hydraulic Engineering Lab**	**0L:0T:2P**	**1 credits**

1. Flow Visualization
2. Studies in Wind Tunnel
3. Boundary Layer
4. Flow around an Aerofoil / circular cylinder
5. Uniform Flow
6. Velocity Distribution in Open channel Flow
7. Venturi Flume
8. Standing Wave Flume
9. Gradually Varied Flow
10. Hydraulic Jump
11. Flow under Sluice Gate
12. Flow through pipes
13. Turbulent flow through pipes
14. Flow visualization
15. Laminar flow through pipes
16. Major losses / Minor losses in pipe.

BCE-553	Transportation Engineering Lab	0L:0T:2P	1 credits

1. Crushing Value Test of Aggregate
2. Impact Value Test of Aggregate
3. Los Angeles Abrasion Value of Aggregate.
4. Penetration Test of Bituminous Sample
5. Softening Point Test of Bituminous Sample
6. Stripping Test of Bituminous Sample
7. Ductility Test of Bituminous Sample
8. Flash & Fire Point Test of Bituminous Sample

BCE-555	Environmental Engineering Lab	0L:0T:2P	1 credits

1. To determine dissolved and suspended solids in a given water sample.
2. To determine the pH value of a given water sample.
3. To determine turbidity of a given water sample.
4. To determine hardness of a given water sample.
5. Determination of residual chlorine and chlorine demand.
6. To measure the sound level with sound level meter.
7. To measure the concentration of air pollutants with high volume sampler.
8. To determine the BOD of a given wastewater sample.

BCE-601	Construction Engineering & Management	2L:1T:0P	3 credits

Pre-requisites: Engineering Economics and Accountancy.

Course Objectives:

CO1	To make them understand the concepts of Project Management for planning to execution of projects
CO2	To make them understand the feasibility analysis in Project Management and network analysis tools for cost and time estimation.
CO3	To enable them to comprehend the fundamentals of Contract Administration, Costing and Budgeting.
CO4	Make them capable to analyze, apply and appreciate contemporary project management tools and methodologies in Indian context.

Module 1:

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

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

Module 2:

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

Planning and organizing construction site and resources- Site: site layout including enabling structures, developing site organization, Documentation at site; Manpower: planning, organizing, staffing, motivation; Materials: concepts of planning, procurement and inventory control; Equipment: basic concepts of planning and organizing; Funds: cash flow; Resource Scheduling- Bar chart, line of balance technique.

Module 3:

Project Monitoring & Control- Supervision, record keeping, periodic progress reports, periodical progress meetings. Updating of plans: purpose, frequency and methods of updating. Common causes of time and cost overruns and corrective measures. Basics of Modern Project management systems such as Lean Construction; Use of Building Information Modelling (BIM) in project management; Quality control: concept of quality, quality of constructed structure, use of manuals and checklists for quality control, role of

inspection, basics of statistical quality control. Safety, Health and Environment on project

sites: accidents; their causes, effects and preventive measures, costs of accidents, occupational health problems in construction, organizing for safety and health.

Contracts Management basics: Importance of contracts; Types of Contracts, parties to a contract;

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

CO1	Understand the roles and responsibilities of a project manager
CO2	Prepare schedule of activities in a construction project
CO3	Prepare tender and contract document for a construction project
CO4	Understand safety practices in construction industry
CO5	Identify the equipment used in construction

Text/Reference Books:

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

BCE-602	Engineering Economics, Estimation & Costing	2L:1T:0P	3 credits

Pre-requisites: Economics

Course Objectives:

CO1	To learn about introduction to economics
CO2	To learn about economics of sampling and Replacement and Maintenance
CO3	To learn about depreciation and Evaluation of public alternatives
CO4	To learn about design analysis
CO5	To learn about value engineering.

Module 1:

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

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

Module 2:

Estimation / Measurements for various items- Introduction to the process of Estimation; Use of relevant Indian Standard Specifications for the same, taking out quantities from the given requirements of the work, comparison of different alternatives, Bar bending schedules, Mass haul Diagrams, Estimating Earthwork and Foundations, Estimating Concrete and Masonry, Finishes, Interiors, BIM and quantity take-offs; adding equipment costs; labour costs; rate analysis, market survey of basic materials.

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

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

Module 3:

Tender- Preparation of tender documents, importance of inviting tenders, contract types, relative merits, pre qualification. General and special conditions, termination of contracts,extraworkandChanges,penaltyandliquidatedcharges,Settlementofdisputes,R.A. Bill & Final Bill, Payment of advance, insurance, claims, price variation, etc. Preparing Bids- Bid Price buildup: Material, Labour, Equipment costs, Risks, Direct & Indirect Overheads,

Profits; Bid conditions, alternative specifications; Alternative Bids.

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

Arbitration, Easement rights.

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

CO1	The ability to understand professional and ethical responsibility and apply them in engineering practices.
CO2	The ability to design a system, component, or process to meet the desired needs within realistic constraints such as economic, environmental, social, political, ethical, health and safety, manufacturability, and sustainability.
CO3	Utilize contracts and tenders in construction practices
CO4	Analyze, & assess the quantity of materials required for civil engineering works as per specifications.
CO5	Evaluate & estimate the cost of expenditure and prepare a detailed rate analysis report.
CO6	Construct detailed report on estimation and valuation process.

Text/Reference Books:

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

CE ELECTIVE-I

BCE-011	Pavement Materials	3L:0T:0P	3 credits

Pre-requisites: Geotechnical Engineering - I, Engineering Geology and Transportation Engineering.

Course Objectives:

CO1	To impart knowledge about pavement materials and design.
CO2	To introduce the fundamental concepts of pavement designing.
CO3	To enable the students to understand the importance of design features of pavements.

Pavement Materials.

Soil - Classification, characteristics, compaction, evaluation of soil strength; stabilized pavement materials; Aggregates: requirements, properties and tests on road aggregates for flexible and rigid pavements. Bitumen: Origin, preparation, properties and tests, constitution of bituminous road binders; requirements; Criterion for selection of different binders. Bituminous Emulsions and Cutbacks: Preparation, characteristics, uses and tests, Bituminous Mixes: Mechanical properties: Resilient modulus, dynamic modulus and fatigue characteristics of bituminous mixes. Bituminous mix design methods and specifications.Weathering and Durability of Bituminous Materials and Mixes. Performance based Bitumen Specifications; Superpave mix design method: design example problems. Cement Concrete for Pavement Construction: Requirements, and design of mix for CC pavement, IRC and IS specifications and tests, joint filler andsealer materials.

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

CO1	Carry out the design of flexible pavement
CO2	Carry out the design of rigid pavements.
CO3	Understand the factors that affect pavement designing.
CO4	Understand the important features of pavement designing.
CO5	Design a flexible pavement using IRC, Asphalt Institute, and AASHTO methods.
CO6	Design a rigid pavement using IRC, and AASHTO methods.

BCE-012	Pavement Design	3L:0T:0P	3 credits

Pre-requisites: Geotechnical Engineering - I, Engineering Geology and Transportation Engineering.

Course Objectives:

CO1	Gain knowledge about the process of collecting data required for design, factors affecting pavement design, and maintenance of pavement.
CO2	Excel in the path of analysis of stress, strain and deflection in pavement.
CO3	Understand the various causes leading to failure of pavement and remedies for the same.
CO4	Develop skills to perform functional and structural evaluation of pavement by suitable methods.

Pavement Design.

Introduction: Types and component parts of pavements, Factors affecting design and performance of pavements. Highway and airport pavements. Stresses and Deflections in Flexible Pavements: Stresses and deflections in homogeneous masses. Burmister's two layer theory, three layer and multi-layer theories; wheel load stresses, various factors in traffic wheel loads; ESWL of multiple wheels. Repeated loads and EWL factors; sustained loads. Pavement behavior under transient traffic loads. Flexible Pavement Design Methods For Highways and Airports: Empirical, semi-empirical and theoretical approaches, development, principle, design steps, advantages; design of flexible pavements as per IRC; Stresses in Rigid Pavements: Types of stresses and causes, factors influencing the stresses; general considerations in rigid pavement analysis, EWL; wheel load stresses, warping stresses, frictional stresses, combined stresses. Rigid Pavement Design: Types of joints in cement concrete pavements and their functions, joint spacing's; design of CC pavement for roads and runways as per IRC, design of joint details for longitudinal joints, contraction joints and expansion joints. IRC method of design by stress ratio method. Design of continuously reinforced concrete pavements; Maintenance, repair and rehabilitation of pavements including design of bituminous and concrete overlays as per IRC

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

CO1	Systematically generate and compile required data's for design of pavement (Highway & Airfield).
CO2	Analyze stress, strain and deflection by boussinesq's, burmister's and westergaard's theory.
CO3	Design rigid pavement and flexible pavement conforming to IRC58-2002 and IRC37-2001.
CO4	Evaluate the performance of the pavement and also develops maintenancestatement based on site specific requirements.
CO5	Design pavement and overlays as per need and field condition.
CO6	Design bituminous mix as per Indian standard.

BCE-013	Geometric Design of Highways	3L:0T:0P	3 credits

Pre-requisites: Surveying.

Course Objectives:

CO1	Develop an understanding of the principles of geometric design in the context of transportation planning and traffic design.
CO2	Understand the design criteria for geometric design of highways.
CO3	Develop the capability to design highways, and utilize the state of the art tools for this process.

Geometric Design of Highways: Introduction: Classification of rural highways and urban roads. Objectives and requirements of highway geometric design; Design Controls: Topography, vehicle characteristics and design vehicle, driver characteristics, speed, traffic flow and capacity, levels of service, pedestrian and other facilities, environmental factors; Design Elements: Sight distances, Horizontal alignment - design considerations, stability at curves, super elevation, widening, transition curves; curvature at intersections, vertical alignment - grades, ramps, design of summit and valley curves, combination of vertical and horizontal alignment including design of hair pin bends, design of expressways, IRC standards and guidelines for design problems; Cross Section Elements: Right of way and width considerations, roadway, shoulders, kerbs traffic barriers, medians, frontage roads; Facilities for pedestrians, bicycles, buses and trucks, Pavement surface characteristics - types, cross slope, skid resistance, unevenness; Design Considerations: Design considerations for rural and urban arterials, freeways, and other rural and urban roads; Design Of Intersections: Characteristics and design considerations of at-grade intersections;; Rotary intersections; Grade separations and interchanges -; Design of Parkinglots

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

CO1	Design cross-sectional, horizontal and vertical elements of roads.
CO2	Design intersection, roundabout, exit & entry ramps.
CO3	Design pedestrian, bicycle and parking facilities.
CO4	Understand the factors that affect flexible pavement construction methodology
CO5	Understand the factors that affect rigid pavement construction methodology
CO6	understand the construction of flexible pavement

BCE-014	Railway Engineering.	3L:0T:0P	3 credits

Pre-requisites: Transportation Engineering.

Course Objectives:

CO1	Impart basic knowledge of railway track components and their functions.
CO2	Introduce geometric design, points and crossings, track resistances, signaling and control system.
CO3	Learn advancement in Railway stations, yards, modernization of railways & High Speed Trains.
CO4	Acquaint with bridge terminology, types of bridges, bridge hydrology and river training works.

Railway Engineering.

Railway track gauge, alignment of railway lines, engineering surveys and construction of new lines, tracks and track stresses; rails, sleepers; ballast; sub grade and formation, rack fittings and fastenings, creep of rails, geometric design of track, curves and super-elevation, points and crossings, track junctions and simple track layouts; rail joints and welding of rails; track maintenance, track drainage; modern methods of track maintenance, rehabilitation and renewal of track; tractive resistance and power, railway stations and yards; railway tunneling; signaling and interlocking; maintenance of railways and high speed trains.

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

CO1	Understand the importance of railway infrastructure planning and design.
CO2	Identify the factors governing design of railway infrastructures.
CO3	Design and analyze the railway track system.
CO4	Understand the process of execution of railway projects.

CE ELECTIVE-II

BCE-021	Contracts Management.	3L:0T:0P	3 credits

Pre-requisites: Construction Engineering.

Course Objectives:

CO1	To understand Concepts of Project Management for Planning & Execution of projects.
CO2	To know and use various optimization tools / techniques applied in Project Management.
CO3	To introduce fundamentals of Contract Administration, Costing and Accounting of Projects.
CO4	To discuss, analyze and appreciate contemporary projects in Indian and international context.

Contracts Management.

Introduction, Importance of Contracts, Overview of Contract Management, Overview of Activities in Contract Management; Planning and People- Resource Management; Types of Contracts, Parties to a Contract; Contract Formation, Formulation of Contract, Contract Start-Up, Managing Relationships; Common contract clauses (Notice to proceed, rights and duties of various parties, notices to be given, Contract Duration and Price. Performance parameters; Delays, penalties and liquidated damages; Force Majeure, Suspension and Termination. Changes & variations, Notices under contracts; Conventional and Alternative Dispute Resolution methods. Various Acts governing Contracts; Contract Administration and Payments- 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, Contract Management in Consultancy,; Managing Risks and Change- Managing Risks, Managing Change; Contract Closure and Review- Ending a Contract, Post-Implementation Review; Legal Aspects in Contract Management- Contract Management Legal View, Dispute Resolution, Integrity in Contract Management; Managing Performance- Introduction, Monitoring and Measurement.

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

CO1	Understanding issues & challenges in identification and selection of projects.
CO2	To develop skills required for project planning & formulation.
CO3	Apply optimization techniques in project management.
CO4	Analyze processes for project execution, control and closing.
CO5	Demonstrating the contracting process as applied in projects.

BCE-022	Construction Project Planning& Systems	3L:0T:0P	3 credits

Pre-requisites: Construction Engineering.

Course Objectives:

CO1	To make them understand the concepts of Project Management for planning to execution of projects.
CO2	To make them understand the feasibility analysis in Project Management and network analysis tools for cost and time estimation.
CO3	To enable them to comprehend the fundamentals of Contract Administration, Costing and Budgeting.
CO4	Make them capable to analyze, apply and appreciate contemporary project management tools and methodologies in Indian context.

Construction Project Planning& Systems.

Definition of Projects; Stages of project planning: pre-tender planning, pre-construction planning, detailed construction planning, role of client and contractor, level of detail. Process of development of plans and schedules, work break-down structure, activity lists, assessment of work content, concept of productivities, estimating durations, sequence of activities, activity utility data; Techniques of planning- Bar charts, Gantt Charts. Networks: basic terminology, types of precedence relationships, preparation of CPM networks: activity on link and activity on node representation, computation of float values, critical and semi critical paths, calendaring networks. PERT- Assumptions underlying PERT analysis, determining three time estimates, analysis, slack computations, calculation of probability of completion. Allocation of Resources- materials, equipment, staff, labour and finance; resource levelling and optimal schedules; Project organization, documentation and reporting systems. Control & monitoring; Temporary Structures in Construction; Construction Methods for various types of Structures; Major Construction equipment; Automation & Robotics in Construction; Modern Project management Systems; Advent of Lean Construction; Importance of Contracts Management; Planning and organizing construction site and resources- Site: site layout including enabling structures, developing site organization, Documentation at site; Manpower: planning, organizing, staffing, motivation; Materials: concepts of planning, procurement and inventory control; Equipment: basic concepts of planning and organizing; Funds: cash flow, sources of funds; Histograms and S-Curves. Earned Value; Resource Scheduling- Bar chart, line of balance technique, resource constraints and conflicts; resource aggregation, allocation, smoothening and levelling. Common Good Practices in Construction; *Project Monitoring & Control*- Supervision, record keeping, periodic progress reports, periodical progress, Meetings. Updating of plans: purpose, frequency and methods of updating. Common causes of time and cost overruns and corrective measures. Basics of Modern Project management systems such as Lean Construction; Use of Building Information Modelling (BIM) in project management; Quality control: concept of quality, quality of constructed structure, use of manuals and checklists for quality control, role of inspection, basics of statistical quality control. Safety, Health and Environment on project sites: accidents; their causes, effects and preventive measures, costs of accidents, occupational health problems in construction, organizing for safety and health.

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

CO1	Understand project characteristics and various stages of a project.
CO2	Understand the conceptual clarity about project organization and feasibility analyses – Market, Technical, Financial and Economic.
CO3	Analyze the learning and understand techniques for Project planning, scheduling and Execution Control.
CO4	Apply the risk management plan and analyse the role of stakeholders.
CO5	Understand the contract management, Project Procurement, Service level Agreements and productivity.
CO6	Understand the How Subcontract Administration and Control are practiced in the Industry.

BCE-023	Repair & Rehabilitation of Structures.	3L:0T:0P	3 credits

Pre-requisites: None
Course Objectives:

CO1	To learn various distress and damages to concrete and masonry structures.
CO2	To understand the importance of maintenance of structures.
CO3	To study the various types and properties of repair materials.
CO4	To asses the damage to structures using various tests.

Repair & Rehabilitation of Structures.

Maintenance and Repair Strategies Maintenance, Repair and Rehabilitation, Facets of Maintenance, importance of Maintenance, Various aspects of Inspection, Assessment procedure for evaluating a damaged structure, causes of deterioration; Strength and Durability Of Concrete- Quality assurance for concrete – Strength, Durability and Thermal properties, of concrete – Cracks, different types, causes – Effects due to climate, temperature, Sustained elevated temperature, Corrosion – Effects of cover thickness; Special Concretes- Polymer concrete, Sulphur infiltrated concrete, Fibre reinforced concrete, High strength concrete, High performance concrete, Vacuum concrete, Self-compacting concrete, Geopolymer concrete, Reactive powder concrete, Concrete made with industrial wastes; Techniques for Repair and Protection Methods- Non-destructive Testing Techniques, Epoxy injection, Shoring, Underpinning, Corrosion protection techniques – Corrosion inhibitors, Corrosion resistant steels, Coatings to reinforcement, cathodic protection; Repair, Rehabilitation and Retrofitting of Structures- Evaluation of root causes; Underpinning & shoring; some simple systems of rehabilitation of structures; Guniting, shotcreting; Non-Destructive testing systems; Use of external plates, carbon fib rewrapping and carbon composites in repairs. Strengthening of Structural elements, Repair of structures distressed due to corrosion, fire, Leakage, earthquake – Demolition Techniques – Engineered demolition methods –Case studies.

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

CO1	Understand the properties of fresh and hardened concrete.
CO2	Know the strategies of maintenance and repair.
CO3	Get an idea of repair techniques.
CO4	Understand the properties of repair materials.
CO5	Understand the retrofitting strategies and techniques.

BCE-024	Sustainable Construction Methods	3L:0T:0P	3 credits

Pre-requisites: None

Course Objectives:

CO1	To provide necessary knowledge about sustainability, green materials, and sustainable construction practices,
CO2	To further the students understanding of the environmental and energetic impacts of construction materials,
CO3	To introduce methods to assess how green materials, buildings, and construction processes and to improve communication skills of the students.

Sustainable Construction Methods.

Types of foundations and construction methods; Basics of Formwork and Staging; Common building construction methods (conventional walls and slabs; conventional framed structure with block work walls); Modular construction methods for repetitive works; Precast concrete construction methods; Basics of Slip forming for tall structures; Basic construction methods for steel structures; Basics of construction methods for Bridges; Identification of cutting edge sustainable construction materials, technologies, and project management strategies for use in the construction industry and evaluation of their potential to reduce the negative environmental impacts of construction activity. Examination of the current LEED for New Construction rating system, and case study analysis of highly successful recent "green construction projects" through student team assignments and presentations. Preparation for the LEED Green Associate professional licensing exam.

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

CO1	Identify criteria essential to determining what makes a building material truly “green”,
CO2	Demonstrate concepts of life-cycle analysis including economic and sustainability aspects and apply these concepts to green building materials,
CO3	Extend their conventional knowledge of design, for forces acting on structures, to the interaction with the environment in which the materials are put into place.

CE ELECTIVE-III

BCE-031	Physico-Chemical Processes for water and wastewater treatment	3L:0T:0P	3 credits

Pre-requisites: Environmental Engineering

Course Objectives:

CO1	The objective of this course is to provide a basic understanding of different Physico-chemical process relevant to Environmental Engineering.
CO2	This course provides an overview of various unit operations and unit process for removal of organics pollutants, emerging contaminant and nutrients found in water and wastewater.

Physico-Chemical Processes for water and wastewater treatment.

The Objective of this course is to provide an in depth understanding of physical and physico-chemical processes used for water and wastewater treatment systems and to provide capability to design such systems. Water purification in natural systems, physical processes, chemical processes and biological processes. Primary, secondary and tertiary treatment. Unit operations, unit processes. Aeration and gas transfer**.** Sedimentation, different types of settling, sedimentation tank design. Coagulation and flocculation, coagulation processes, stability of colloids, destabilization of colloids, destabilization in water and wastewater treatment, transport of colloidal particles, design aspects. Filtration: filtration processes, Hydraulics of flow through porous media, Rate control patterns and methods, Filter effluent quality parameters, mathematical model for deep granular filters, slow sand filtration, rapid sand filtration, pre- coat filtration, design aspects. Disinfection: Types of disinfectants, Kinetics of disinfection, chlorination and its theory, Design of Chlorinators. Precipitation: Hardness removal, Iron, Mn, and heavy metal removal; Adsorption, adsorption equilibrium and adsorption isotherm, rates of adsorption, Sorption kinetics in batch reactors, continuous reactors, factors affecting adsorption. Ion Exchange-exchange processes, materials and reactions, methods of operation, Application, design aspects. Membrane Processes, Reverse osmosis, Ultra-filtration, Electro dialysis.

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

CO1	Understanding of source of different pollutant in surface and sub-surface waters and wastewater and its treatment using Physico-chemical process.
CO2	Understand the conventional and advanced treatment process and its designing and modification to enhance its efficiency.
CO3	Understand various unit operation and Physico-chemical process for treatment of emerging contaminant found in our environment.

BCE-032	Transport of water and wastewater	3L:0T:0P	3 credits

Pre-requisites: Environmental Engineering

Course Objectives:

CO1	To apply knowledge of mathematics, physics, chemistry, and microbiology to solve and analyze engineering problems related to water and wastewater collection, transport, quality and treatment.
CO2	To use the fundamental principles of mass balance, chemical kinetics and equilibrium to design water or wastewater reactors to achieve a desirable treatment goal.

Transport of water and wastewater.

The objective of the course is to make students gain insight into how the water and wastewater gets transported through conduits and open channels, and use the same for the design, operation and maintenance of these systems. WaterSupply Systems: Storage requirements, impounding reservoirs, intake structures, pipe hydraulics, design of distribution systems, distribution and balancing reservoirs, pipe materials, appurtenances, design for external loads, maintenance and operation. SanitarySewerage Systems: Flow estimation, sewer materials, hydraulics of flow in sewers, sewer lay out, sewer transitions, materials for sewers, appurtenances, manholes, sewer design, conventional and model based design, sewage pumps and pumping stations, corrosion prevention, operation and maintenance, safety. Storm water Drainage Systems: Drainage layouts, storm runoff estimation, hydraulics of flow in storm water drains, materials, cross sections, design of storm water drainage systems, inlets, storm water pumping, operation and maintenance.

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

CO1	Select or construct appropriate treatment schemes to remove certain pollutants present in water or wastewater.
CO2	Design a water or wastewater treatment component
CO3	Balance chemical reactions and use balanced reactions to determine the distribution of species at equilibrium.
CO4	Understand selected contemporary global water and wastewater issues such as water shortage, wastewater reuse and emerging contaminants.

BCE-033	Rural water supply and onsite sanitation systems	3L:0T:0P	3 credits

Pre-requisites: Water and Wastewater Engineering

Course Objectives:

CO1	Student should be able to make technology choice to deal with water quality issues, operate and maintain working treatment systems and do troubleshooting of the problems in these systems
CO2	The student will be able to apply the knowledge gained from the subject in EIA studies for water component and water pollution control strategies.

Rural water supply and onsite sanitation systems.

Attributes of water supply systems, drinking water quality. Relationships between diseases and water quality, hygiene and sanitation. Need for water treatment. Point of use water treatment systems, filters, bio-sand filters, disinfection systems for rural areas, chlorination, solar disinfection systems, removal of arsenic, fluoride and iron. Onsite sanitation systems: Nexus between water quality and sanitation. Importance of hydrogeology on selection of onsite sanitation systems, Design of Septic tanks, single pit and double pit toilets. Small bore systems, bio digesters, reed beds, constructed wetlands, and sludge/sepage management systems.

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

CO1	Understand water quality concepts and their effect on treatment process selection.
CO2	Appreciate the importance and methods of operation and maintenance of water supply systems.
CO3	Communicate effectively in oral and written presentations to technical and non-technical audiences.

BCE-034	Air and Noise Pollution Control	3L:0T:0P	3 credits

Pre-requisites: Industrial Pollution Control.

Course Objectives:

CO1	To understand and evaluate the behaviour of air and noise pollutants.
CO2	Strategies to control their presence in the ambient atmosphere.

Air and Noise Pollution Control

Air pollutants, Sources, classification, Combustion Processes and pollutant emission, Effects on Health, vegetation, materials and atmosphere, Reactions of pollutants in the atmosphere and their effects-Smoke, smog and ozone layer disturbance, Greenhouse effect. Air sampling and pollution measurement methods, principles and instruments, Ambient air quality and emission standards, Air pollution indices, Air Act, legislation and regulations, control principles, Removal of gaseous pollutants by adsorption, absorption, reaction and other methods. Particulate emission control, settling chambers, cyclone separation, Wet collectors, fabric filters, electrostatic precipitators and other removal methods like absorption, adsorption, precipitation etc. Biological air pollution control technologies, Indoor air quality. Noise pollution: Basics of acoustics and specification of sound; sound power, sound intensity and sound pressure levels; plane, point and line sources, multiple sources; outdoor and indoor noise propagation; psychoacoustics and noise criteria, effects of noise on health, annoyance rating schemes; special noise environments: Infrasound, ultrasound, impulsive sound and sonic boom; noise standards and limit values; noise instrumentation and monitoring procedure. Noise indices. Noise control methods

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

CO1	Brief on the behaviour of air pollutants in atmosphere.
CO2	Design different types of control equipment's for the abatement of air and noise.
CO3	Evaluate the engineering solutions for industrial and vehicular air pollution problems.

CE ELECTIVE-IV

BCE-041	Hydraulic Structures/Irrigation Engineering	3L:0T:0P	3 credits

Pre-requisites: None

Course Objectives:

CO1	Relate the head works constructed at the head of the canal and types and different components and their purposes.
CO2	Understand different theories behind the design of impervious floor in permeable soils
CO3	Identify canal regulation structures and cross drainage structures come in the alignment of the channels.

Hydraulic Structures/Irrigation Engineering

This course should discuss key issues in designing irrigation channels and hydraulic structures used in irrigation systems Estimation of crop water requirement; Design of lined and unlined channels; Analysis for surface and sub-surface flow at hydraulic structures; Design of barrages and weirs; Design of Head and cross regulators; Design of canal falls, transitions and cross drainage works; Design principles for gravity and earthen dams

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

CO1	Design the different water retaining structures.
CO2	Analyze the parameters needed in the design of weirs/barrages in permeable soils.
CO3	Analyze and design the Gravity dams and Earth dams with available foundation strata.
CO4	Design the canal regulation structures and cross drainage structure.

BCE-042	Unsteady Open Channel Flow	3L:0T:0P	3 credits

Pre-requisites: Fluid Mechanics.

Course Objectives:

CO1	To develop a basic knowledge of open channel flow relationships by applying fluid properties, hydrostatics, and the conservation equations for mass, momentum, and energy. among the terms
CO2	To gain proficiency in applying the conservation equations to open channel flow problems.

Unsteady Open Channel Flow:

This course should discuss how to analyze for unsteady flows in open channels; Derivation of 1-D and 2-D shallow water flow equations; Consideration for non-hydrostatic pressure distribution; Basics of numerical methods: Finite- Difference and Finite Element Methods; Latest shock capturing Finite Volume methods for solving 1-D and 2-D shallow water flow equations; Dam break flow; Flood routing in large channel networks, Flood routing in compound channels; Flood routing in channels with flood plains, Surface irrigation flow modeling

Pre-Requisite: Basic course in Hydraulic Engineering

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

CO1	Ability to explain the terms of the open channel flow equations and explain the interactions among the terms.
CO2	Ability to explain the physical mechanisms of hydraulic jumps, surges, and critical, uniform, and gradually-varying flows. 2. Ability to explain and appl
CO3	Ability to solve open channel flow problems through the selection and use of appropriate equations.

BCE-043	River Engineering	3L:0T:0P	3 credits

Pre-requisites: Water resource Engineering

Course Objectives:

CO1	An ability to identify, formulate, and solve engineering problems.
CO2	An ability to effectively communicate in writing and speaking.

River Engineering:

Knowledge about river behavior is essential for practicing hydraulic and water resources engineers. River Morphology (Bars; Bends and Meanders, Thalweg; Braiding; Bifurcations etc.); Sediment Transport Mechanics (Bed forms, Bed Load transport, Transport of suspended sediment, Critical Shear stress, Sediment Transport Equations); Aggradation and Degradation; Local Scour at Bridge Piers and other Hydraulic Structures. Measurements in Rivers (Stage measurements, Channel geometry, Discharge, Sediment samplers and suspended and bed load measurement), Physical river Models (fixed and movable bed models; sectional models, distorted Models), Mathematical models for aggradations, degradation and local scour, River Protection and Training Works (Revetments, Dikes, Gabions, Spurs, Bank Protective measures and Bed control structures), Design of river training and flood protection structures, Diversion and Cofferdams; River regulations systems; Dredging and Disposal, River restoration

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

CO1	Make observations of and investigate hypotheses about river processes and the impacts of river engineering alternatives
CO2	Discuss regional and global river systems and management.
CO3	Additional required supplies and field trip information.

BCE-044	Urban Hydrology and Hydraulics	3L:0T:0P	3 credits

Pre-requisites: Water resource Engineering

Course Objectives:

CO1	To give basic concepts of urban rainfall-runoff processes
CO2	To give principles of culvert analyses for various inlet/outlet conditions
CO3	To give principles of culvert analyses for various inlet/outlet conditions
CO4	To give principles of storm water collection system design,

Urban Hydrology and Hydraulics

Hydraulic analysis and design of urban, highway, airport, and small rural watershed drainage problems; discussion of overland and drainage channel flows; hydraulics of storm-drain systems and culverts; determination of design flow; runoff for highways, airports, and urban areas; design of drainage gutters, channels, sewer networks, and culverts.

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

CO1	Characterize rainfall-runoff relations in urban areas
CO2	Explain the basic concepts of urban drainage systems
CO3	Design culverts, earth channels and storm water collection systems
CO4	Design detention basins and retention ponds

Practical

BCE-651	Engineering Economics, Estimation & Costing Lab	0L:0T:4P	2 credits

1. Deriving an approximate estimate for a multistoried building by approximate methods.
2. Detailed estimate for the following with the required material survey for the same.
    a. Ground plus three storied RCC Framed structure building with block work walls
    b. bridge with minimum2spans
    c. factory building
    d. roadwork
    e. cross drainage work
    f. Ground plus three storied building with load-bearing walls g Cost of finishes, MEP works for(f)above
3. Preparation of valuation report in standard Government form.
4. Assignments on rate analysis, specifications and simple estimates.
5. Detailed estimate of minor structure.

Preparation of Bar bending schedule