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MK University, Patan
Faculty of Engineering Technology,
Department of Civil Engineering(CE)

B. TECH (CIVIL ENGINEERING) SEM-I									
SR NO.	COURSE TYPE	COURSE CODE	COURSE NAME	LECTURE (HRS.)/ WEEK	PRACTICAL (HRS.)/ WEEK	CREDITS	EXAMINATION		TOTAL MARKS
							INTERNAL	EXTERNAL	
1	MAJOR	BTCE101	ENGINEERING MATHEMATICS-I	4	0	4	40	60	100
2	MAJOR	BTCE102	ENGINEERING PHYSICS	4	2	6	90	60	150
3	MAJOR	BTCE103	ENGINEERING GRAPHICS & CAD	4	0	4	40	60	100
4	MINOR	BTCE104	BASICS OF CIVIL ENGINEERING	4	2	6	90	60	150
5	VAC	BTCE105	COMMUNICATION SKILLS-I	2	0	2	0	50	50
TOTAL				18	4	22	260	290	550

B. TECH (CIVIL ENGINEERING) SEM-II									
SR NO.	COURSE TYPE	COURSE CODE	COURSE NAME	LECTURE (HRS.)/ WEEK	PRACTICAL (HRS.)/WEEK	CREDITS	EXAMINATION		TOTAL MARKS
							INTERNAL	EXTERNAL	
1	MAJOR	BTCE201	ENGINEERING MECHANCS	4	2	6	90	60	150
2	MAJOR	BTCE202	BUILDING MATERIALS& CONSTRUCTIONS	4	2	6	90	60	150
3	MAJOR	BTCE203	SURVEYING & GEOMATICS	4	0	4	40	60	100
4	MINOR	BTCE204	ENVIRONMENTAL SCIENCE	4	0	4	40	60	100
5	VAC	BTCE205	INDIAN CONSTITUTION	2	0	2	0	50	50
TOTAL				18	4	22	260	290	550

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B. TECH (CIVIL ENGINEERING) SEM-III									
SR NO.	COURSE TYPE	COURSE CODE	COURSE NAME	LECTURE (HRS.)/ WEEK	PRACTICAL (HRS.)/ WEEK	CREDITS	EXAMINATION		TOTAL MARKS
							INTERNAL	EXTERNAL	
1	MAJOR	BTCE301	STRENGTH OF MATERIALS	4	0	4	40	60	100
2	MAJOR	BTCE302	FLUID MECHANICS	4	2	6	90	60	150
3	MAJOR	BTCE303	STRUCTURAL ANALYSIS-I	4	2	6	90	60	150
4	MINOR	BTCE304	GEOLOGY FOR ENGINEERS	4	0	4	40	60	100
5	SEC	BTCE305	AUTOCAD CIVIL3D BASICS	0	2	2	00	50	50
TOTAL				16	6	22	260	290	550

B. TECH (CIVIL ENGINEERING) SEM-IV									
SR NO.	COURSE TYPE	COURSE CODE	COURSE NAME	LECTURE (HRS.)/ WEEK	PRACTICAL (HRS.)/ WEEK	CREDITS	EXAMINATION		TOTAL MARKS
							INTERNAL	EXTERNAL	
1	MAJOR	BTCE401	CONCRET TECHNOLOG	4	0	4	40	60	100
2	MAJOR	BTCE402	GEOTECHNICAL ENGINEERING	4	2	6	90	60	150
3	MAJOR	BTCE403	STRUCTURAL ANALYSIS-II	4	0	4	40	60	100
4	MINOR	BTCE404	WATER RESOURCE ENGINEERING	4	0	4	40	60	100
5	SEC	BTCE405	MINI PROJECT	0	2	2	00	50	50
6	VAC	BTCE406	PROFESSIONAL ETHICS	2	0	2	0	50	50
TOTAL				18	4	22	210	340	550

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B. TECH (CIVIL ENGINEERING) SEM-V									
SR NO.	COURSE TYPE	COURSE CODE	COURSE NAME	LECTURE (HRS.)/ WEEK	PRACTICAL (HRS.)/WEEK	CREDITS	EXAMINATION		TOTAL MARKS
							INTERNAL	EXTERNAL	
1	MAJOR	BTCE501	DESIGN OF RC STRUCTURES	4	2	6	90	60	150
2	MAJOR	BTCE502	TRANSPORTATION ENGINEERING	4	0	4	40	60	100
3	MAJOR	BTCE503	HYDROLOGY & IRREGATION	4	2	6	90	60	150
4	MINOR	BTCE504	CONSTRUCTION MANAGEMENT	4	0	4	40	60	100
6	VAC	BTCE505	PROJECT PLANNING TOOLS	0	2	2	50	0	50
TOTAL				16	6	22	310	240	550

B. TECH (CIVIL ENGINEERING) SEM-VI									
SR NO.	COURSE TYPE	COURSE CODE	COURSE NAME	LECTURE (HRS.)/ WEEK	PRACTICAL (HRS.)/WEEK	CREDITS	EXAMINATION		TOTAL MARKS
							INTERNAL	EXTERNAL	
1	MAJOR	BTCE601	DESIGN OF STEEL STRUCTURE	4	2	6	90	60	150
2	MAJOR	BTCE602	ENVIRONMENTAL ENGINEERING	4	0	4	40	60	100
3	MAJOR	BTCE603	FOUDATION ENGINEERING	4	2	6	90	60	150
4	MINOR	BTCE604	REMOTE SENSING & GIS	4	0	4	40	60	100
5	SEC	BTCE605	APTITUDE & CARRER SKILLS	0	2	2	50	0	50
TOTAL				16	6	22	310	240	550

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B. TECH (CIVIL ENGINEERING) SEM-VII									
SR NO.	COURSE TYPE	COURSE CODE	CORUSE NAME	LECTURE (HRS.)/ WEEK	PRACTICAL (HRS.)/ WEEK	CREDITS	EXAMINATION		TOTAL MARKS
							INTERNAL	EXTERNAL	
1	MAJOR	BTCE701	EARTHQAKE EGNIEERING	4	0	4	40	60	100
2	MAJOR	BTCE702	ADVANCED CONCRETE DESIGN	4	2	6	90	60	150
3	MINOR	BTCE703	PAVEMENT ENGINEERING	4	2	6	90	60	150
4	SEC	BTCE704	BIM & REVIT FOR CIVIL ENGINEERING	0	2	2	00	50	50
5	VAC	BTCE705	Project Phase-I	0	4	4	100	00	100
TOTAL				12	10	22	320	230	550

B. TECH (CIVIL ENGINEERING) SEM-VIII									
SR NO.	COURSE TYPE	COURSECODE	CORSE NAME	LECTURE (HRS.)/ WEEK	PRACTICAL (HRS.)/ WEEK	CREDITS	EXAMINATION		TOTAL MARKS
							INTERN AL	EXTERN AL	
1	MAJOR	BTCE801	PRE-STRESSED CONCRETE	4	2	6	90	60	150
2	MAJOR	BTCE802	TRAFFIC ENGINEERING & PLANNING	4	2	6	90	60	150
3	MINOR	BTCE803	SUSTAINABLE & GREEN BUILDING	4	2	6	90	60	150
4	SEC	BTCE804	Project Phase-II	0	4	4	100	100	200
TOTAL				12	10	22	370	280	650

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SUBJECT CODE: BTCE101

SUBJECT NAME: ENGINEERING MATHEMATICS-I

Course Objective:

- The concept of rank of a matrix which is used to know the consistency of system of linear equations and also to find the eigen vectors of a given matrix.
- Finding maxima and minima of functions of several variables.
- Applications of first order ordinary differential equations. (Newton's law of cooling, Natural growth and decay)
- How to solve first order linear, nonlinear partial differential equations and also method of separation of variables technique to solve typical second order partial differential equations.
- Solving differential equations using Laplace Transforms.

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

CO1	The concept of rank of a matrix which is used to know the consistency of system of linear equations and also to find the eigen vectors of a given matrix
CO2	Finding maxima and minima of functions of several variables
CO3	Applications of first order ordinary differential equations
CO4	How to solve first order linear, nonlinear partial differential equations and also method of separation of variables technique to solve typical second order partial differential equations

Unit	Content	Credit	Weightage
I	Matrices Introduction, types of matrices-symmetric, skew-symmetric, Hermitian, skew-Hermitian, orthogonal, unitary matrices. Rank of a matrix - echelon form, normal form, consistency of system of linear equations (Homogeneous and Non-Homogeneous). Eigen values and Eigen vectors and their properties (without proof), Cayley-Hamilton theorem (without proof), Diagonalization.	1	25%
II	Functions of Several Variables Limit continuity, partial derivatives and total derivative. Jacobian-Functional dependence and independence. Maxima and minima and saddle points, method of Lagrange multipliers, Taylor's theorem for two variables.	1	25%
III	Ordinary Differential Equations First order ordinary differential equations: Exact, equations reducible to exact form. Applications of first order differential equations - Newton's law of cooling, law of natural growth and decay. Linear differential equations of second and higher order with constant coefficients: Non-homogeneous term of the type f(x) = eax, sinax, cosax, xn , eax V and xn V. Method of variation of parameters.	1	25%

IV	Partial Differential Equations Introduction, formation of partial differential equation by elimination of arbitrary constants and arbitrary functions, solutions of first order Lagrange's linear equation and non-linear equations, Charpit's method, Method of separation of variables for second order equations and applications of PDE to one dimensional (Heat equation).	1	25%

TEXT BOOKS:

1. Higher Engineering Mathematics by B V Ramana ., Tata McGraw Hill.
2. Higher Engineering Mathematics by B.S. Grewal, Khanna Publishers.
3. Advanced Engineering Mathematics by Kreyszig, John Wiley & Sons.

REFERENCE BOOKS:

i)Advanced Engineering Mathematics by R.K Jain & S R K Iyenger, Narosa Publishers.
ii)Advanced Engineering Mathematics by Michael Green Berg, Pearson Publishers.
iii)Engineering Mathematics by N.P Bali and Manish Goyal.

SUBJECT CODE: BTCE102

SUBJECT NAME: ENGINEERING PHYSICS

Course Objectives:

- To provide a foundation in fundamental physics concepts relevant to electrical engineering applications.
- To understand electromagnetic theory, semiconductor physics, and materials science in electrical contexts.
- To apply physical principles to analyze and design electrical devices, circuits, and systems.
- To develop problem-solving skills through theoretical analysis and practical experimentation.

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

CO1	Apply concepts of electromagnetism to analyze electric and magnetic fields in engineering systems.
CO2	Explain semiconductor physics and its relevance to electronic and electrical devices.
C03	Analyze wave optics, laser physics, and photonic devices used in optical communication and sensing.
C04	Characterize materials (dielectric, magnetic, superconducting) and their applications in electrical engineering.

Unit	Content	Credit	Weightage
I	**Electromagnetic Theory & Applications** • **Vector Analysis:** Gradient, divergence, curl, Gauss's and Stokes' theorems. • **Electrostatics:** Coulomb's law, electric field, Gauss's law, electric potential, capacitance. • **Magnetostatics:** Biot-Savart law, Ampere's law, magnetic materials, inductance. • **Maxwell's Equations:** Integral and differential forms, displacement current, electromagnetic waves. • **Applications:** Transmission lines, waveguides,	1	25%

	antennas (basic concepts).		
II	**Semiconductor Physics & Devices** • **Band Theory of Solids:** Conductors, semiconductors, insulators, Fermi level. • **Intrinsic & Extrinsic Semiconductors:** Carrier concentration, mobility, conductivity. • **PN Junction Diode:** Formation, depletion region, forward and reverse bias, diode equation. • **Special Semiconductor Devices:** Zener diode, LED, photodiode, solar cells. • **Transistor Basics:** BJT and MOSFET structure (introduction). **Module 3: Wave Optics & Laser Physics**	1	25%
III	**Wave Optics & Laser Physics** • **Interference:** Young's double slit, thin films, Newton's rings. • **Diffraction:** Single slit, diffraction grating, resolving power. • **Polarization:** Types, Malus's law, Brewster's law. • **Lasers:** Stimulated emission, population inversion, He-Ne and semiconductor lasers. • **Applications:** Fiber optics, holography, optical sensors.	1	25%
IV	**Materials Science for Electrical Engineering** • **Dielectric Materials:** Polarization mechanisms, dielectric constant, losses, applications in capacitors. • **Magnetic Materials:** Dia-, para-, ferro-, ferri-magnetism, hysteresis, applications in transformers and motors. • **Superconductivity:** Meissner effect, Type I and II superconductors, applications in power transmission and MRI. • **Nano materials:** Quantum dots, carbon nanotubes, applications in sensors and electronics. • **Thermal Properties:** Thermal conductivity, expansion, thermoelectric effects.	1	25%

Textbooks:

- *Engineering Physics* – R. K. Gaur & S. L. Gupta (Dhanpat Rai Publications)
- *A Textbook of Engineering Physics* – M. N. Avadhanulu & P. G. Kshirsagar (S. Chand)
- *Fundamentals of Physics* – Halliday, Resnick & Walker (Extended for Engineers)

Reference books:

- *Electromagnetic Waves and Radiating Systems* – E. C. Jordan & K. G. Balmain
- *Principles of Electronics* – V. K. Mehta (for semiconductor sections)
- *Introduction to Solid State Physics* – Charles Kittel
- *Optics* – Ajoy Ghatak
- *Materials Science and Engineering* – William D. Callister

Online Platforms:

- NPTEL:
  - *Engineering Physics* – IIT Madras

- *Electromagnetic Theory* – IIT Bombay
- *Semiconductor Physics* – IIT Kanpur

- Coursera:
  - *Introduction to Electromagnetism* – Rice University
  - *Optics and Photonics* – MIT

PRACTICAL LIST:

Module 1: Electromagnetism & Measurements

- Magnetic Field Measurement using Helmholtz coil and Gauss meter.
- Verification of Biot-Savart Law for a current-carrying conductor.
- Measurement of Dielectric Constant of different materials.
- Study of Earth's Magnetic Field using tangent galvanometer.

Module 2: Semiconductor Devices & Characteristics

- V-I Characteristics of PN Junction Diode and Zener diode.
- Determination of Energy Band Gap of a semiconductor using four-probe method.
- Characteristics of Photodiode/LED and study of photoelectric effect.
- Solar Cell Characteristics: I-V curve, efficiency calculation.

Module 3: Optics & Lasers

- Determination of Wavelength using diffraction grating.
- Newton’s Rings Experiment for wavelength determination.
- Verification of Malus’s Law using polarizer-analyzer setup.
- Study of Laser Characteristics: Divergence, intensity profile.

Module 4: Material Properties & Applications

- Measurement of Thermal Conductivity of metals (Lee's disc method).
- Study of Hysteresis Loop for ferromagnetic materials.
- Determination of Planck's constant using photoelectric effect.
- Demonstration of Superconductivity using high-Tc superconductor (Meissner effect demo).

SUBJECT CODE: BTCE103

SUBJECT NAME: ENGINEERING CHEMISTRY

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

CO1	Apply electrochemical principles to corrosion prevention in mechanical systems.
CO2	Analyze fuels, lubricants, and alternative energy sources for efficient engineering applications.
C03	Select appropriate polymers, composites, and nano-materials for mechanical design.
C04	Implement water treatment and environmental protection measures in engineering projects.

Unit	Content	Credit	Weightage
I	**ELECTROCHEMISTRY & CORROSION**	1	25%

	• **Electrochemical Cells:** Galvanic and electrolytic cells, EMF, Nernst equation. • **Batteries:** Primary and secondary batteries (Li-ion, lead-acid, Ni-Cd), fuel cells. • **Corrosion:** Types (chemical, electrochemical), factors affecting corrosion. • **Corrosion Control:** Cathodic and anodic protection, coatings, inhibitors. • **Relevance to Mechanical Systems:** Pipeline corrosion, automotive parts, marine structures.		
II	**ENERGY SOURCES, FUELS & LUBRICANTS** • **Conventional Fuels:** Coal, petroleum, natural gas – classification, properties, refining. • **Alternative Energy Sources:** Hydrogen, biofuels, solar cells, nuclear energy. • **Combustion:** Stoichiometry, calorific value, flue gas analysis. • **Lubricants:** Types (solid, liquid, semi-solid), properties, additives, selection criteria. • **Engineering Applications:** IC engines, turbines, gear systems.	1	25%
III	**ENGINEERING MATERIALS: POLYMERS, COMPOSITES & NANOMATERIALS** • **Polymers:** Classification, polymerization, properties (Tg, Tm), mechanical behavior. • **Engineering Polymers:** PVC, nylon, epoxy, PTFE, fiber-reinforced polymers. • **Composites:** Matrix and reinforcement, types, applications in automotive/aerospace. • **Nanomaterials:** Synthesis, properties, CNTs, graphene, nanocomposites. • **Material Selection:** For lightweight design, wear resistance, thermal stability.	1	25%
IV	**WATER CHEMISTRY & ENVIRONMENTAL ENGINEERING** • Water Quality Parameters: Hardness, alkalinity, DO, BOD, COD. • Water Treatment: Softening (lime-soda, ion exchange), desalination, purification. • Boiler Feed Water: Scale and sludge formation, treatment, blow down. • Environmental Pollution: Air, water, soil pollutants, control measures. Green Chemistry: Principles, sustainable engineering practices.	1	25%

TEXT BOOKS:

1. **Engineering Chemistry** – Jain & Jain
2. **Engineering Chemistry** – Shashi Chawla
3. **A Textbook of Engineering Chemistry** – S.S. Dara
4. **Engineering Chemistry: Fundamentals and Applications** – Shikha Agarwal

REFERENCE BOOKS:

1. **Chemistry for Engineers** – J.O.M. Bockris
2. **Material Science and Engineering: An Introduction** – William D. Callister
3. **Corrosion Engineering** – Mars G. Fontana
4. **Polymer Science and Technology** – Joel R. Fried
5. **Environmental Chemistry** – A.K. De

SUBJECT CODE: BTCE104

SUBJECT NAME: BASICS OF CIVIL ENGINEERING

Course Objectives:

- To introduce students to the broad spectrum and significance of Civil Engineering.
- To familiarize students with the primary sub-disciplines and scope of civil engineering.
- To develop an understanding of basic materials, construction techniques, and infrastructure systems.
- To impart knowledge of surveying principles and their role in civil projects.
- To create awareness about the role of civil engineers in sustainable development and environmental protection.
- To develop initial professional ethics and responsibility.

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

CO1	Identify and describe the various fields of civil engineering and their societal impact.
CO2	Explain the properties and uses of basic construction materials.
C03	Understand fundamental concepts of buildings, infrastructure, and surveying.
C04	Perform basic linear and angular measurements using surveying instruments.

Unit	Content	Credit	Weightage
I	**Module 1: Introduction to Civil Engineering & Materials** Scope and Specializations: Structural, Geotechnical, Water Resources, Environmental, Transportation, Construction Management. Role of a Civil Engineer in Infrastructure Development (Buildings, Roads, Bridges, Dams, etc.). Introduction to Engineering Materials: Properties and uses of Stone, Bricks, Cement, Concrete, Steel, Timber, and modern composites.	1	25%
II	**Module 2: Building Construction & Planning**	1	25%

	Basic Components of a Building (Substructure & Superstructure). Types of Buildings and Structures. Introduction to Planning: Concept of Built-up area, FAR, and basic bylaws. Construction techniques overview: Foundations (shallow & deep), Masonry, Roofs, Floors.		
III	**Module 3: Surveying & Levelling** Purpose and fundamental principles of surveying. Classification of surveying. Introduction to linear measurement (Chaining) and angular measurement (Compass). Concepts of Levelling: Terminology, reduction of levels by Height of Instrument (HI) method.	1	25%
IV	**Module 4: Environmental Engineering & Sustainability** Role of Civil Engineers in Environmental Protection. Introduction to Water Supply: Sources and demand. Introduction to Waste Management: Sewage and solid waste. Basic concepts of Sustainable and Green Building (Brief overview).	1	25%

TEXT BOOKS:

- **"Basic Civil Engineering"** by Satheesh Gopi, Pearson.
- **"A Textbook of Basic Civil Engineering"** by Dr. M. Chakraborti, Subhas Publishing.
- **"Surveying (Vol. 1)"** by Dr. B.C. Punmia, Laxmi Publications (For Surveying Module).

REFERENCE BOOKS:

- **"**Introduction to Civil Engineering" **by S. S. Bhavikatti, I.K. International.**
- "Civil Engineering: Conventional and Objective Type" **by R.S. Khurmi & J.K. Gupta, S. Chand.**
- "Building Construction" **by B.C. Punmia, Laxmi Publications.**
- "Environmental Engineering" **by Howard S. Peavy, Donald R. Rowe, George Tchobanoglous, McGraw-Hill.**

ONLINE RESOURCES:

- NPTEL Courses **on "Introduction to Civil Engineering" by IIT professors.**
- Coursera: **"Construction Management" Specialization by Columbia University, "Introduction to Engineering Mechanics" by Georgia Tech.**

PRACTICAL LIST:

- Study of bricks, tiles, and stones: Identification and quality tests.
- Study of cement and concrete: Demonstration of properties and mix design concept.
- Chain Survey: Ranging, chaining, and plotting a small area.
- Compass Survey: Measuring bearings of a closed traverse.
- Dumpy Level / Auto Level: Performing differential levelling and plotting a profile.
- Study of building components using models / drawings.
- Visit to a construction site / materials testing lab (Report submission)

SUBJECT CODE: BTCE105

SUBJECT NAME: ENGINEERING GRAPHICS & CAD

Course Objectives:

- To develop the ability to visualize engineering components and structures.
- To impart knowledge of technical drawing standards, conventions, and symbols used in civil engineering practice.
- To equip students with skills in manual drafting of engineering drawings.
- To introduce Computer-Aided Drafting (CAD) tools for creating 2D and 3D civil engineering drawings.
- To prepare students to interpret and generate plans, elevations, sections, and structural details.

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

CO1	Apply BIS codes and conventions in engineering drawing.
CO2	Construct projections of points, lines, planes, and solids.
C03	Prepare civil engineering drawings (building plans, sections, and elevations) manually and using CAD.
C04	Create and modify 2D drawings and basic 3D models using CAD software.

PRACTICAL LIST:

- Part A: Manual Drawing
- **Sheet 1:** Lettering, line work, dimensioning, and geometrical constructions.
- **Sheet 2:** Orthographic projections of points and lines.
- **Sheet 3:** Projections of planes and simple solids.
- **Sheet 4:** Sectional views of solids and true shape of sections.
- **Sheet 5:** Development of lateral surfaces of solids.
- **Sheet 6:** Building drawing – line plan of a small house (plan only).

- Part B: Computer-Aided Drafting (CAD)
- **CAD Exercise 1:** AutoCAD basics – drawing commands, modify commands, layers, text, dimensioning.
- **CAD Exercise 2:** Drawing of a building plan with doors, windows, and furniture symbols.
- **CAD Exercise 3:** Elevation and sectional drawing of a single-room building.
- **CAD Exercise 4:** Preparation of a title block, layout, and plotting to scale.
- **CAD Exercise 5:** Simple structural detailing (footing, column, beam layout).
- **Mini-Project:** Complete set of drawings (plan, elevation, section, site plan) for a small residential unit using CAD.

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SEMESTER-II

SUBJECT CODE: BTCE201

SUBJECT NAME: BASICS OF CIVIL ENGINEERING

Course Objectives:

- To understand fundamental concepts of forces, moments, and equilibrium.
- To analyze systems of forces and compute resultants.
- To apply principles of equilibrium to solve problems involving beams, trusses, and frames.
- To study properties of surfaces and solids including centroids and moments of inertia.
- To introduce basics of friction and its applications in civil engineering structures.

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

CO1	Apply laws of mechanics to resolve force systems and determine resultants.
CO2	Analyze equilibrium of particles and rigid bodies in two and three dimensions.
C03	Determine centroid, center of gravity, and moment of inertia for various sections.
C04	Analyze simple trusses and beams for support reactions.

Unit	Content	Credit	Weightage
I	Fundamentals & Statics of Particles Introduction to mechanics: Basic concepts, Newton's laws Force systems: Concurrent and non-concurrent forces Resolution and composition of forces: Parallelogram law, triangle law, polygon law Equilibrium of particles: Free body diagrams, Lami's theorem Forces in space: Rectangular components, direction cosines	1	25%
II	Equilibrium of Rigid Bodies Moment of a force: Varignon's theorem, couple Resultant of force systems: Concurrent, parallel, and general force systems Equilibrium of rigid bodies in 2D and 3D Types of supports and reactions: Fixed, hinged, roller Analysis of simple beams: Simply supported, cantilever, overhanging	1	25%
III	Analysis of Structures Plane trusses: Perfect and imperfect trusses Methods of analysis: Method of joints, method of sections Frames and machines: Analysis of pin-connected frames Cables and arches: Introduction and basic concepts	1	25%

	Distributed forces: Center of gravity, centroid of lines, areas, and volumes		
IV	Friction & Properties of Surfaces Friction: Laws of dry friction, angle of repose Applications: Wedges, ladders, belt friction Properties of surfaces: Second moment of area, parallel axis theorem, perpendicular axis theorem Moment of inertia of standard sections: Rectangle, triangle, circle, composite sections Introduction to virtual work method	1	25%

TEXT BOOKS:

- **"Vector Mechanics for Engineers: Statics"** by Beer & Johnston, McGraw Hill.
- **"Engineering Mechanics: Statics"** by J.L. Meriam & L.G. Kraige, Wiley.
- **"Problems in Engineering Mechanics"** by S. Timoshenko, D.H. Young, McGraw Hill.
- **"Engineering Mechanics: Statics"** by A.K. Tayal, Umesh Publications.

REFERENCE BOOKS:

- **"Vector Mechanics for Engineers: Statics"** by Beer & Johnston, McGraw Hill.
- **"Engineering Mechanics: Statics"** by J.L. Meriam & L.G. Kraige, Wiley.
- **"Problems in Engineering Mechanics"** by S. Timoshenko, D.H. Young, McGraw Hill.
- **"Engineering Mechanics: Statics"** by A.K. Tayal, Umesh Publications.

ONLINE RESOURCES:

- **NPTEL:** Courses by IITs - "Engineering Mechanics" by Prof. Manoj Harbola (IITK), "Solid Mechanics" by Prof. S.P. Madhav
- **MIT OpenCourseWare:** "Engineering Mechanics I"
- **Coursera:** "Mechanics: Motion, Forces, Energy and Gravity" (UNSW), "Engineering Systems in Motion"

PRACTICAL LIST:

- **Verification of parallelogram law of forces** using force table/apparatus.
- **Determination of support reactions** for simply supported beam with various loads.
- **Analysis of jib crane** for forces in members.
- **Study of friction** on inclined plane and determination of coefficient of friction.
- **Determination of centroid** of irregular lamina using balancing method.
- **Analysis of simple truss** using method of joints (model demonstration).
- **Experiment on moment of inertia** using bifilar/torsional pendulum.
- **Force analysis in framed structures** using physical models.

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SUBJECT CODE: BTCE202
SUBJECT NAME: BULIDING MATERIALS AND CONSTRUCTION
Course Objectives:

- To study properties, testing, and applications of conventional building materials.
- To understand manufacturing processes and quality control of construction materials.
- To introduce modern construction materials and sustainable alternatives.
- To learn principles of building construction techniques and practices.
- To understand construction sequences for different structural elements.
- To study building services and finishing works.

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

CO1	Select appropriate materials for different construction applications.
CO2	Perform standard tests on construction materials and interpret results.
C03	Explain manufacturing processes and quality requirements of materials.
C04	Describe construction techniques for various building elements.

Unit	Content	Credit	Weightage
I	Stone, Clay & Aggregates **Stones:** Classification, quarrying, dressing, properties, testing, uses **Clay Products:** Bricks (manufacturing, classification, properties, tests), tiles, terracotta **Aggregates:** Classification, properties, tests (crushing, impact, abrasion), grading **Alternative Materials:** Fly ash bricks, AAC blocks, stabilized blocks	1	25%
II	Cement, Concrete & Mortar **Cement:** Composition, types (OPC, PPC, special cements), manufacturing, properties, tests **Concrete:** Ingredients, properties (fresh & hardened), mix design concept, additives, special concretes **Mortar:** Types, properties, uses, testing **Concrete Technology:** Curing, quality control, non-destructive testing basics	1	25%
III	Metals, Timber & Finishes **Metals:** Steel (types, properties, uses, corrosion), aluminum, protective coatings	1	25%

	Timber: Structure, seasoning, defects, preservation, engineered wood products **Finishing Materials:** Paints, varnishes, distempers, properties, applications **Modern Materials:** Glass, plastics, composites, adhesives, waterproofing compounds		
IV	Building Construction & Services **Building Elements:** Foundations (types, suitability), masonry (stone, brick, block), floors, roofs **Construction Techniques:** Formwork, scaffolding, shoring, underpinning **Finishing Works:** Plastering, pointing, painting, flooring, cladding **Building Services:** Damp-proofing, thermal insulation, acoustics basics **Building Planning:** Principles, bylaws, green building concepts	1	25%

TEXT BOOKS:

- **"Building Construction"** by B.C. Punmia, Ashok Kumar Jain, Arun Kumar Jain, Laxmi Publications.
- **"Building Materials"** by S.K. Duggal, New Age International.
- **"Engineering Materials"** by S.C. Rangwala, Charotar Publishing House.

REFERENCE BOOKS:

- **"Construction Technology"** by Roy Chudley & Roger Greeno, Pearson.
- **"Concrete Technology"** by M.S. Shetty, S. Chand.
- **"Building Materials in Civil Engineering"** by Haimei Zhang, Woodhead Publishing.
- **"Handbook of Civil Engineering"** by R.P. Rethaliya, Atul Prakashan.
- **National Building Code of India (Latest Edition)** - Relevant sections.

ONLINE RESOURCES:

- **NPTEL:**
  1. "Building Materials and Construction" by IIT Roorkee
  2. "Concrete Technology" by IIT Madras
  3. "Advanced Construction Materials" by IIT Kharagpur
- **Coursera:**
  1. "Construction Management" specialization
  2. "Materials Science for Engineers"

PRACTICAL LIST:

- **Tests on Bricks:**
  1. Compression strength test
  2. Water absorption test

3. Efflorescence test
4. Dimension and shape test

- **Tests on Cement:**
  1. Fineness test (sieve method)
  2. Standard consistency test
  3. Initial and final setting time
  4. Soundness test (Le-Chatelier method)
- **Tests on Aggregates:**
  1. Sieve analysis and fineness modulus
  2. Specific gravity and water absorption
  3. Aggregate crushing value test
  4. Aggregate impact value test
- **Tests on Concrete:**
  1. Slump test for workability
  2. Compaction factor test
  3. Casting and testing of concrete cubes for compressive strength
  4. Demonstration of rebound hammer test (NDT)
- **Tests on Other Materials:**
  1. Tensile test on mild steel (demonstration)
  2. Seasoning of timber (demonstration)
  3. Viscosity test on paints

- Drawing/Model Exercises:
- **Building Construction Drawings:**
  1. Foundation types and details
  2. Brick/stone masonry bonds (English, Flemish)
  3. Doors and windows details
  4. Roof types (RCC, truss, jack arch)
- **Site Visits & Reports:**
  1. Visit to brick kiln/cement plant
  2. Visit to ready-mix concrete plant
  3. Construction site visit for sequence observation
  4. Material testing laboratory visit

SUBJECT CODE: BTCE203
SUBJECT NAME: SURVEYING AND GEOMATICS

Course Objectives:

- To introduce fundamental principles and classification of surveying.
- To train students in using conventional surveying instruments for linear and angular measurements.
- To develop skills in levelling, contouring, and area/volume computations.
- To introduce modern geomatics technologies: Total Station, GPS, and Remote Sensing.
- To understand applications of surveying in civil engineering projects.

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

CO1	Apply surveying principles for measurement, leveling, and contouring.
CO2	Operate traditional instruments (chain, compass, level, and theodolite) for field surveys.
C03	Perform traverse surveying, compute coordinates, and adjust errors.
C04	Operate modern surveying equipment (Total Station, GPS) and

	process data.

Unit	Content	Credit	Weightage
I	Fundamentals and Chain Surveying **Introduction:** Definition, principles, classification, scales, units **Linear Measurements:** Chains, tapes, ranging, chaining on slopes, errors **Chain Surveying:** Instruments, survey stations, baseline, offsets, booking **Plotting:** Field book, conventional symbols, plotting chain survey **Obstacles in Chaining:** Methods to overcome various obstacles	1	25%
II	Compass and Leveling **Compass Surveying:** Bearings (whole circle, reduced), prismatic compass, traversing **Local attraction:** Detection, correction, plotting traverses **Leveling:** Basic definitions, types of levels, temporary adjustments **Methods:** Differential, profile, cross-section leveling, booking (HI method, Rise & Fall) **Contouring:** Characteristics, methods, uses in civil engineering **Curve Setting:** Simple circular curves (elements, setting out methods)	1	25%
III	Theodolite and Traverse Surveying **Theodolite:** Types, parts, adjustments, measurement of horizontal and vertical angles **Traverse Surveying:** Open and closed traverses, latitude and departure **Traverse Computations:** Balancing by Bowditch/Transit rule, Gale's table **Area Computation:** From coordinates, by planimeter **Tacheometry:** Principles, stadia method, tangential method **Triangulation:** Basic concepts, classification of triangulation systems	1	25%
IV	Modern Surveying and Geomatics **Total Station:** Components, working, field procedure, data processing	1	25%

	GPS/GNSS: Principles, segments, positioning methods, applications in surveying **Remote Sensing:** Basic concepts, platforms, sensors, image interpretation **GIS:** Components, data types, spatial analysis, civil engineering applications **Photogrammetry:** Principles, aerial photography, stereoscopy **Advanced Topics:** LIDAR, UAV/Drone surveying, 3D laser scanning (overview)		

TEXT BOOKS:

- **"Surveying (Vol. 1, 2 & 3)"** by Dr. B.C. Punmia, Ashok Kumar Jain, Arun Kumar Jain, Laxmi Publications.
- **"Textbook of Surveying"** by S.K. Duggal, McGraw Hill Education.
- **"Surveying and Levelling"** by R. Subramanian, Oxford University Press.

REFERENCE BOOKS:

- **"Higher Surveying"** by A.M. Chandra, New Age International.
- **"Elementary Surveying: An Introduction to Geomatics"** by Paul R. Wolf & Charles D. Ghilani, Pearson.
- **"Remote Sensing and GIS"** by B. Bhatta, Oxford University Press.
- **"GPS Satellite Surveying"** by Alfred Leick, Wiley.
- **"Surveying Theory and Practice"** by James M. Anderson & Edward M. Mikhail, McGraw Hill.

ONLINE RESOURCES:

- **NPTEL:**
  1. "Surveying" by Prof. Bharat Lohani (IIT Kanpur)
  2. "Advanced Surveying" by IIT Roorkee
  3. "Remote Sensing and GIS" by IIT Bombay
  4. "GPS Surveying" by IIT Kharagpur
- **Coursera:**
  1. "Geospatial and Environmental Analysis" (UC Davis)
  2. "GIS, Mapping, and Spatial Analysis" (University of Toronto)
  3. "Drone Surveying" (Various providers)

MK UNIVERSITY

PATAN, GUJARAT

ESTABLISHED BY THE GUJARAT GOVT. RECOGNIZED BY UGC UNDER SECTION 2(f) OF UGC ACT,1956

SEMESTER-III

SUBJECT CODE: BTCE301

SUBJECT NAME: STRENGTH OF MATERIALS

Course Objectives:

- To understand the behavior of solid bodies subjected to various types of loading.
- To analyze stress, strain, and deformation in structural elements under axial, bending, torsional, and combined loads.
- To study mechanical properties of materials and stress-strain relationships.
- To determine shear force, bending moment, and stresses in beams.
- To analyze columns for buckling and stability.

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

CO1	Calculate stress, strain, and deformation in axially loaded members.
CO2	Draw shear force and bending moment diagrams for statically determinate beams.
C03	Compute bending and shear stresses in beams.
C04	Analyze torsion in circular shafts and buckling in columns.

Unit	Content	Credit	Weightage
I	Simple Stresses and Strains **Introduction:** Concept of stress and strain, types of stresses (normal, shear), Hooke's Law **Stress-Strain Diagrams:** For ductile and brittle materials, mechanical properties **Axial Loading:** Deformation of bars with varying cross-sections, composite sections **Thermal Stresses:** Temperature effects, compound bars **Elastic Constants:** Relationship between E, G, K, and μ **Strain Energy:** Resilience, proof resilience, sudden and impact loading	1	25%
II	Shear Force and Bending Moment **Types of Beams and Loads:** Simply supported, cantilever, overhanging beams **Shear Force and Bending Moment:** Sign conventions, relationships between load, SF, and BM **SF and BM Diagrams:** For various loading conditions (point loads, UDL, UVL, couples) **Theory of Simple Bending:** Assumptions, bending equation, flexural rigidity **Bending Stresses:** Calculation in symmetrical and unsymmetrical sections	1	25%

	Shear Stresses: Distribution in rectangular, circular, and I-sections		
III	Torsion and Columns **Torsion of Circular Shafts:** Theory of pure torsion, torsion equation **Power Transmission:** Relationship between torque, power, and speed **Composite Shafts:** Series and parallel combinations **Springs:** Close-coiled helical springs under axial load **Columns and Struts:** Euler's theory for long columns, effective length, slenderness ratio **Empirical Formulae:** Rankine-Gordon formula, Johnson's parabolic formula	1	25%
IV	Complex Stresses and Strain Energy **Principal Stresses:** Plane stress transformation, Mohr's circle for stress **Strain Analysis:** Principal strains, strain rosettes **Theories of Failure:** Maximum principal stress, maximum shear stress, distortion energy theories **Combined Stresses:** Bending and torsion, bending and axial loads **Deflection of Beams:** Double integration method, Macaulay's method **Thin Cylinders and Shells:** Hoop and longitudinal stresses	1	25%

TEXT BOOKS:

- **"Strength of Materials"** by R.K. Bansal, Laxmi Publications.
- **"Strength of Materials"** by S. Ramamrutham & R. Narayanan, Dhanpat Rai Publishing.
- **"Mechanics of Materials"** by R.C. Hibbeler, Pearson Education.

REFERENCE BOOKS:

- **"Strength of Materials"** by S. Timoshenko, D.H. Young, J.V. Rao, McGraw Hill.
- **"Strength of Materials"** by B.C. Punmia, Ashok Kumar Jain, Arun Kumar Jain, Laxmi Publications.
- **"Advanced Mechanics of Materials"** by Arthur P. Boresi & Richard J. Schmidt, Wiley.
- **"Mechanics of Materials"** by James M. Gere & Barry J. Goodno, Cengage Learning.
- **"Problems in Strength of Materials"** by Pytel & Singer, Harper Collins.

ONLINE RESOURCES:

- **NPTEL:**
  1. "Strength of Materials" by Prof. S.P. Madhav (IIT Madras)
  2. "Mechanics of Solids" by IIT Kharagpur
  3. "Advanced Strength of Materials" by IIT Roorkee
  4. "Structural Analysis" by IIT Delhi
- **Coursera:**

1. "Mechanics of Materials" series by Georgia Tech
2. "Engineering Mechanics" by Korea Advanced Institute of Science and Technology
3. "Material Behavior" by University of California, Davis

SUBJECT CODE: BTCE302
SUBJECT NAME: FLUID MECHANICS
Course Objectives:

- To understand the behavior of solid bodies subjected to various types of loading.
- To analyze stress, strain, and deformation in structural elements under axial, bending, torsional, and combined loads.
- To study mechanical properties of materials and stress-strain relationships.
- To determine shear force, bending moment, and stresses in beams.
- To analyze columns for buckling and stability.

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

CO1	Calculate stress, strain, and deformation in axially loaded members.
CO2	Draw shear force and bending moment diagrams for statically determinate beams.
C03	Compute bending and shear stresses in beams.
C04	Analyze torsion in circular shafts and buckling in columns.

Unit	Content	Credit	Weightage
I	Simple Stresses and Strains **Introduction:** Concept of stress and strain, types of stresses (normal, shear), Hooke's Law **Stress-Strain Diagrams:** For ductile and brittle materials, mechanical properties **Axial Loading:** Deformation of bars with varying cross-sections, composite sections **Thermal Stresses:** Temperature effects, compound bars **Elastic Constants:** Relationship between E, G, K, and μ **Strain Energy:** Resilience, proof resilience, sudden and impact loading	1	25%
II	Shear Force and Bending Moment **Types of Beams and Loads:** Simply supported, cantilever, overhanging beams **Shear Force and Bending Moment:** Sign conventions, relationships between load, SF, and BM **SF and BM Diagrams:** For various loading conditions (point loads, UDL, UVL, couples) **Theory of Simple Bending:** Assumptions, bending equation, flexural rigidity	1	25%

	Bending Stresses: Calculation in symmetrical and unsymmetrical sections **Shear Stresses:** Distribution in rectangular, circular, and I-sections		
III	Dimensional Analysis and Pipe Flow **Dimensional Analysis:** Buckingham π-theorem, dimensionless numbers (Re, Fr, We, etc.) **Model Studies:** Similitude, scale ratios **Flow in Pipes:** Major losses (Darcy-Weisbach equation), minor losses **Pipe Networks:** Series and parallel pipes, equivalent pipes, branching pipes **Hydraulic Gradient Line and Total Energy Line** **Boundary Layer Concepts:** Development, thickness definitions, separation	1	25%
IV	Drag, Lift and Compressible Flow **Drag and Lift:** Drag on flat plates and submerged bodies, lift on airfoils **Flow Past Spheres and Cylinders:** Stokes' law, flow around cylinders **Laminar Flow:** Exact solutions (Couette, Poiseuille flow) **Turbulent Flow:** Characteristics, velocity distribution, mixing length theory **Introduction to Compressible Flow:** Mach number, isentropic flow, normal shock waves **Open Channel Flow Basics:** Comparison with pipe flow, specific energy	1	25%

TEXT BOOKS:

- **"Fluid Mechanics and Hydraulic Machines"** by R.K. Bansal, Laxmi Publications.
- **"A Textbook of Fluid Mechanics and Hydraulic Machines"** by R.K. Rajput, S. Chand.
- **"Fluid Mechanics"** by Dr. P.N. Modi & Dr. S.M. Seth, Standard Book House.

REFERENCE BOOKS:

- **"Fluid Mechanics"** by Frank M. White, McGraw Hill.
- **"Introduction to Fluid Mechanics"** by R.W. Fox, A.T. McDonald, P.J. Pritchard, Wiley.
- **"Fluid Mechanics: Fundamentals and Applications"** by Yunus A. Cengel & John M. Cimbala, McGraw Hill.
- **"Engineering Fluid Mechanics"** by K.L. Kumar, S. Chand.
- **"Fluid Mechanics Through Problems"** by R.J. Garde, New Age International.

ONLINE RESOURCES:

- **NPTEL:**
  1. "Fluid Mechanics" by Prof. S.K. Som, IIT Kharagpur
  2. "Advanced Fluid Mechanics" by IIT Bombay
  3. "Fluid Machines" by IIT Roorkee

4. "Computational Fluid Dynamics" by IIT Kanpur

- **Coursera:**
  1. "Fundamentals of Fluid-Solid Interactions" (École Polytechnique)
  2. "Fluid Mechanics" (Korea Advanced Institute of Science and Technology)
  3. "Engineering: Building with Nature" (Delft University)

PRACTICAL LIST:

- **Calibration of Pressure Gauges** using dead weight tester.
- **Hydrostatic Force** on submerged plane surface (center of pressure determination).
- **Bernoulli's Theorem Verification** using variable area duct.
- **Flow Measurement:**
  1. Calibration of Venturimeter
  2. Calibration of Orifice meter
  3. Coefficient of discharge for rectangular/triangular notch
- **Pipe Friction:**
  1. Determination of friction factor for pipes
  2. Minor losses in pipe fittings (bends, elbows, valves)
- **Metacentric Height** determination for floating bodies.
- **Reynolds Experiment** for flow visualization (laminar, transition, turbulent).
- **Impact of Jets** on vanes (flat, curved) to verify momentum principle.
- **Boundary Layer** measurement over a flat plate.
- **Viscosity Measurement:**
  1. Using capillary tube viscometer
  2. Using falling sphere viscometer
- **Demonstration Experiments:**
  1. Cavitation phenomenon
  2. Flow past cylinder/sphere for drag visualization
  3. Hydraulic jump in open channel

SUBJECT CODE: BTCE303
SUBJECT NAME: STRUCTURAL ANALYSIS-I
Course Objectives:

- To analyze statically determinate and indeterminate structures.
- To determine forces, stresses, and deformations in beams, frames, and trusses.
- To apply classical methods (SLOPE-DEFLECTION, MOMENT DISTRIBUTION) for indeterminate structures.
- To understand influence lines for moving loads on beams and trusses.
- To introduce matrix methods and computer applications in structural analysis.

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

CO1	Analyze statically determinate beams, frames, and trusses.
CO2	Apply classical methods to solve indeterminate structures.
C03	Draw influence lines for beams and trusses under moving loads.
C04	Determine deflections in beams using various methods.

Unit	Content	Credit	Weightage
I	Analysis of Determinate Structures **Review:** Static determinacy and indeterminacy (beams, frames, trusses) **Truss Analysis:** Method of joints, method of sections, compound trusses **Cables and Arches:** Three-hinged arches, parabolic cables under UDL **Moving Loads:** Absolute maximum bending moment, equivalent UDL **Deflection of Beams:** Double integration, Macaulay's, moment-area, conjugate beam methods **Energy Methods:** Castigliano's theorems, virtual work method for trusses	1	25%
II	Indeterminate Structures - Force Method **Introduction to Indeterminate Structures:** Degree of static indeterminacy **Force Method (Flexibility Method):** Concept of compatibility, redundant forces **Analysis of:** Propped cantilevers, fixed beams, continuous beams (two-span) **Application to:** Single-bay single-story portal frames **Three-Hinged and Two-Hinged Arches:** Rib-shortening, temperature effects **Suspension Bridges:** Basic analysis concepts	1	25%
III	Indeterminate Structures - Displacement Method **Slope-Deflection Method:** Derivation of equations, sign convention **Analysis of:** Continuous beams, portal frames (single-bay), multi-story frames **Moment Distribution Method:** Stiffness factors, carry-over factors, distribution factors **Analysis of:** Continuous beams with and without sinking, symmetric frames **Kani's Method:** Introduction and applications to continuous beams **Column Analogy Method:** Introduction and basic applications	1	25%
IV	Influence Lines and Matrix Methods **Influence Lines:** Muller-Breslau principle, qualitative influence lines	1	25%

	ILD for: Determinate beams, compound beams, three-hinged arches **ILD for:** Trusses (floor beams, panel loading), maximum force determination **Introduction to Matrix Methods:** Flexibility vs stiffness methods **Direct Stiffness Method:** Local and global coordinates, transformation matrices **Computer Applications:** Introduction to structural analysis software		

TEXT BOOKS:

- **"Structural Analysis"** by S.S. Bhavikatti, Vikas Publishing House.
- **"Basic Structural Analysis"** by C.S. Reddy, McGraw Hill Education.
- **"Structural Analysis"** by R.C. Hibbeler, Pearson Education.

REFERENCE BOOKS:

- **"Intermediate Structural Analysis"** by C.K. Wang, McGraw Hill.
- **"Theory of Structures"** by S.P. Timoshenko & D.H. Young, McGraw Hill.
- **"Structural Analysis - A Unified Approach"** by A. Ghali, A.M. Neville & T.G. Brown, Spon Press.
- **"Matrix Analysis of Structures"** by Aslam Kassimali, Cengage Learning.
- **"Structural Analysis"** by R. Vaidyanathan & P. Perumal, Laxmi Publications.
- **"Structural Analysis - In Theory and Practice"** by Alan Williams, Elsevier.

ONLINE RESOURCES:

- **NPTEL:**
  1. "Structural Analysis" by Prof. S.R. Satish Kumar & Prof. P. Banerjee (IIT Madras)
  2. "Advanced Structural Analysis" by IIT Kharagpur
  3. "Matrix Methods of Structural Analysis" by IIT Kanpur
  4. "Structural Dynamics" by IIT Roorkee
- **Coursera:**
  1. "Engineering Structural Analysis" (Georgia Tech)
  2. "Mechanics of Materials" series
  3. "Structural Materials" (University of California, Davis)

PRACTICAL LIST:

- **Deflection Test:** Simply supported beam under point load/UDL - verification with theoretical values.
- **Continuous Beam Analysis:** Two-span continuous beam - experimental vs theoretical moment values.
- **Portal Frame Analysis:** Single-bay portal frame under various loads - measurement of moments at joints.
- **Truss Analysis:** Warren/Pratt truss - measurement of member forces under different loading conditions.
- **Three-Hinged Arch:** Determination of horizontal thrust and bending moments.
- **Influence Line Demonstration:** For simply supported beam - moving load experiment.

- **Column Buckling:** Euler buckling load determination for different end conditions.
- **Moment Distribution:** Model frame analysis using moment distribution method verification.

- Software Exercises:
- **Basics:** Modeling simple beams, trusses, and frames.
- **Analysis using STAAD:**
  1. Continuous beam analysis
  2. Plane frame analysis
  3. Truss analysis
- **ETABS Introduction:** Basic modeling of 2D frames.
- **MATLAB/Excel:** Programming basic structural analysis problems (matrix operations).

- Drawing Exercises:
- **SFD/BMD:** For continuous beams using moment distribution method.
- **Influence Line Diagrams:** For beams and trusses.
- **Deflected Shapes:** For various structural systems.

SUBJECT CODE: BTCE304
SUBJECT NAME: GEOLOGY FOR ENGINEERS
Course Objectives:

- To understand the fundamental principles of geology and earth processes.
- To identify minerals, rocks, and geological structures relevant to engineering projects.
- To study geological factors affecting construction, tunneling, and foundation design.
- To analyze geological hazards (earthquakes, landslides) and mitigation measures.
- To apply geological knowledge to site investigation and civil engineering projects.

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

CO1	Identify common minerals and rocks used in construction.
CO2	Interpret geological maps and understand subsurface geology.
C03	Analyze geological factors affecting dam, tunnel, and foundation design.
C04	Assess geological hazards and recommend mitigation measures.

Unit	Content	Credit	Weightage
I	Introduction and Mineralogy **Introduction to Engineering Geology:** Scope, importance, branches of geology **Earth Structure:** Internal constitution, plate tectonics, continental drift **Mineralogy:** Physical properties of minerals, study of common rock-forming minerals (quartz, feldspar, mica, calcite, amphibole, clay minerals) **Optical Properties:** Basics of polarizing microscope	1	25%

	Weathering: Types, processes, engineering significance **Geological Time Scale:** Relative and absolute dating methods		
II	Petrology and Structural Geology **Petrology:** Classification of rocks **Igneous:** Formation, texture, common types (granite, basalt, gabbro) **Sedimentary:** Formation, bedding, common types (sandstone, limestone, shale) **Metamorphic:** Agents, foliation, common types (gneiss, schist, marble, slate) **Structural Geology:** **Folds:** Types, terminology, engineering significance **Faults:** Classification, recognition in field, engineering problems **Joints:** Types, spacing, orientation, effect on rock mass strength **Unconformities:** Types and engineering implications	1	25%
III	Engineering Geology Applications **Geological Investigations for Engineering Projects:** Site investigation methods Geophysical methods (seismic, electrical resistivity) **Geology of Construction Materials:** Building stones, aggregates, clay Quality requirements and testing **Geology of Dams and Reservoirs:** Site selection factors Geological problems (leakage, uplift pressure) **Geology of Tunnels:** Alignment selection Geological problems (water ingress, rock bursts, squeezing ground)	1	25%
IV	Geological Hazards and Groundwater **Geological Hazards:** **Earthquakes:** Causes, measurement, seismic zones of India **Landslides:** Types, causes, preventive measures **Subsidence:** Causes and control **Groundwater Geology:** Occurrence and movement Aquifer types, well hydraulics basics Groundwater problems in excavations **Coastal and River Geology:** Coastal erosion and protection River morphology and bank protection	1	25%

	Geology of Foundations: Bearing capacity considerations Settlement problems		

TEXT BOOKS:

- **"Engineering Geology"** by N. Chenna Kesavulu, Macmillan Publishers India.
- **"Geology for Engineers"** by F.G. Bell, Butterworth-Heinemann.
- **"Engineering and General Geology"** by Parbin Singh, S.K. Kataria & Sons.

REFERENCE BOOKS:

- **"Principles of Engineering Geology"** by K.V.G.K. Gokhale & B.C. Sharma, Tata McGraw Hill.
- **"Engineering Geology"** by Subinoy Gangopadhyay, Oxford University Press.
- **"Fundamentals of Engineering Geology"** by P.T. Sawant, S. Chand Publishing.
- **"Geology for Civil Engineers"** by A.C. McLean & C.D. Gribble, Routledge.
- **"Engineering Geology: Rock in Engineering Construction"** by Richard E. Goodman, Wiley.
- **"Indian Mineral Resources"** by S. Krishnaswamy, S. Chand Publishing.
- **"Geological Maps** by A. Maltman, Wiley.

ONLINE RESOURCES:

- **NPTEL:**
  1. "Engineering Geology" by IIT Roorkee
  2. "Geology for Engineers" by IIT Kharagpur
  3. "Earth Science" by IIT Bombay
  4. "Applied Geology" by IIT (ISM) Dhanbad
- **Coursera:**
  1. "Our Earth: Its Climate, History, and Processes" (University of Manchester)
  2. "Geology: Earth Science for Everyone" (University of Colorado Boulder)
  3. "Planet Earth...and You!" (University of Illinois)

SUBJECT CODE: BTCE305
SUBJECT NAME: AUTOCAD CIVIL 3D BASIS
Course Objectives:

- **To introduce** the fundamental concepts and interface of AutoCAD Civil 3D software.
- **To develop** skills in creating and managing civil engineering drawings digitally.
- **To train** students in generating topographic surfaces, contours, and earthwork calculations.
- **To enable** students to design alignments, profiles, and cross-sections for transportation projects.
- **To familiarize** with corridor modeling for roads, highways, and site development.
- **To introduce** pipe network design for stormwater and utility systems.
- **To develop** competency in creating construction documentation and quantity takeoffs.
- **To prepare** students for industry-standard civil design practices and workflows.

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

CO1	Navigate the Civil 3D interface and set up drawing templates with appropriate units, scales, and layers.

CO2	Create, import, and manage survey points and generate topographic surfaces from point data.
C03	Design horizontal alignments and vertical profiles for roads and plot them in profile views.
C04	Model corridors using assemblies, calculate earthwork volumes, and generate cross-sections.

PRACTICAL LIST:

Exercise 1: Getting Started with Civil 3D	Create 50-100 sample points	Modify surface by adding/removing points	Shoulder (1.5m)	Shoulder (1.5m)	Module 4: Parcels & Pipe Networks (Weeks 9-12)	Create pipe network profile
Interface Navigation:	**Point Groups and Styles:**	Calculate surface volume between two surfaces	Ditch	Ditch	Exercise 7: Parcel Layout	Add pipe and structure labels
Workspace setup (Civil 3D workspace)	Create point groups based on description codes	Exercise 4: Alignment Creation	Embankment	Embankment	**Site Parcel Creation:**	Create pipe network tables
Tool space (Prospector, Settings, Survey)	Assign different point styles and labels	**Horizontal Alignment:**	Subassembly properties and parameters	Subassembly properties and parameters	Create parcels from existing polylines	**Interference Check:**
Tool palettes and Ribbon customization	Edit point elevations and properties	Create alignment from polyline	**Corridor Modeling:**	**Corridor Modeling:**	Subdivide large parcel into 6 smaller lots	Check conflicts between pipes and other utilities
Command line and dynamic input	**Point Table Generation:**	Design using tangents, curves, and spirals	Create corridor using alignment, profile, and assembly	Create corridor using alignment, profile, and assembly	Add parcel labels (area, lot number)	Adjust vertical alignments
Drawing Setup:	Create point tables	Add superelevation data	Set frequency lines (10m interval)	Set frequency lines (10m interval)	**Parcel Styles and Tables:**	Exercise 9: Grading and Earthworks
Setting units (Metric/Imperial)	Export points to external files	**Alignment Labels and Tables:**	Add regions with different assemblies	Add regions with different assemblies	Create parcel area tables	**Feature Line Creation:**
Drawing scale and limits	Exercise 3: Surface Creation	Stationing (0+000 to 5+000)	**Corridor Surface:**	**Corridor Surface:**	Apply different styles to different parcel types	Create grading feature lines
Layer creation and management	**TIN Surface from Points:**	Create station offset labels	Extract corridor surface	Extract corridor surface	Renumber parcels	Set feature line elevations
Template usage (.dwt files)	Create surface from imported points	Generate alignment table	Create boundary for corridor surface	Create boundary for corridor surface	**Right-of-Way Creation:**	Create grading groups
Basic Drawing Commands	Add boundary to surface	**Profile Creation:**	Calculate cut/fill volumes	Calculate cut/fill volumes	Create road right-of-way	**Surface Grading:**

Practice:					(30m width)	
Create a simple site boundary (500m × 300m)	Surface style customization (contours, triangles, points)	Create surface profile along alignment	Exercise 6: Cross-Sections	Exercise 6: Cross-Sections	Set back lines from ROW	Create parking lot grading (2% slope)
Add text and dimensions	**Surface Analysis:**	Design profile (vertical curves, grades)	**Sample Line Creation:**	**Sample Line Creation:**	Exercise 8: Pipe Networks	Create building pad (100m × 50m)
Plot setup and page layout	Create contour map (1m interval)	Profile view creation with multiple profiles	Create sample lines along alignment (50m interval)	Create sample lines along alignment (50m interval)	**Storm Drainage Network:**	Calculate cut/fill for building pad
Module 2: Points, Surfaces & Alignments (Weeks 3-5)	Perform slope analysis (color-coded slope map)	Module 3: Corridors & Sections (Weeks 6-8)	Define sample line groups	Define sample line groups	Create pipe network (gravity system)	Exercise 10: Integrated Project
Exercise 2: Point Creation and Management	Elevation banding	Exercise 5: Assembly and Corridor Creation	**Section Views:**	**Section Views:**	Add pipes (300mm, 450mm diameter)	Design a small residential subdivision with:
Importing Survey Data:	Watershed analysis	**Assembly Creation:**	Create multiple section views	Create multiple section views	Add structures (manholes, inlets)	**Site Layout:**
Create point file format (.txt/.csv)	**Surface Editing:**	Create typical road assembly:	Add materials (cut/fill) to sections	Add materials (cut/fill) to sections	Set pipe slopes (minimum 0.5%)	200m × 150m site boundary
Import points from Excel (Northing, Easting, Elevation, Description)	Add breaklines	Lane (3.5m)	Label sections with elevations and offsets	Label sections with elevations and offsets	**Profile and Labels:**	20m wide road through center

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SEMESTER-IV

SUBJECT CODE: BTCE401

SUBJECT NAME: CONCRETE TECHNOLOGY

Course Objectives:

- To impart. knowledge of the properties and behavior of the constituent materials of concrete: cement, aggregates, water, and admixtures
- To understand the fundamental properties of fresh and hardened concrete, including workability, strength, durability, and elasticity.
- To learn the concepts of concrete mix design for proportioning concrete ingredients to achieve the desired strength and durability.
- To study special concretes, non-destructive testing methods, and the importance of quality control in concrete construction.
- To be familiar with common practices in concrete production, placing, compaction, and curing.

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

CO1	knowledge of the properties and behavior of the constituent materials of concrete: cement, aggregates, water, and admixtures
CO2	Understand the fundamental properties of fresh and hardened concrete, including workability, strength, durability, and elasticity.
C03	Learn the concepts of concrete mix design for proportioning concrete ingredients to achieve the desired strength and durability.
C04	Study special concretes, non-destructive testing methods, and the importance of quality control in concrete construction.

Unit	Content	Credit	Weightage
I	**Constituent Materials** • **Cement:** Chemical composition of OPC, hydration process, types of cement (PPC, PSC, RHPC, etc.), testing and storage. • **Aggregates:** Classification, physical and mechanical properties (grading, fineness modulus, bulking, moisture content, strength, toughness), soundness and deleterious materials. Lightweight and heavyweight aggregates. • **Water:** Quality requirements for mixing and curing. • **Chemical and Mineral Admixtures:** Accelerators, retarders, plasticizers, superplasticizers, air-entraining agents. Fly ash, GGBS, silica fume, metakaolin.	1	25%
II	• **Properties of Concrete**	1	25%

	• **Fresh Concrete:** Workability factors and measurement (Slump, Compaction Factor, Vee-Bee tests). Segregation, bleeding, and setting times. • **Hardened Concrete:** 1. **Strength:** Compressive, tensile, flexural strength. Factors affecting strength. Water-Cement Ratio law (Abram's Law), Gel-Space ratio. 2. **Elastic Properties:** Stress-strain behavior, modulus of elasticity, Poisson's ratio, creep, and shrinkage (plastic & drying). • **Durability of Concrete:** Significance, chemical attack (sulphate, chloride, acid), alkali-aggregate reaction, corrosion of reinforcement, freeze-thaw action. Permeability and its importance.		
III	**Concrete Mix Design and Production** • **Principles of Concrete Mix Design (IS 10262:2019):** Concept of target mean strength, statistical quality control. Steps in mix proportioning for nominal and design mixes. Introduction to ACI and DOE methods. • **Production and Practice:** Batching, mixing, transportation, placing, compaction (vibration techniques), finishing, and curing methods (water curing, membrane curing, steam curing).	1	25%
IV	**Special Concretes and Testing** **Special Concretes:** Introduction to Ready-Mix Concrete (RMC), Self-Compacting Concrete (SCC), High-Performance Concrete (HPC), Fiber-Reinforced Concrete (FRC), Shotcrete, Mass Concrete. **Testing of Concrete:** Destructive testing of cubes/cylinders. **Non-Destructive Testing (NDT):** Rebound Hammer (Schmidt Hammer), Ultrasonic Pulse Velocity (UPV), Rebar locator, Cover meter, Core extraction and testing. **Quality Control:** Introduction to statistical methods, control charts for concrete strength.	1	25%

TEXT BOOKS:

- **M.S. Shetty,** *Concrete Technology: Theory and Practice*, S. Chand & Company.
- **A.M. Neville & J.J. Brooks,** *Concrete Technology*, Pearson Education.

REFERENCE BOOKS:

- **Gambhir, M.L.,** *Concrete Technology*, McGraw Hill Education.
- **IS Codes:** *IS 456:2000 (Plain & Reinforced Concrete), IS 10262:2019 (Concrete Mix Design), IS 516:2021 (Strength Testing), IS 13311 (Part 1 & 2):1992 (NDT Methods)*.
- **P. Kumar Mehta & Paulo J.M. Monteiro,** *Concrete: Microstructure, Properties, and Materials*, McGraw Hill.

- **Santhakumar, A.R.,** *Concrete Technology*, Oxford University Press.

ONLINE RESOURCES

- **NPTEL:** Courses by Prof. B. Bhattacharjee (IIT Delhi) and Prof. Manu Santhanam (IIT Madras).
- **MIT Open Course Ware (OCW):** Resources on Civil Engineering Materials.

PRACTICAL LIST:

- **Tests on Cement:** Fineness (by sieving/air permeability), Standard consistency, Initial & Final setting time, Compressive strength of cement mortar.
- **Tests on Aggregates:**
  - Sieve analysis (grading), Fineness Modulus calculation.
  - Specific gravity, water absorption, and bulk density.
  - Aggregate impact value and abrasion value (Los Angeles).
- **Tests on Fresh Concrete:**
  - Workability: Slump Test, Compaction Factor Test.
  - Measurement of air content (Air Entrainment Meter).
- **Tests on Hardened Concrete:**
  - Casting, curing, and compressive strength testing of concrete cubes/cylinders at 7 & 28 days.
  - Flexural strength test on beams.
  - Demonstration of **Non-Destructive Tests:** Rebound Hammer and Ultrasonic Pulse Velocity.
- **Demonstration / Mix Design Exercise:**
  - Demonstration of concrete mixing, batching, and casting.
  - **Major Experiment:** Complete mix design (as per IS 10262) for a given grade, followed by batching, casting, curing, and testing to verify the target strength.
  - Effect of admixtures (super plasticizer) on workability and strength.

SUBJECT CODE: BTCE402

SUBJECT NAME: GEOTECHNICAL ENGINEERING

Course Objectives:

- To introduce the fundamental principles of soil mechanics and its application in civil engineering.
- To understand soil formation, classification, and index properties of soils.
- To analyse soil permeability, seepage, and effective stress concepts.
- To evaluate stress distribution in soil masses and soil compaction characteristics.
- To determine shear strength parameters and consolidation behavior of soils.
- **Course Outcomes:** At the end of the course students shall be able to

CO1	Introduce the fundamental principles of soil mechanics and its application in civil engineering.
CO2	Understand soil formation, classification, and index properties of soils.
C03	Analyse soil permeability, seepage, and effective stress concepts.
C04	Evaluate stress distribution in soil masses and soil compaction characteristics.

Unit	Content	Credit	Weightage

I	Introduction to Soil Mechanics and Soil Classification **Soil Formation:** Weathering processes, residual and transported soils, major soil deposits of India. **Basic Definitions:** Three-phase system (solid, water, air), void ratio, porosity, degree of saturation, water content, specific gravity. **Index Properties:** Determination of particle size distribution (sieve and hydrometer analysis), consistency limits (Atterberg limits: liquid limit, plastic limit, shrinkage limit). **Soil Classification Systems:** IS Classification (IS 1498), Unified Soil Classification System (USCS), AASHTO system. **Soil Compaction:** Standard and modified Proctor tests, factors affecting compaction, field compaction control.	1	25%
II	Soil Water and Seepage Analysis **Permeability:** Darcy's law, factors affecting permeability, laboratory determination (constant head and falling head tests), field permeability tests. **Effective Stress Principle:** Total, neutral, and effective stresses, quick sand condition, capillary rise in soils. **Seepage Analysis:** Laplace equation, flow nets – construction and applications (seepage quantity, uplift pressure, exit gradient), seepage through earth dams. **Stress Distribution in Soils:** Boussinesq's theory for point load, line load, and uniformly loaded area (circular and rectangular), Westergaard's theory, Newmark's influence chart, pressure bulb concept.	1	25%
III	Consolidation and Shear Strength **Consolidation:** Terzaghi's one-dimensional consolidation theory, spring analogy, pre-consolidation pressure, normally and over-consolidated clays. **Consolidation Test:** Determination of compression index, coefficient of consolidation (square root of time and logarithm of time methods), secondary compression. **Shear Strength:** Mohr-Coulomb failure criterion, drained and untrained conditions, total and effective stress parameters. **Shear Strength Tests:** Direct shear test, unconfined compression test, triaxial test (UU, CU, CD), vane shear test, pore pressure parameters.	1	25%
IV	Earth Pressure Theories and Stability Analysis **Lateral Earth Pressure:** Earth pressure at rest, active and passive states, Rankine's theory (cohesive and cohesionless	1	25%

	soils, submerged and inclined backfill), Culmann's graphical method. **Retaining Walls:** Types, stability checks against overturning, sliding and bearing capacity, drainage behind retaining walls. **Slope Stability:** Infinite and finite slopes, factor of safety, Swedish circle method, friction circle method, Taylor's stability number. **Introduction to Shallow Foundations:** Types, bearing capacity concepts (Terzaghi, Meyerhof, IS methods), settlement analysis.		

TEXT BOOKS:

- **Braja M. Das,** *Principles of Geotechnical Engineering*, Cengage Learning.
- **K. R. Arora,** *Soil Mechanics and Foundation Engineering*, Standard Publishers.
- **Gopal Ranjan & A.S.R. Rao,** *Basic and Applied Soil Mechanics*, New Age International.

REFERENCE BOOKS:

- **V.N.S. Murthy,** *Textbook of Soil Mechanics and Foundation Engineering*, CBS Publishers.
- **T.W. Lambe & R.V. Whitman,** *Soil Mechanics*, John Wiley & Sons.
- **B.M. Das,** *Advanced Soil Mechanics*, Taylor & Francis.
- **IS Codes:** *IS 2720 (Various Parts - Soil Testing Methods), IS 1498 (Soil Classification), IS 6403 (Bearing Capacity), IS 8009 (Foundation Design).*

ONLINE RESOURCES

- **NPTEL:** Comprehensive courses by Prof. N. Sivakugan (IIT Madras) and Prof. B. V. S. Viswanadham (IIT Bombay).
- **MIT Open Course Ware:** Course "Soil Behaviour" and related geotechnical resources.

PRACTICAL LIST:

- Practical 1: Identification of Common Rock-Forming Minerals.
- Practical 2: Identification and Classification of Igneous Rocks.
- Practical 3: Identification and Classification of Sedimentary Rocks.
- Practical 4: Identification and Classification of Metamorphic Rocks. Practical 5: Study of Geological Maps and Construction of Geological Cross-Sections.
- Practical 6: Interpretation of Geological Structures from Maps and Models.
- Practical 7: Stereo net Plotting and Analysis of Structural Data.
- Practical 8: Interpretation of Engineering Geophysical Data. Practical
- 9: Determination of Physical and Index Properties of Rocks.
- Practical 10: Identification and Classification of Soils for Engineering Purposes.
- Practical 11: Engineering Geological Field Visit and Report.
- Practical 12: Project-Based Case Study Analysis.

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SUBJECT CODE: BTCE403
SUBJECT NAME: SRUCTURAL ANALYSIS-II

Course Objectives:

- To analyze indeterminate structures using force and displacement methods.
- To introduce matrix methods for structural analysis.
- To understand the analysis of beams, frames, arches, and cables under various loads.
- To apply analysis techniques to moving loads and influence lines.
- To develop problem-solving skills for real-world indeterminate structures.

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

CO1	Able to analyze indeterminate structures using force and displacement methods.
CO2	Able to introduce matrix methods for structural analysis.
C03	Able to understand the analysis of beams, frames, arches, and cables under various loads.
C04	Able to apply analysis techniques to moving loads and influence lines.

Unit	Content	Credit	Weightage
I	**Force Method (Flexibility Method)** • Static and kinematic indeterminacy • Principle of superposition, compatibility conditions • Analysis of beams, frames, and trusses by force method • Application to settlements, temperature changes	1	25%
II	**Displacement Method (Slope Deflection Method)** • Slope-deflection equations • Analysis of continuous beams and frames without side-sway • Analysis of frames with side-sway	1	25%
III	**Matrix Methods of Structural Analysis** • Flexibility matrix method • Stiffness matrix method • Coordinate transformation, assembly of global stiffness matrix • Analysis of beams and plane frames using matrix methods	1	25%
IV	• **Moving Loads and Influence Lines** • Influence lines for determinate beams and trusses • Muller-Breslau principle for indeterminate structures • Absolute maximum bending moment and shear force • Analysis for rolling loads (concentrated and UDL)	1	25%

TEXT BOOKS:

- Structural Analysis by R. C. Hibbeler
- Theory of Structures by S. Ramamrutham
- Indeterminate Structural Analysis by C. K. Wang
- Basic Structural Analysis by Reddy

REFERENCE BOOKS:

- Structural Analysis by T. S. Thandava moorthy
- Matrix Analysis of Structures by Aslam Kassimali
- Advanced Structural Analysis by Devdas Menon
- Structural Analysis: A Unified Classical and Matrix Approach by Ghali, Neville, and Brown

ONLINE RESOURCES:

- NPTEL – Courses by Prof. Devdas Menon / Prof. R. P. Katta
- Coursera – "Structural Analysis" by Georgia Tech

PRACTICAL LIST:

- Solving a two-span continuous beam using flexibility coefficients
- Analysis of a portal frame with side-sway by force method
- Truss analysis with redundant members
- Analysis of a continuous beam with fixed and simply supported ends
- Frame analysis with joint translations
- Moment distribution method (as an extension) – quick analysis of beams
- Formulating flexibility matrix for a propped cantilever beam
- Developing stiffness matrix for a simple frame
- MATLAB/Excel implementation for solving 2D frame
- Drawing ILD for reactions, shear, moment in continuous beams
- Determining critical load positions for given bending moment
- Analysis of bridge trusses for moving loads
- Force method analysis of a continuous beam experimentally (using simply supported beam setup with added supports).
- Slope-deflection analysis of a two-story frame manually and using structural software.
- Matrix stiffness method applied to a 2D truss using Excel/MATLAB.
- Influence line analysis for a bridge model under moving point loads.

SUBJECT CODE: BTCE404

SUBJECT NAME: WATER RESOURCE ENGINEERING

Course Objectives:

- To introduce fundamental hydrological processes and the hydrological cycle.
- To impart knowledge of surface water and groundwater resource assessment.
- To teach the planning, design, and management of irrigation systems.
- To familiarize students with water resource planning concepts including reservoirs and dams.

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

CO1	**Analyze** hydrological processes and estimate key parameters like rainfall, runoff, and evaporation.
CO2	**Design** basic hydraulic structures and irrigation systems.
C03	**Apply** principles of groundwater hydrology and well hydraulics.

C04	**Evaluate** water resource systems for planning and management.

Unit	Content	Credit	Weightage
I	**Engineering Hydrology** Hydrological cycle, water budgets Precipitation: forms, measurement, data analysis, frequency analysis Abstraction from precipitation: evaporation, infiltration, evapotranspiration Runoff: factors, measurement, hydrographs, unit hydrograph theory	1	25%
II	**Surface Water Systems & Irrigation** Streamflow measurement: stage-discharge relations Reservoir planning: types, storage zones, mass curves, sedimentation Irrigation: necessity, methods (surface, drip, sprinkler), water requirements Canal design: alignment, lining, losses, Kennedy's and Lacey's theories	1	25%
III	**Groundwater Engineering** Aquifer properties: porosity, permeability, storativity Darcy's law, groundwater flow equations (introduction) Well hydraulics: steady and unsteady flow, pumping tests Groundwater exploration and recharge methods	1	25%
IV	**Water Resources Planning & Hydraulic Structures** Water resource planning: concepts, single and multi-purpose projects Dams: types, selection criteria, forces, gravity dam stability analysis Spillways and energy dissipators River training works and flood control	1	25%

TEXT BOOKS:

- Engineering Hydrology by K. Subramanya (McGraw Hill)
- Water Resources Engineering by Larry W. Mays (Wiley)
- Irrigation Engineering and Hydraulic Structures by Santosh Kumar Garg (Khanna Publishers)
- Groundwater Hydrology by David K. Todd & Larry W. Mays (Wiley)

REFERENCE BOOKS:

- Applied Hydrology by Ven Te Chow, David Maidment, & Larry Mays (McGraw Hill)
- Water-Resources Engineering by David A. Chin (Pearson)
- Hydrology and Water Resources Engineering by Patra (Narosa)
- Hydrology: Principles, Analysis, and Design by H. M. Raghunath (New Age)

ONLINE RESOURCES:

- NPTEL – Courses by Prof. Rajesh Srivastava (IIT Roorkee) & Prof. P. K. Mohanty (IIT Kharagpur)

- Coursera – "Water Resources Management and Policy" (University of Geneva)

SUBJECT CODE: BTCE405
SUBJECT NAME: PROFESSIONAL ETHICS
Course Objectives:

- To instil a foundational understanding of moral philosophy, values, and ethical theories relevant to engineering.
- To familiarize students with professional codes of conduct, such as those from ASCE, IEEE, and national engineering bodies.
- To develop the analytical skills needed to address ethical conflicts involving public safety, conflicts of interest, environmental responsibility, and intellectual property.
- To emphasize the engineer's social responsibility towards sustainable development, risk management, and ethical leadership.

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

CO1	**Explain** the core principles, theories, and codes of ethics governing the engineering profession.
CO2	**Analyze** real-world engineering scenarios to identify ethical dilemmas, conflicts of interest, and issues of professional responsibility.
C03	**Apply** systematic frameworks for ethical reasoning and decision-making to resolve professional dilemmas.
C04	**Recognize** the critical importance of safety, sustainability, and social welfare in engineering practice, including the engineer's role in risk assessment and whistleblowing.

Unit	Content	Credit	Weightage
I	**Foundations of Engineering Ethics** **Ethics vs. Morality:** Definitions, scope, and importance in engineering. **Moral Reasoning & Ethical Theories:** Utilitarianism (Bentham, Mill) Duty Ethics (Kant) Rights Ethics Virtue Ethics **Professionalism & Codes of Ethics:** Characteristics of a profession. Purpose, structure, and limitations of professional codes (using ASCE/IEI as primary examples). The concept of **self-regulation**. **Core Professional Responsibilities:** Paramountcy of public safety, health, and welfare. Competence and lifelong learning. Honesty, integrity, and impartiality.	1	50%
II	**Applications and Contemporary Issues in Engineering Ethics**	1	50%

	Ethical Decision-Making Frameworks: Systematic steps for analyzing and resolving dilemmas (e.g., the *Line-Drawing* method, *Potter Box*). **Key Areas of Ethical Conflict:** **Conflict of Interest:** Types (actual, potential, apparent) and management. **Risk, Safety, and Informed Consent:** The engineer's role in risk assessment, communication, and the **precautionary principle**. **Whistleblowing:** Conditions for justification, ethical dilemmas, and institutional support/protection. **Intellectual Property & Credit:** Plagiarism, confidentiality, and fair credit assignment. **Engineer's Broader Societal Role:** **Environmental Ethics:** Sustainable development, stewardship, and the triple bottom line. **Globalization and Ethics:** Cross-cultural issues, bribery, and the *Foreign Corrupt Practices Act*. **Case Studies:** Analysis of major engineering failures (e.g., *Challenger*, *Bhopal*, *Grenfell Tower*) and success stories from an ethical perspective.		

TEXT BOOKS:

- "Engineering Ethics: Concepts and Cases" by Charles E. Harris, Jr., Michael S. Pritchard, and Michael J. Rabins.
- "Ethics in Engineering Practice and Research" by Caroline Whitbeck.

REFERENCE BOOKS:

- "Professional Ethics in Engineering" by R. Subramanian.
- "The Ethical Engineer: Contemporary Concepts and Cases" by Robert McGinn.
- "Codes of Ethics" from major professional bodies (e.g., ASCE, Institution of Engineers India (IEI), NSPE).

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SEMESTER-V

SUBJECT CODE: BTCE501
SUBJECT NAME: DESIGN OF RC STRUCTURES

Course Objectives:

- To impart knowledge of limit state design philosophy and material properties.
- To develop skills in designing flexural members (beams and slabs).
- To teach design of compression members (columns) and foundations.
- To introduce concepts of detailing, serviceability, and seismic provisions.

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

CO1	**Apply** fundamental principles of limit state design to RC elements.
CO2	**Design** beams, slabs, columns, and footings as per IS 456:2000.
C03	**Analyze** and detail shear, torsion, and serviceability requirements.
C04	**Prepare** structural drawings and detailing for RC elements.

Unit	Content	Credit	Weightage
I	**Introduction & Design Philosophy** RC materials: Concrete and steel properties Limit state design philosophy (IS 456) Load combinations and partial safety factors Analysis of singly/doubly reinforced rectangular sections	1	25%
II	**Design of Beams for Shear, Torsion & Serviceability** Shear behavior and design (IS 456 provisions) Design of shear reinforcement Torsion in RC members (theory and design) Serviceability limit states: Deflection, cracking control	1	25%
III	**Design of Slabs & Columns** One-way and two-way slab design (IS 456) Flat slabs introduction Column design: Short column (axial, uniaxial, biaxial bending) Slender columns concept Column reinforcement detailing	1	25%
IV	**Design of Foundations & Special Topics** Isolated footings: Axial and eccentric loading Combined footings introduction Introduction to earthquake-resistant design (IS 13920) Retaining walls introduction (cantilever type)	1	25%

TEXT BOOKS:

- "Reinforced Concrete Design" by S. Unnikrishna Pillai & Devdas Menon (McGraw Hill)
- "Limit State Design of Reinforced Concrete" by V. L. Shah & S. R. Karve (Structures Publications)

- "Design of Reinforced Concrete Structures" by S. Ramamrutham (Dhanpat Rai)
- "Reinforced Concrete Design" by N. Subramanian (Oxford University Press)

REFERENCE BOOKS:

- "IS 456:2000 Plain and Reinforced Concrete - Code of Practice" (BIS)
- "IS 13920:2016 Ductile Detailing of RC Structures" (BIS)
- "SP 16:1980 Design Aids for Reinforced Concrete to IS 456" (BIS)
- "Reinforced Concrete Fundamentals" by Phil M. Ferguson

ONLINE RESOURCES:

- NPTEL – Courses by Prof. N. Dhang (IIT KGP) & Prof. A. K. Jain (IIT Delhi)
- Coursera – "Concrete Technology" (Delft University of Technology)

PRACTICAL LIST:

- Design of singly reinforced rectangular beam
- Design of doubly reinforced beam
- Use of SP-16 design charts
- Preparation of typical beam cross-section detailing
- Design of beam for shear and torsion
- Check for deflection control
- Detailing of shear links and stirrups
- Crack width calculation for serviceability
- Design of simply supported one-way slab
- Design of two-way slab using coefficient method
- Design of short column with uniaxial bending
- Preparation of slab reinforcement detailing drawings
- Design of square isolated footing
- Design of wall footing
- Detailing of ductile RC beam as per IS 13920
- Complete structural drawing of a small RC building frame

SUBJECT CODE: BTCE502

SUBJECT NAME: TRANSPORTATION ENGINEERING

Course Objectives:

- To introduce the scope, importance, and modes of transportation systems.
- To impart knowledge of highway geometric design, alignment, and intersections.
- To teach the design principles of flexible and rigid pavements.
- To introduce traffic engineering, control devices, and transportation planning basics.

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

CO1	**Analyze** transportation systems, traffic characteristics, and flow parameters.
CO2	**Design** geometric elements of highways and intersections based on standards.
C03	**Evaluate** pavement materials, design flexible and rigid pavements, and assess their performance.
C04	**Plan** basic transportation systems and apply traffic control and management techniques.

Unit	Content	Credit	Weightage

I	**Introduction & Highway Geometric Design** Transportation systems: Modes, characteristics, importance Highway development and planning in India (NHDP, PMGSY) Geometric design: Cross-section elements, sight distances (SSD, OSD, ISD) Horizontal alignment: Superelevation, extra widening, transition curves Vertical alignment: Gradients, vertical curves	1	25%
II	**Traffic Engineering & Control** Traffic characteristics: Volume, speed, density, flow relationships Traffic studies: Volume, speed, OD, parking, and accident studies Traffic flow theory: Macroscopic and microscopic models Traffic control devices: Signs, signals, markings (IRC standards) Intersection design: At-grade (channelization, rotary), grade-separated	1	25%
III	**Pavement Materials & Design** Pavement types: Flexible, rigid, composite Pavement materials: Subgrade, aggregates, bitumen, cement Flexible pavement design: IRC 37 method, CBR approach, mechanistic-empirical basics Rigid pavement design: IRC 58 method, stresses in CC pavement (Westergaard's theory), joints	1	25%
IV	**Pavement Management & Transportation Planning** Pavement evaluation: Roughness (IRI), skid resistance, structural evaluation (Benkelman Beam, FWD) Pavement maintenance and rehabilitation strategies Transportation planning process: Trip generation, distribution, modal split, assignment (4-step model basics) Intelligent Transportation Systems (ITS): Components and applications Sustainable transportation: Concepts and green initiatives	1	25%

TEXT BOOKS:

- "Principles of Transportation Engineering" by Partha Chakroborty & Animesh Das (Prentice Hall India)
- "Highway Engineering" by S. K. Khanna & C. E. G. Justo (Nem Chand & Bros)
- "Traffic Engineering and Transportation Planning" by L. R. Kadiyali (Khanna Publishers)
- "Pavement Analysis and Design" by Yang H. Huang (Pearson)

REFERENCE BOOKS:

- "Transportation Engineering: An Introduction" by C. Jotin Khisty & B. Kent Lall (Pearson)
- "IRC (Indian Roads Congress) Codes & Guidelines (IRC: 37, 73, 86, etc.)
- "AASHTO (American Association of State Highway and Transportation Officials) Guidelines

- "Pavement Design and Materials" by A. T. Papagiannakis & E. A. Masad (Wiley)

ONLINE RESOURCES:

- NPTEL – Courses by Prof. B. K. Rao (IIT Bombay) & Prof. A. K. Sarkar (IIT Roorkee)
- Coursera – "Sustainable Urban Mobility" (Eindhoven University of Technology)

SUBJECT CODE: BTCE503

SUBJECT NAME: HYDROLOGY AND IRREGATION

Course Objectives:

- To understand the hydrological cycle and processes governing water movement.
- To learn methods of surface and groundwater estimation and flood routing.
- To design irrigation canals and understand irrigation methods.
- To plan and design water storage structures and evaluate irrigation efficiency.

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

CO1	**Analyze** hydrological processes and estimate key parameters (rainfall, evaporation, infiltration, runoff).
CO2	**Apply** hydrograph analysis techniques and design flood estimation methods.
C03	**Design** irrigation systems, canals, and related hydraulic structures.
C04	**Evaluate** water resource systems, reservoir capacity, and irrigation efficiencies.

Unit	Content	Credit	Weightage
I	**Engineering Hydrology Fundamentals** Hydrological cycle, water budget equation Precipitation: Forms, measurement, analysis (hyetograph, mass curve) Abstraction losses: Evaporation, evapotranspiration, infiltration (Horton's, Philip's equations) Runoff: Factors, measurement, runoff coefficients	1	25%
II	**Hydrograph Analysis & Flood Estimation** Streamflow measurement: Stage-discharge relationship Hydrographs: Components, base flow separation Unit hydrograph theory: Derivation, applications, S-hydrograph Flood estimation: Rational method, frequency analysis (Gumbel's method), flood routing (introductory)	1	25%
III	**Irrigation Engineering & Canal Design** Irrigation: Necessity, benefits, types Soil-water-plant relationships: Soil moisture constants, consumptive use, duty-delta Irrigation methods: Surface, sprinkler, drip irrigation Canal design: Alignment, losses, Kennedy's and Lacey's theories, canal lining	1	25%

IV	Water Storage & Irrigation Structures Reservoirs: Types, storage zones, capacity determination (mass curve method), sedimentation Dams: Types (gravity, earth), spillways, energy dissipators Irrigation structures: Headworks, cross-drainage works (aqueduct, syphon), outlets Irrigation water management: Efficiency, water logging, drainage	1	25%

TEXT BOOKS:

- "Engineering Hydrology" by K. Subramanya (McGraw Hill)
- "Irrigation Engineering and Hydraulic Structures" by Santosh Kumar Garg (Khanna Publishers)
- "Hydrology and Water Resources Engineering" by S. K. Garg (Khanna Publishers)
- "Water Resources Engineering" by Larry W. Mays (Wiley)

REFERENCE BOOKS:

- "Applied Hydrology" by Ven Te Chow, David Maidment & Larry Mays (McGraw Hill)
- "Groundwater Hydrology" by David K. Todd & Larry W. Mays (Wiley)
- "Irrigation: Theory and Practice" by A. M. Michael (Vikas Publishing)
- "Handbook of Hydrology" by David R. Maidment (McGraw Hill)

ONLINE RESOURCES:

- NPTEL – Courses by Prof. R. Srivastava (IIT Roorkee) & Prof. P. K. Mohanty (IIT Kharagpur)
- Coursera – "Water Resources Management" (University of Colorado)

PRACTICAL LIST:

- Rainfall data analysis: Intensity-Duration-Frequency (IDF) curves
- Infiltration test using double-ring infiltrometer
- Estimation of evaporation using empirical formulas
- Derivation of unit hydrograph from given storm data
- Flood frequency analysis using Gumbel's method
- Application of Rational method for small catchment runoff estimation
- Design of unlined canal using Lacey's theory
- Design of lined canal
- Calculation of irrigation water requirement for a crop
- Reservoir capacity determination using mass curve
- Design of ogee spillway profile
- Layout of canal network with cross-drainage works

SUBJECT CODE: BTCE504
SUBJECT NAME: CONSTRUCTION MANAGEMENT

Course Objectives:

- To introduce construction project lifecycle and organizational structures.
- To teach project planning, scheduling, and control methods using CPM/PERT.
- To develop skills in cost estimation, tendering, and contract management.
- To understand site management, safety, quality control, and emerging technologies.

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

CO1	**Apply** project planning, scheduling, and control techniques (CPM/PERT).
CO2	**Estimate** construction costs, prepare bids, and manage project budgets.
C03	**Analyze** resource allocation, site management, and quality control requirements.
C04	**Evaluate** safety regulations, contract administration, and modern construction technologies.

Unit	Content	Credit	Weightage
I	**Project Planning & Scheduling** Construction project lifecycle: Initiation, planning, execution, closure Work Breakdown Structure (WBS) Network analysis: CPM (Critical Path Method), PERT (Program Evaluation Review Technique) Float calculation, critical path identification Resource levelling and smoothing	1	25%
II	**Cost Estimation & Contract Management** Types of estimates: Preliminary, detailed, revised Rate analysis: Material, labor, equipment costs Tender process: Bid preparation, evaluation, award Contract types: Lump-sum, item-rate, cost-plus Contract documents and clauses	1	25%
III	**Construction Equipment & Site Management** Equipment selection: Earthmoving, hauling, concrete, hoisting equipment Equipment productivity and cost analysis Site layout planning: Temporary facilities, material storage Material management: Inventory control, procurement Quality control: Inspection, testing, quality assurance plans	1	25%
IV	**Safety, Modern Practices & Professional Ethics** Construction safety: OSHA standards, Indian Factories Act, safety management plans Accident prevention, personal protective equipment (PPE) Emerging technologies: BIM (Building Information Modeling), prefabrication, IoT in construction Green building concepts (LEED/IGBC) Professional ethics and role of project manager	1	25%

TEXT BOOKS:

- "Construction Project Management: Planning, Scheduling and Controlling" by K. K. Chitkara (McGraw Hill)
- "Construction Management: Theory and Practice" by N. P. A. Smith & A. R. T. Horman (Pearson)
- "Construction Planning, Equipment and Methods" by R. L. Peurifoy & C. J. Schexnayder (McGraw Hill)

- "Project Management for Engineering and Construction" by G. D. Oberlender (McGraw Hill)

REFERENCE BOOKS:

- "Construction Project Management" by S. Seetharaman (Umesh Publications)
- "Estimating and Costing in Civil Engineering" by B. N. Dutta (UBS Publishers)
- "CPWD Specifications & Schedule of Rates (CPWD Publications)
- "IS Codes (IS 7272, IS 1200, IS 383, etc.)

ONLINE RESOURCES:

- NPTEL – Courses by Prof. A. K. Sachdeva (IIT Roorkee) & Prof. B. V. S. Viswanadham (IIT Bombay)
- Coursera – "Construction Management" (Columbia University)

SUBJECT CODE: BTCE505

SUBJECT NAME: PROJECT MANAGEMENT TOOLS

Course Objectives:

- To introduce manual and digital project planning methodologies.
- To develop proficiency in industry-standard scheduling software.
- To teach resource allocation, levelling, and cost-loading techniques.
- To enable monitoring and control through baseline comparison and progress tracking.

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

CO1	**Select** appropriate project planning tools for different construction project phases.
CO2	**Develop** Work Breakdown Structures (WBS), network diagrams, and Gantt charts.
C03	**Apply** software tools (MS Project/Primavera) to create schedules, allocate resources, and track progress.
C04	**Analyze** project performance using earned value management and reporting techniques.

PRACTICAL LIST:

- Category 1: Foundational Manual Techniques
- *Software used: Pen/Paper, Excel*
- Work Breakdown Structure (WBS) Development
    1. Create a WBS for a 2-storey residential building (minimum 4 levels).
    2. Develop a WBS dictionary with activity descriptions.
- Network Diagram Construction
    1. Draw Activity-on-Node (AON) and Activity-on-Arrow (AOA) diagrams for a small bridge construction project.
    2. Calculate forward/backward passes, identify critical path, and determine float values.
- Gantt Chart Creation
    1. Develop a manual Gantt chart for a water treatment plant project (15-20 activities).
    2. Apply different bar colors to indicate critical vs. non-critical activities.
- Category 2: Software-Based Scheduling (MS Project)
- *Software used: Microsoft Project*

4. Basic Schedule Creation

- Create a complete schedule for a school building project (30+ activities).

- Establish task dependencies (FS, SS, FF, SF), assign durations, and set milestones.
- Resource Allocation & Leveling
    1. Assign labor (masons, carpenters) and equipment (concrete mixer, crane) resources to activities.
    2. Perform resource leveling to resolve overallocations.
    3. Create resource histograms and usage graphs.
- Cost Loading & Budgeting
    1. Assign material and labor costs to activities.
    2. Generate S-curves for planned vs. actual expenditure.
    3. Create cash flow projections for the project.
- Category 3: Advanced Planning (Primavera P6)
- *Software used: Oracle Primavera P6*

7. Enterprise Project Structure Setup

- Create Organizational Breakdown Structure (OBS) and Work Breakdown Structure (WBS).
- Set up calendars (global, project, resource).
- Establish coding structures (activity codes, project codes).
- Complex Project Scheduling
    1. Schedule a highway construction project with multiple phases (earthwork, pavement, bridges).
    2. Apply constraints (start-on, finish-by, mandatory).
    3. Create multiple project baselines for comparison.
- Progress Monitoring & Control
    1. Update schedule with actual progress (percent complete, actual dates).
    2. Generate variance reports (schedule variance, cost variance).
    3. Create custom dashboards and portfolio views.
- Category 4: Integrated Tools & Special Applications
- *Software used: Excel, BIM tools, specialized software*

10. Earned Value Management (EVM) Analysis
- Calculate PV, EV, AC, CV, SV, CPI, SPI for a construction project.
- Forecast EAC and ETC using Excel templates.
- Create performance measurement charts.

- 4D BIM Scheduling Integration
    1. Link schedule activities with 3D BIM model elements (using Navisworks/Twinmotion).
    2. Create construction sequence animations.
    3. Identify spatial clashes in the schedule.
- Lean Construction Tools
    1. Develop Location-Based Scheduling (LBS) using flowline charts.
    2. Create Last Planner System® templates (weekly work plans, PPC tracking).
    3. Apply pull planning techniques for a repetitive construction process.
- Category 5: Real-World Applications
- Delay Analysis & Recovery Planning
    1. Analyze project delays using time-impact analysis.
    2. Develop accelerated/recovery schedules.
    3. Create what-if scenarios for delay mitigation.
- Reporting & Dashboard Creation
    1. Design custom reports: daily progress, weekly updates, monthly executive summaries.
    2. Create visual dashboards showing KPIs (schedule performance, resource utilization).

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SEMESTER-VI

SUBJECT CODE: BTCE601

SUBJECT NAME: DESIGN OF STEEL STRUCUTURE

Course Objectives:

- Introduce the fundamentals of steel as a structural material and its behavior under various loads.
- Enable students to understand and apply relevant IS codes (IS 800, IS 875, etc.) in the design of steel members and connections.
- Develop skills in designing tension members, compression members, beams, beam-columns, and bolted/welded connections.
- Familiarize students with the design of simple industrial structures such as roof trusses and gantry girders.
- Enhance practical design abilities through drawing-based assignments and software tools.

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

CO1	The fundamentals of steel as a structural material and its behavior under various loads.
CO2	To understand and apply relevant IS codes (IS 800, IS 875, etc.) in the design of steel members and connections.
C03	Develop skills in designing tension members, compression members, beams, beam-columns, and bolted/welded connections.
C04	Familiarize students with the design of simple industrial structures such as roof trusses and gantry girders.

Unit	Content	Credit	Weightage
I	**Introduction to Steel Structures** • Properties of structural steel, types of steel sections, advantages and disadvantages of steel structures. • Loads on structures: dead, live, wind, seismic, crane loads (as per IS 875). • Concept of limit state design, partial safety factors, load combinations. • Introduction to IS 800:2007.	1	25%
II	**Design of Connections** • Types of connections: bolted and welded. • Failure modes of bolted joints, design of bolted connections (bearing type and friction grip). • Welded connections: fillet and butt welds, design considerations. • Simple and moment-resistant connections.	1	25%
III	**Design of Members** • **Tension members:** Types, design as per IS 800, effect of shear lag. • **Compression members:** Slenderness ratio, buckling class, design of axially loaded columns, built-up columns, lacing and battening. • **Beams:** Laterally restrained and unrestrained beams, design for bending, shear, deflection, and web	1	25%

	buckling/crippling. • **Beam-columns:** Combined axial force and bending moment, interaction formula.		
IV	**Practical Applications and Industrial Structures** • Design of roof trusses (including purlins and sag rods). • Design of gantry girders for industrial buildings. • Introduction to plate girders and stiffener design. • Overview of steel frames (portal frames, multi-story frames).	1	25%

TEXT BOOKS:
- "Design of Steel Structures" by N. Subramanian – Oxford University Press.
- "Limit State Design of Steel Structures" by S.K. Duggal – McGraw Hill Education.

REFERENCE BOOKS:
- IS 800:2007 – Indian Standard for General Construction in Steel.
- IS 875 (All Parts) – Code of Practice for Design Loads.
- "Design of Steel Structures" by Ramachandra & Virendra Gehlot – Scientific Publishers.
- "Design of Steel Structures" by Edwin H. Gaylord, Jr. – McGraw Hill.

ONLINE RESOURCES:
- NPTEL Course: "Design of Steel Structures" by Prof. Damodar Maity (IIT Kharagpur).
- Steel Construction Institute (SCI) resources

PRACTICAL LIST:
- **Practical Module 1: Connection Detailing**
- Drawing of bolted connections (lap joint, butt joint with cover plates).
- Drawing of welded connections (beam-to-beam, beam-to-column).
- **Practical Module 2: Member Design & Detailing**
- Detailing of a tension member with lug angle and splice.
- Detailing of a built-up compression member with lacing/battening.
- **Practical Module 3: Beam & Column Detailing**
- Detailing of a laterally restrained steel beam with stiffeners.
- Detailing of a column base (slab base, gusseted base).
- **Practical Module 4: Industrial Structure Detailing**
- Layout and detailing of a steel roof truss (including joint details).
- Detailing of a gantry girder with bracket connection.

SUBJECT CODE: BTCE602
SUBJECT NAME: ENVIRONMENTAL ENGINEERING
Course Objectives:
- Explain the fundamental concepts of environmental chemistry, microbiology, and ecology relevant to engineered systems.
- Apply principles of water demand estimation, source selection, and water quality standards to public water supply planning.
- Design basic unit operations and processes for water treatment (screening, sedimentation, filtration, disinfection).

- Analyze and design preliminary and primary unit processes for wastewater collection and treatment (sewers, screens, grit chambers, sedimentation).
- Develop an integrated understanding of environmental protection laws and sustainable solid waste management practices.

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

CO1	Remembering & Understanding – Recall fundamental principles and comprehend the scope of environmental engineering.
CO2	Applying – Apply scientific and engineering principles to solve problems related to water supply and sanitation.
C03	Analyzing & Evaluating – Analyze data, evaluate alternatives, and design basic components of water and wastewater treatment systems.
C04	Creating & Synthesizing – Propose integrated solutions for solid waste management and understand societal/environmental contexts.

Unit	Content	Credit	Weightage
I	**Introduction & Water Supply Engineering** • **Introduction:** Multidisciplinary nature, scope, and historical context. Environmental legislation (Water Act, EPA). Concepts of sustainability and circular economy. • **Water Demand & Sources:** Population forecasting, per capita demand, types of demand, variations. Surface and groundwater sources, source selection, intake structures. • **Water Quality & Standards:** Physical, chemical, and biological characteristics. Drinking water standards (WHO, BIS). Introduction to water-borne diseases. • **Conveyance of Water:** Pipes, pumps, and basics of distribution systems (layout, service reservoirs).	1	25%

II	**Water Treatment**
	• **Unit Operations & Processes:** Theory and design of:
	  ○ **Screening & Aeration**
	  ○ **Sedimentation** (Plain & Chemical)
	  ○ **Coagulation & Flocculation**
	  ○ **Filtration** (Slow Sand, Rapid Sand, Pressure Filters)
	  ○ **Disinfection** (Chlorination, Ozonation, UV)
	• **Advanced Treatments:** Brief introduction to softening, desalination, and removal of specific contaminants (Fe, Mn, Fluoride).
		1	25%

III	**Wastewater Engineering**
	• **Wastewater Characteristics & Collection:** Quantity estimation, physical/chemical/biological characteristics. Sewerage systems (separate, combined), sewer appurtenances, materials, and construction aspects.
	• **Primary Treatment:** Design of:
	  ○ **Screens & Grit Chambers**
	  ○ **Primary Sedimentation Tanks**
	• **Introduction to Secondary Treatment:** Overview of biological treatment principles (Aerobic: Activated Sludge Process, Trickling Filters; Anaerobic: Septic Tanks, UASB). Effluent disposal standards.
		1	25%

IV	**Air Pollution & Solid Waste Management** • **Air Pollution:** Sources, classification, and effects of air pollutants. Ambient air quality standards. Basic control methods for particulate matter (Cyclones, ESP, Baghouses) and gaseous pollutants (Scrubbers). • **Solid Waste Management:** Sources, composition, and characteristics. Functional elements: Collection, segregation, storage, transportation, processing (composting, RDF), and disposal (landfills, incineration). Concept of 3Rs (Reduce, Reuse, Recycle).	1	25%

TEXT BOOKS:

- "Environmental Engineering" by Howard S. Peavy, Donald R. Rowe, George Tchobanoglous – McGraw Hill.
- "Water Supply Engineering" by Dr. B.C. Punmia, Dr. Arun K. Jain, Dr. Ashok K. Jain – Laxmi Publications.
- "Wastewater Engineering: Treatment and Resource Recovery" by Metcalf & Eddy, Inc. (5th Ed.) – McGraw Hill.

REFERENCE BOOKS:

- "Environmental Engineering" by P. Venugopala Rao – PHI Learning.
- "Water and Wastewater Technology" by Mark J. Hammer & Mark J. Hammer Jr. – Pearson.
- "CPHEEO Manuals on Water Supply & Treatment and Sewerage & Sewage Treatment" – Govt. of India Publications.
- "Introduction to Environmental Engineering" by Mackenzie L. Davis and David A. Cornwell – McGraw Hill.

ONLINE RESOURCES:

- NPTEL: "Water and Wastewater Engineering" by Prof. C. Venkobachar (IIT Bombay) and "Environmental Engineering - I" by Prof. B. J. Alappat (IIT Delhi).
- SWAYAM / MOOC Platforms: Relevant courses on water treatment and sustainable engineering.

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SUBJECT CODE: BTCE603
SUBJECT NAME: FOUNDATION ENGINEERING

Course Objectives:

- Understand soil-structure interaction and site investigation methods for foundation design.
- Evaluate bearing capacity and settlement of shallow foundations under different loading conditions.
- Analyze and design deep foundations (piles and caissons) for axial and lateral loads.
- Design retaining structures and slope stabilization methods.
- Apply geotechnical principles to solve practical foundation problems using codes and standards.

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

CO1	Select appropriate foundation types based on soil profiles and loading conditions.
CO2	Compute bearing capacity and settlement of shallow foundations using theoretical and empirical methods.
C03	Design and analyze pile foundations and evaluate pile load capacity.
C04	Design retaining walls and assess slope stability under various conditions.

Unit	Content	Credit	Weightage
I	**Introduction & Site Investigation** • **Overview:** Role of foundation engineering, types of foundations, failure cases. • **Soil Exploration:** Planning investigations, methods (SPT, CPT, geophysical), sampling techniques. • **Field Tests:** Standard Penetration Test (SPT), Cone Penetration Test (CPT), Plate Load Test. • **Soil Reports:** Interpretation of borehole data, preparation of geotechnical investigation reports.	1	25%
II	**Shallow Foundations** • **Bearing Capacity:** Terzaghi's, Meyerhof's, IS 6403 methods; effect of water table, eccentric and inclined loads. • **Settlement Analysis:** Immediate, consolidation, and creep settlement; allowable settlement criteria. • **Design of Footings:** Isolated, combined, strap, and raft foundations; proportioning and reinforcement detailing.	1	25%
III	**Deep Foundations** • **Pile Foundations:** Types (driven, bored, micro piles), load transfer mechanism, static and dynamic analysis. • **Pile Capacity:** Ultimate load capacity (α, β, λ methods), pile load tests, group efficiency, and settlement. • **Pile Design:** Structural design of piles, pile caps,	1	25%

	and connections; introduction to laterally loaded piles. • **Caissons & Wells:** Types, construction methods, design principles.		
IV	**Earth Retaining Structures & Slope Stability** • **Retaining Walls:** Types (gravity, cantilever, counterfort), earth pressure theories (Rankine, Coulomb), stability checks (overturning, sliding, bearing). • **Sheet Piles:** Cantilever and anchored walls, design principles. • **Slope Stability:** Modes of failure, infinite slope analysis, method of slices (Fellenius, Bishop), stabilization methods.	1	25%

TEXT BOOKS:

- "Principles of Foundation Engineering" by Braja M. Das – Cengage Learning.
- "Soil Mechanics and Foundation Engineering" by Dr. K. R. Arora – Standard Publishers.
- "Foundation Analysis and Design" by Joseph E. Bowles – McGraw Hill.

REFERENCE BOOKS:

- "Geotechnical Engineering: Principles and Practices" by Donald P. Coduto – Pearson.
- "IS 6403: Code of Practice for Determination of Bearing Capacity of Shallow Foundations.
- "IS 2911: Code of Practice for Design and Construction of Pile Foundations.
- "Foundation Design" by Wayne C. Teng – Prentice Hall.

ONLINE RESOURCES:

- NPTEL: "Foundation Engineering" by Prof. N. K. Samadhiya (IIT Roorkee).
- Coursera/edX: Geotechnical Engineering courses (e.g., "Soil Mechanics" by Georgia Tech).

PRACTICAL LIST:

Practical Module 1: Site Investigation & Soil Profiling

- Field Test Simulation: Analysis and interpretation of SPT/CPT data from field logs.
- Laboratory Correlation: Determining engineering properties (φ, c) from index properties for foundation design.

Practical Module 2: Shallow Foundation Design

- Bearing Capacity Calculation: Design of an isolated footing for given soil and load data using IS code.
- Settlement Estimation: Computation of total settlement for a proposed raft foundation.

Practical Module 3: Pile Foundation Design

- Pile Capacity Estimation: Calculation of ultimate load capacity for a single pile using static methods.
- Pile Group Analysis: Determination of group efficiency and settlement for a pile group.

Practical Module 4: Retaining Wall & Slope Stability

- Retaining Wall Design: Stability analysis (overturning, sliding, bearing) for a cantilever retaining wall.
- Slope Stability Analysis: Factor of safety calculation using method of slices for a given slope profile.

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SUBJECT CODE: BTCE604
SUBJECT NAME: REMOTE SENSING AND GIS

Course Objectives:

- Understand the fundamental principles of remote sensing, photogrammetry, and Geographic Information Systems (GIS).
- Acquire knowledge of different remote sensing platforms, sensors, and data types (optical, thermal, microwave).
- Apply image processing techniques for feature extraction, classification, and change detection in civil engineering applications.
- Develop skills in spatial data analysis, database management, and map creation using GIS software.
- Integrate RS and GIS for solving real-world civil engineering problems such as urban planning, watershed management, and infrastructure monitoring.

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

CO1	Explain the physics of remote sensing, sensor characteristics, and data acquisition platforms.
CO2	Perform basic digital image processing operations (enhancement, transformation, classification).
C03	Create, manage, and analyze spatial data using GIS tools and techniques.
C04	Apply RS & GIS in civil engineering domains like land use mapping, hydrological modeling, and transportation planning.

Unit	Content	Credit	Weightage
I	**Fundamentals of Remote Sensing** • **Introduction:** Definition, history, and scope in civil engineering. • **Electromagnetic Radiation (EMR):** EMR spectrum, interaction with atmosphere and earth surface (reflection, absorption, transmission). • **Platforms & Sensors:** Satellite orbits (geostationary, sun-synchronous), sensor types (active vs. passive), resolution (spatial, spectral, temporal, radiometric). • **Data Products:** Introduction to optical (Landsat, Sentinel), thermal, and microwave (SAR) data.	1	25%
II	**Digital Image Processing** • **Pre-processing:** Radiometric and atmospheric correction, geometric correction, image registration. • **Image Enhancement:** Contrast stretching, filtering (spatial and frequency domain). • **Image Transformation:** Indices (NDVI, NDWI), Principal Component Analysis (PCA). • **Image Classification:** Supervised and unsupervised classification, accuracy assessment.	1	25%
III	**Geographic Information Systems (GIS)**	1	25%

	• **Introduction to GIS:** Components, data models (vector, raster), coordinate systems and map projections. • **Spatial Data Input & Management:** Data digitization, scanning, GPS integration, attribute data, geodatabase concepts. • **Spatial Analysis:** Buffering, overlay operations, network analysis, interpolation techniques (IDW, Kriging). • **GIS Output:** Cartography, map design, and visualization.		
IV	**Applications in Civil Engineering** • **Land Use/Land Cover (LULC) Mapping:** Change detection analysis for urban sprawl. • **Water Resources Engineering:** Watershed delineation, flood mapping, and drought assessment. • **Transportation & Infrastructure:** Route planning, site suitability analysis, and pavement condition monitoring. • **Disaster Management:** Landslide susceptibility mapping, post-disaster damage assessment. • **Integration with BIM/CAD:** Introduction to geospatial data in civil engineering projects.	1	25%

TEXT BOOKS:

- "Remote Sensing and Image Interpretation" by Thomas M. Lillesand, Ralph W. Kiefer, Jonathan W. Chipman – Wiley.
- "Geographic Information Systems: A Management Perspective" by Stan Aronoff – WDL Publications.
- "Fundamentals of Remote Sensing" by George Joseph – Universities Press.

REFERENCE BOOKS:

- "Remote Sensing and GIS" by Basudeb Bhatta – Oxford University Press.
- "Introduction to Geographic Information Systems" by Kang-Tsung Chang – McGraw Hill.
- "Principles of Geographical Information Systems" by Peter A. Burrough, Rachael A. McDonnell, Christopher D. Lloyd – Oxford University Press.
- "Digital Image Processing" by Rafael C. Gonzalez and Richard E. Woods – Pearson.

ONLINE RESOURCES:

- NPTEL: "Remote Sensing and GIS" by Prof. R. Nagarajan (IIT Bombay) / "Principles of Remote Sensing" by Prof. P. K. Garg (IIT Roorkee).
- Coursera/edX: "GIS, Mapping, and Spatial Analysis" (University of Toronto), "Remote Sensing Image Acquisition, Analysis and Applications" (UNSW Sydney).

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SEMESTER-VII

SUBJECT CODE: BTCE701
SUBJECT NAME: EARTHQUAKE ENGINEERING

Course Objectives:

- Understand the causes of earthquakes, seismic waves, and measurement of earthquake parameters.
- Learn the principles of structural dynamics and response of single and multi-degree-of-freedom systems to earthquake ground motion.
- Comprehend and apply seismic codes (IS 1893, IS 13920, IS 4326) for the analysis and design of earthquake-resistant structures.
- Analyze and design structural systems and non-structural elements considering seismic loads and detailing for ductility.
- Evaluate seismic vulnerability and apply retrofitting techniques for existing structures.

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

CO1	Explain the seismological background, plate tectonics, and measurement of earthquake characteristics.
CO2	Formulate and solve equations of motion for SDOF and MDOF systems under seismic excitation.
C03	Perform equivalent lateral force analysis and response spectrum analysis as per IS 1893 (Part 1).
C04	Apply ductile detailing provisions (IS 13920) for reinforced concrete beams, columns, and beam-column joints.

Unit	Content	Credit	Weightage
I	**Seismology and Earthquake Characteristics** • **Introduction:** Earthquake engineering objectives and significance, historical earthquakes and lessons learned. • **Seismology:** Plate tectonics, fault types, seismic waves (P, S, surface waves), focus, epicenter, magnitude scales (Richter, Moment Magnitude), intensity scales (MMI, MSK). • **Strong Ground Motion:** Characteristics of accelerograms, frequency content, duration, factors affecting ground motion. • **Seismic Hazard:** Seismic zones of India (as per IS 1893), basics of seismic hazard analysis.	1	25%
II	**Structural Dynamics for Earthquake Engineering** • **Vibration Fundamentals:** Degrees of freedom, simple harmonic motion. • **Single-Degree-of-Freedom (SDOF) Systems:** Equation of motion (undamped and damped), free and forced vibration, Duhamel's integral. • **Response of SDOF Systems to**	1	25%

	Earthquake: Response history analysis, concept of response spectrum (pseudo-velocity, pseudo-acceleration, displacement). • **Multi-Degree-of-Freedom (MDOF) Systems:** Lumped mass model, mode shapes, natural frequencies, modal analysis, introduction to time history analysis.		
III	**Seismic Analysis and Design of Structures** • **Seismic Design Philosophy:** Concept of ductility, energy dissipation, capacity design, and strong-column weak-beam principle. • **Indian Seismic Codes:** Overview of IS 1893 (Part 1): Criteria for Earthquake Resistant Design of Structures. • **Seismic Analysis Methods:** Equivalent Static Lateral Force Method (as per IS 1893), Response Spectrum Method, introduction to dynamic analysis. • **Seismic Design of RC Structures:** Design lateral force calculation, story shear, drift limitations. Introduction to ductile detailing as per IS 13920 for beams, columns, and joints.	1	25%
IV	**Special Topics and Mitigation Strategies** • **Seismic Design of Masonry and Steel Structures:** Basic concepts for confined masonry and steel frames (braced and moment-resisting). • **Non-Structural Elements:** Seismic design considerations for partitions, cladding, and equipment. • **Seismic Evaluation and Retrofitting:** Vulnerability assessment of existing buildings, common deficiencies, retrofitting techniques (jacketing, shear walls, base isolation, dampers). • **Case Studies:** Analysis of performance of structures in past earthquakes.	1	25%

TEXT BOOKS:

- "Earthquake-Resistant Design of Structures" by Pankaj Agarwal and Manish Shrikhande – Prentice Hall of India.
- "Dynamics of Structures: Theory and Applications to Earthquake Engineering" by Anil K. Chopra – Pearson Education.
- "Earthquake Engineering" by Dr. S. K. Duggal – Oxford University Press.

REFERENCE BOOKS:

- "IS 1893 (Part 1): Criteria for Earthquake Resistant Design of Structures.
- "IS 13920: Ductile Detailing of Reinforced Concrete Structures Subjected to Seismic Forces.
- "Earthquake Tips" by C. V. R. Murty – IIT Kanpur / NICEE.

- "Fundamentals of Earthquake Engineering" by Amr S. Elnashai and Luigi Di Sarno – Wiley.

ONLINE RESOURCES:

- NPTEL: "Earthquake Engineering" by Prof. V. R. Panchanathan (IIT Roorkee) / "Dynamics of Structures" by Prof. A. K. Jain (IIT Roorkee).
- Coursera/edX: "Earthquake Engineering and Disaster Risk Reduction" (University of Tokyo), "Engineering of Structures: Response of Structures" (Dartmouth College).

SUBJECT CODE: BTCE702
SUBJECT NAME: ADVANCED CONCRETE DESIGN

Course Objectives:

- Apply limit state philosophy for the analysis and design of specialized reinforced and prestressed concrete elements.
- Design complex structural systems like continuous beams, slabs (two-way, flat, grid), and columns for combined axial and biaxial bending.
- Understand the principles of prestressing, losses, and design prestressed concrete beams for serviceability and ultimate strength.
- Design reinforced concrete structures for seismic forces and apply ductile detailing as per IS codes.
- Analyze and design deep beams, corbels, and other non-standard elements using strut-and-tie models.

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

CO1	Design continuous beams and one-way slabs for moment redistribution.
CO2	Analyze and design two-way slabs (flat slabs, grid floors) and columns subjected to biaxial bending.
C03	Design prestressed concrete flexural members for service and ultimate limit states.
C04	Apply seismic design principles and ductile detailing for beams, columns, and beam-column joints in RC frames.

Unit	Content	Credit	Weightage
I	**Design of Continuous Beams & Slabs** • **Limit State Design Review:** Stress block parameters, assumptions, and design equations. • **Continuous Beams:** Analysis for gravity loads, moment redistribution (as per IS 456), design for flexure and shear, curtailment of reinforcement. • **One-way Slabs:** Design of continuous slabs, provision of torsion reinforcement at corners. • **Serviceability:** Control of deflection and crack width in continuous systems.	1	25%
II	**Design of Two-way Slabs & Columns** • **Two-way Slabs:** Behavior, design methods (IS 456 coefficient method, yield line theory), detailing. • **Flat Slabs:** Components, direct design method, shear in flat slabs, drop panels, and column heads. • **Grid Floors / Waffle Slabs:** Analysis and design	1	25%

	principles. • **Columns:** Design for axial load and uniaxial/biaxial bending using interaction diagrams, slender columns, and detailing.		
III	**Prestressed Concrete** • **Basic Concepts:** Principles, advantages, materials (concrete, steel), types of prestressing (pre-tensioning, post-tensioning). • **Losses of Prestress:** Short-term and long-term losses, calculation as per IS 1343. • **Design for Flexure:** Serviceability limit state (stress checks), ultimate limit state (flexural strength), partial prestressing. • **Design of End Blocks:** Anchorage zone stresses, bursting reinforcement.	1	25%
IV	**Advanced Topics & Seismic Design** • **Seismic Design of RC Structures:** Philosophy of ductile design, design lateral forces (IS 1893), ductile detailing as per IS 13920 (special confining reinforcement, joint detailing). • **Design of Disturbed Regions:** Deep beams, corbels, pile caps, and openings in beams – analysis using Strut-and-Tie Models (STM). • **Introduction to Retrofitting:** Basic concepts for strengthening concrete members.	1	25%

TEXT BOOKS:

- "Reinforced Concrete Design" by S. Unnikrishna Pillai and Devdas Menon – McGraw Hill Education.
- "Prestressed Concrete" by N. Krishna Raju – McGraw Hill Education.
- "Limit State Design of Reinforced Concrete" by Dr. B. C. Punmia, Dr. A. K. Jain, Dr. A. K. Jain – Laxmi Publications.

REFERENCE BOOKS:

- "IS 456: Plain and Reinforced Concrete – Code of Practice.
- "IS 1343: Code of Practice for Prestressed Concrete.
- "IS 13920: Ductile Detailing of Reinforced Concrete Structures Subjected to Seismic Forces.
- "Design of Reinforced Concrete Structures" by S. Ramamrutham – Dhanpat Rai Publishing.
- "Strut-and-Tie Models for Unified Design of Structural Concrete" by Prof. K. Vijaya Rangan.

ONLINE RESOURCES:

- NPTEL:
  1. "Advanced Reinforced Concrete Design" by Prof. N. Dhang (IIT Kharagpur).
  2. "Prestressed Concrete Structures" by Prof. D. N. Trikha (IIT Kharagpur).
- Coursera/edX:
  1. "Concrete Structures" series (Delft University of Technology).

PRACTICAL LIST:

Continuous Beam & Slab Design

- Design of a Continuous Beam: Complete design of a three-span continuous beam for given loads, including moment redistribution, shear design, and bar curtailment. *(Drawing Sheet: Reinforcement detailing with bending schedule)*.
- Design of a Continuous One-way Slab: Design of a slab continuous over supports, including provision of torsion reinforcement. *(Drawing Sheet: Plan and section with detailing)*.

Practical Module 2: Two-way Slab & Column Design

- Design of a Two-way Slab: Design of a simply supported two-way slab using IS code coefficients. *(Drawing Sheet: Plan showing main and distribution steel)*.
- Design of a Column Subjected to Biaxial Bending: Design of an RC column for axial load and biaxial moments using interaction charts. *(Drawing Sheet: Cross-section and reinforcement detailing)*.

Practical Module 3: Prestressed Concrete Design

- Design of a Prestressed Concrete Beam: Design of a simply supported post-tensioned beam for serviceability (stresses) and ultimate moment capacity. Calculation of prestress losses. *(Drawing Sheet: Section, cable profile, and anchorage zone detailing)*.
- End Block Design: Design of anchorage zone reinforcement for a post-tensioned beam. *(Drawing Sheet: Detailing of end block reinforcement)*.

Practical Module 4: Seismic Detailing & Strut-and-Tie Models

- Ductile Detailing of a Beam-Column Joint: Detailed design and sketching of reinforcement for an exterior beam-column joint as per IS 13920. *(Drawing Sheet: Joint elevation and section showing confinement, anchorage, and joint shear reinforcement)*.
- Design of a Corbels: Design of a corbel using the Strut-and-Tie Model method. *(Drawing Sheet: STM schematic and reinforcement detailing)*.

A **mini-project** involving the comprehensive design of a small building element (e.g., a flat slab panel with columns) is recommended for integration.

SUBJECT CODE: BTCE703

SUBJECT NAME: PAVEMENT ENGINEERING

Course Objectives:

- Understand the types, functions, and structural behavior of flexible and rigid pavements under traffic and environmental loading.
- Characterize pavement materials and apply principles of soil mechanics for subgrade evaluation and stabilization.
- Design flexible and rigid pavements using empirical (IRC, AASHTO) and mechanistic-empirical methods.
- Evaluate pavement condition, analyze failure mechanisms, and select appropriate maintenance and rehabilitation strategies.
- Plan and execute pavement construction, quality control, and drainage systems.

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

CO1	Classify pavements and explain the role of each layer in stress distribution and performance.
CO2	Determine engineering properties of pavement materials (aggregates, bitumen, concrete) and conduct tests for quality control.

C03	Design flexible pavements using IRC 37 and rigid pavements using IRC 58 for given traffic and subgrade conditions.
C04	Analyze pavement distresses, evaluate structural capacity, and recommend maintenance/rehabilitation treatments.

Unit	Content	Credit	Weightage

I	**Introduction to Pavements and Materials**
	• **Overview:** Pavement types (flexible, rigid, composite), functions, and components. Pavement cross-section and terminology.
	• **Traffic & Loading:** Vehicle classification, axle loads, traffic volume studies, Equivalent Single Axle Load (ESAL), traffic growth factors.
	• **Subgrade Engineering:** Soil classification for pavements, CBR test, modulus of subgrade reaction, subgrade improvement and stabilization.
	• **Pavement Materials:**
	  ○ **Aggregates:** Properties, tests (crushing, abrasion, impact, shape).
	  ○ **Bituminous Materials:** Bitumen types, penetration, viscosity, ductility tests; modified binders.
	  ○ **Concrete:** Properties for rigid pavements, mix design overview.
		1	25%

II	**Flexible Pavement Design** • **Stress Distribution Theory:** Boussinesq's theory, layered system concepts, stress analysis in flexible pavements. • **Design Approaches:** Empirical (CBR method, Group Index), mechanistic-empirical (elastic layered theory). • **IRC Guidelines:** IRC 37: Guidelines for the Design of Flexible Pavements (latest revision). Design steps, catalog selection, use of software IITPAVE. • **Design Inputs:** Traffic data, material characteristics, environmental factors, reliability and performance criteria.	1	25%
III	**Rigid Pavement Design & Analysis** • **Concrete Pavement Types:** Jointed Plain Concrete Pavement (JPCP), Jointed Reinforced Concrete Pavement (JRCP), Continuously Reinforced Concrete Pavement (CRCP). • **Behavior & Stresses:** Westergaard's analysis, stresses due to wheel load, temperature, and moisture (warping, friction). • **IRC Guidelines:** IRC 58: Guidelines for the Design of Plain Jointed Rigid Pavements for Highways.	1	25%

	Thickness design, joint design (spacing, types, sealing), reinforcement design. • **PCC Mix Design:** Introduction to IRC 44 for pavement quality concrete.		
IV	**Construction, Evaluation & Rehabilitation** • **Construction Practices:** o Flexible: Bituminous mix types (Marshall, Superpave), laying, compaction. o Rigid: Paving, joint construction, curing, texturing. • **Pavement Evaluation:** Surface characteristics (skid resistance, roughness), structural evaluation (Benkelman Beam, Falling Weight Deflectometer), distress survey (cracking, rutting, potholes). • **Pavement Management Systems (PMS):** Concept, pavement condition index (PCI), maintenance strategies (routine, periodic, rehabilitation). • **Overlay Design:** Functional and structural overlays for flexible and rigid pavements (IRC 81, IRC 115).	1	25%

TEXT BOOKS:

- "Pavement Analysis and Design" by Yang H. Huang – Pearson Education.
- "Principles of Pavement Engineering" by Nick Thom – ICE Publishing.
- "Highway Engineering" by S.K. Khanna and C.E.G. Justo – Nem Chand & Bros.

REFERENCE BOOKS:

- IRC 37: Guidelines for the Design of Flexible Pavements.
- IRC 58: Guidelines for the Design of Rigid Pavements for Highways.
- "Pavement Design and Materials" by A.T. Papagiannakis and E.A. Masad – Wiley.
- "Bituminous Road Construction in India" by R. Srinivasa Kumar – Prentice Hall India.
- "Concrete Pavement Design, Construction, and Performance" by Norbert Delatte – CRC Press.

ONLINE RESOURCES:

- NPTEL:
  1. "Pavement Materials and Construction" by Prof. A. Veeraragavan (IIT Madras).
  2. "Pavement Design" by Prof. S. Chandra (IIT Roorkee).

PRACTICAL LIST:

Material Characterization

- Aggregate Tests: Aggregate Impact Test & Los Angeles Abrasion Test – Determination of toughness and hardness. *(Report: Tabulate results, compare with MORTH specifications).*
- Bitumen Tests: Penetration Test & Ductility Test – Consistency and elasticity evaluation. *(Report: Interpret grade and suitability for different climates).*

Practical Module 2: Subgrade & Mix Design

- California Bearing Ratio (CBR) Test: Determination of CBR value for subgrade soil for pavement design. *(Report: Plot load vs. penetration curve, compute CBR, recommend subgrade treatment).*
- Marshall Mix Design: Determination of Optimum Bitumen Content (OBC) for a given aggregate

gradation. *(Report: Plot stability, flow, density, voids; determine OBC).*

Practical Module 3: Pavement Design

- Flexible Pavement Design using IRC 37: Design a flexible pavement for a given traffic (msa) and subgrade CBR using IRC 37 charts/software. *(Design Sheet: Present layered cross-section with thicknesses and material specifications).*
- Rigid Pavement Design using IRC 58: Design a jointed concrete pavement slab thickness and joint details for given traffic and subgrade modulus. *(Design Sheet: Present slab layout with joint types, spacing, and reinforcement details).*

Practical Module 4: Evaluation & Rehabilitation

- Pavement Condition Survey & PCI Calculation: Conduct a manual distress survey on a sample pavement section (field/photographs). Calculate Pavement Condition Index (PCI). *(Report: Distress summary sheet, PCI calculation, recommend maintenance action).*
- Overlay Design Project: Design a bituminous overlay for a distressed flexible pavement using deflection data (Benkelman Beam/FWD principles). *(Design Sheet: Determine overlay thickness and type based on IRC 81 guidelines).*

A field visit to a hot mix plant or highway construction site is highly recommended.

Use of **public-domain software** (IITPAVE, KENPAVE) should be integrated into design modules.

SUBJECT CODE: BTCE704

SUBJECT NAME: BIM AND REVIT FOR CIVIL ENGINEERING

Course Objectives:

- Understand Building Information Modeling (BIM) concepts, standards, and workflows in the AEC industry.
- Navigate and utilize Autodesk Revit's interface, tools, and project environment for civil engineering applications.
- Create intelligent 3D models of civil engineering structures (buildings, foundations, structural systems) with parametric elements.
- Generate construction documentation (drawings, schedules, quantities) and perform basic clash detection.
- Collaborate using BIM processes and understand integration with other tools (AutoCAD, Navisworks, Civil 3D).

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

CO1	Explain BIM dimensions (3D-7D), benefits, standards (ISO 19650), and roles in project lifecycle.
CO2	Develop a BIM Execution Plan (BEP) for a simple project and set up a Revit project with shared coordinates.
C03	Create a complete 3D BIM model of a multi-story RC structure including architectural, structural, and foundation systems.
C04	Extract accurate construction drawings, material schedules, and quantity take-offs from the BIM model.

PRACTICAL LIST:

Practical Module 1: Project Setup & Basic Modeling

- Revit Interface & Project Setup:

1. Create a new project using structural template.
2. Set up project units (metric), levels (Ground, First, Second floor), and structural grids.
3. Save project with proper naming convention.

- Basic Structural Elements:
  1. Model columns (concrete rectangular) on grid intersections for all levels.
  2. Model beams between columns for each floor.
  3. Create a structural floor slab for ground level.

Practical Module 2: Detailed Structural Modeling

- Foundation & Reinforcement:
  1. Model isolated footings below columns with step-by-step dimensions.
  2. Add basic reinforcement to one footing using Rebar tools.
  3. Create a combined footing for two adjacent columns.
- Multi-Story Structure:
  1. Complete the structural model for a 3-story building with columns, beams, and slabs.
  2. Add structural walls (shear walls) at specific locations.
  3. Create a staircase between two floors.

Practical Module 3: Documentation & Quantities

- Construction Drawings:
  1. Generate floor plans, elevations (4 sides), and building sections (2 directions).
  2. Create a foundation plan with details.
  3. Set up A1 size sheets, place views with proper scales, and add title blocks.
- Schedules & Annotations:
  1. Create a structural column schedule showing mark, size, material, and quantity.
  2. Generate concrete volume schedule for all structural elements.
  3. Annotate all drawings with dimensions, text, and element tags.

Practical Module 4: Coordination & Visualization

- Coordination & Clash Detection:
  1. Link an architectural model (provided) to your structural model.
  2. Perform clash detection between structural and architectural elements.
  3. Resolve clashes by adjusting structural elements and document changes.
- Presentation & Output:
  1. Create a 3D rendered view of the complete building.
  2. Produce a walkthrough video showing all floors and structural systems.
  3. Export complete drawing set as PDF and IFC format for interoperability.

PROJECT WORK (Integrated)

- Final BIM Project: Develop a complete BIM model for a G+2 Residential Building including:
- Architectural components (walls, doors, windows, roofs)
- Structural system (columns, beams, slabs, footings, reinforcement)
- Documentation (plans, elevations, sections, details, schedules)
- Coordination check and basic 4D simulation (construction sequence)

MK UNIVERSITY

PATAN, GUJARAT

ESTABLISHED BY THE GUJARAT GOVT. RECOGNIZED BY UGC UNDER SECTION 2(f) OF UGC ACT,1956

SEMESTER-VIII

SUBJECT CODE: BTCE801
SUBJECT NAME: PRE-STREESED CONCRETE
Course Objectives:

- Understand the fundamental concepts, materials, and systems of pre-stressed concrete.
- Analyze and design pre-stressed concrete members for serviceability limit states (stress checks).
- Design pre-stressed concrete members for ultimate limit states (flexural and shear strength).
- Compute short-term and long-term losses in pre-stress and understand their influence on design.
- Design anchorage zones and detailing for pre-tensioned and post-tensioned members.

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

CO1	Explain the principles, advantages, and applications of pre-stressed concrete, and differentiate between pre-tensioning and post-tensioning.
CO2	Calculate stresses in pre-stressed concrete sections at transfer and service stages, and design sections based on permissible stresses.
C03	Determine losses of pre-stress (elastic shortening, friction, creep, shrinkage, relaxation) and incorporate them into design.
C04	Design pre-stressed concrete beams for flexural and shear strength as per IS 1343.

Unit	Content	Credit	Weightage

I	**Introduction and Materials**
	• **Basic Concepts:** Principle of pre-stressing, comparison with RCC, historical development, applications (bridges, buildings, nuclear vessels).
	• **Systems and Methods:** Pre-tensioning vs post-tensioning, stages of loading (transfer and service), types of tendons (wires, strands, bars), anchorage systems.
	• **Materials:**
	  ○ **Concrete:** High-strength concrete, properties required for pre-stressed concrete.
	  ○ **Steel:** Types of pre-stressing steel (high tensile wires, strands, bars), stress-strain behavior, relaxation characteristics.
	• **Analysis of Sections:** Basic assumptions, stress distribution at transfer and service, concept of load balancing, pressure line, and cable profile.
		1	25%

II	**Losses of Pre-stress and Serviceability Design**
	• **Losses of Pre-stress:**
	  ○ **Immediate Losses:** Elastic shortening, anchorage slip, friction (wobble and curvature).
	  ○ **Time-dependent Losses:** Creep of concrete,
		1	25%

	shrinkage of concrete, relaxation of steel. ○ **Calculation of Total Losses** as per IS 1343. • **Serviceability Limit State Design:** ○ **Stress Criteria:** Permissible stresses in concrete and steel at transfer and service. ○ **Design of Sections:** Design of rectangular and I-sections for given bending moments. ○ **Cable Profile:** Linear and parabolic profiles, eccentricity limits, concordant cables.		
III	**Ultimate Limit State Design** • **Flexural Strength:** Behavior of pre-stressed beams at failure, strain compatibility method, IS 1343 code provisions for ultimate moment capacity. • **Design for Shear and Torsion:** Shear resistance of pre-stressed concrete, design of shear reinforcement as per IS 1343, introduction to torsional design. • **Deflection and Crack Control:** Short-term and long-term deflection calculations, crack width control in partially pre-stressed members. • **Transmission Length and Bond:** Transmission length in pre-tensioned members, bond stress development.	1	25%
IV	**Design of End Zones and Applications** • **Anchorage Zone Design:** ○ **End Block in Post-tensioned Members:** Stress distribution, bursting forces, design of reinforcement using equilibrium method and IS code method. ○ **Bearing Stresses:** Design for local bearing stresses behind anchorages. • **Detailing:** Detailing of tendons, anchorage zones, joints, and couplers. • **Applications and Special Topics:** ○ Pre-stressed concrete slabs (one-way, two-way, flat slabs). ○ Pre-stressed concrete bridges (types, segmental construction). ○ Pre-stressed concrete poles, sleepers, and pipes. • **Introduction to Composite Construction:** Pre-stressed concrete beams with cast-in-situ slabs.	1	25%

TEXT BOOKS:

- "Prestressed Concrete" by N. Krishna Raju – McGraw Hill Education.
- "Prestressed Concrete" by S. Ramamrutham – Dhanpat Rai Publishing.

REFERENCE BOOKS:

- "IS 1343: 2012 – Code of Practice for Prestressed Concrete.
- "Prestressed Concrete Structures" by T.Y. Lin and Ned H. Burns – Wiley.
- "Design of Prestressed Concrete Structures" by T.Y. Lin – Wiley.
- "Prestressed Concrete Designer's Handbook" by P.W. Abeles and B.K. Bardhan-Roy – Viewpoint Publications.

ONLINE RESOURCES:

- NPTEL:
    1. "Prestressed Concrete Structures" by Prof. D. N. Trikha (IIT Kharagpur).
    2. "Advanced Structural Analysis" by Prof. D. N. Trikha.

PRACTICAL LIST:

Practical Module 1: Section Properties and Stresses

- Calculation of Section Properties:
    1. Compute gross and transformed section properties (A, I, Zt, Zb) for a given I-section.
    2. Determine kern distances and limiting eccentricities.
- Stress Analysis at Transfer and Service:
    1. Calculate stresses at top and bottom fibers for a simply supported pre-tensioned beam at transfer and under service loads.
    2. Check against permissible stresses as per IS 1343.

Practical Module 2: Losses and Cable Profile Design

- Computation of Pre-stress Losses:
    1. Calculate all short-term and long-term losses for a given post-tensioned beam.
    2. Determine the effective pre-stress after losses.
- Design of Cable Profile:
    1. Design a parabolic cable profile for a simply supported beam for given moments.
    2. Determine eccentricities at critical sections (mid-span, supports, quarter points) and check against limits.

Practical Module 3: Ultimate Strength Design

- Flexural Strength Design:
    1. Design a pre-stressed concrete beam for ultimate flexural strength using strain compatibility.
    2. Compare the ultimate moment capacity with the required factored moment.
- Shear Design:
    1. Design shear reinforcement for a pre-stressed concrete beam at critical sections.
    2. Calculate shear capacity with and without shear reinforcement.

Practical Module 4: Detailing and End Zone Design

- End Block Design:
    1. Design the end block reinforcement for a post-tensioned beam with multiple anchorages.
    2. Calculate bursting forces and design the reinforcement layout. *(Drawing Sheet: Detailing of end block reinforcement)*.
- Complete Member Detailing:
    1. Prepare detailed drawing of a simply supported pre-stressed concrete beam showing:
        1. Elevation with cable profile and anchorage details.
        2. Cross-section at mid-span and support.
        3. Rebar detailing for shear reinforcement and end block. *(Drawing Sheet: A1 size sheet with all details)*.

Design a post-tensioned I-girder for a highway bridge for given span and loading.

Include: cross-section design, cable profile design, loss calculations, ultimate strength checks, end block design, and detailed drawings.

SUBJECT CODE: BTCE802
SUBJECT NAME: TRAFFIC ENGINEERING AND PLANNING
Course Objectives:

- Understand the fundamental characteristics of traffic flow, vehicle performance, and driver behavior.
- Apply techniques for traffic data collection, analysis, and interpretation for engineering studies.
- Design and evaluate geometric elements of highways, intersections, and interchanges for safety and efficiency.
- Analyze traffic capacity, level of service, and signalized intersection timing plans.
- Comprehend the principles of transportation planning, traffic management, and intelligent transportation systems.

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

CO1	Define and explain traffic stream parameters (volume, speed, density) and their interrelationships.
CO2	Conduct and analyze common traffic studies (volume, speed, delay, parking, accident).
C03	Design at-grade intersections (signalized and unsignalized) and basic grade-separated interchanges.
C04	Apply capacity and level-of-service analysis methodologies for highways and intersections as per Indian (IRC) and International (HCM) guidelines.

Unit	Content	Credit	Weightage

I	**Traffic Stream Characteristics and Studies**
	• **Introduction:** Scope and importance of traffic engineering, components of traffic system (road-user, vehicle, roadway).
	• **Traffic Stream Parameters:** Volume, Speed (time-mean, space-mean), Density, and their relationships. Fundamental diagrams of traffic flow.
	• **Traffic Studies and Analysis:**
	  ○ Volume Studies: Definitions (ADT, AADT, PHF), methods of counting.
	  ○ Speed Studies: Spot speed, travel time and delay studies.
	  ○ Parking Studies: Inventory, accumulation, turnover, parking demand analysis.
	  ○ Accident Studies: Causes, analysis (collision diagrams, condition diagrams), remedial measures.
		1	25%

II	**Highway Capacity and Intersection Design** • **Capacity and Level of Service (LOS):** Basic concepts, factors affecting capacity. Introduction to	1	25%

	Highway Capacity Manual (HCM) and IRC 106. ○ Capacity analysis for uninterrupted flow facilities (basic freeway segments, multilane highways). ○ Capacity analysis for interrupted flow facilities (signalized intersections). • **Intersection Design:** Types of intersections (at-grade, grade-separated). ○ **At-Grade Intersections:** Design principles, sight distance requirements, channelization. ○ **Grade-Separated Interchanges:** Types (diamond, cloverleaf, directional), selection criteria.		
III	**Traffic Control and Analysis** • **Traffic Control Devices:** Signs (regulatory, warning, informative), markings, islands, and signals as per IRC 67. • **Signal Design:** Principles of traffic signals, warrants for signal installation (IRC 93). ○ **Design of Isolated Fixed-Time Signals:** Webster's method, IRC method for cycle time, green split, and clearance intervals. • **Unsignalized Intersections:** Capacity and level of service for priority (stop/yield) controlled intersections. • **Roundabouts:** Entry, circulating, and exit capacities, geometric design principles.	1	25%
IV	**Transportation Planning and Management** • **Transportation Planning:** Four-stage planning process (Trip Generation, Distribution, Mode Split, Traffic Assignment). Urban transportation surveys (home-interview, cordon-line). • **Travel Demand Forecasting:** Trip generation models (regression, category analysis), trip distribution models (gravity model), modal split. • **Traffic Management:** Area Traffic Control Systems (ATCS), Intelligent Transportation Systems (ITS) – components and applications. • **Sustainable Transportation:** Concepts of Transit-Oriented Development (TOD), Non-Motorized Transport (NMT) facilities, and traffic calming measures.	1	25%

TEXT BOOKS:

- "Traffic Engineering and Transport Planning" by Dr. L.R. Kadiyali – Khanna Publishers.

- "Traffic Engineering: Theory and Practice" by Louis J. Pignataro – Prentice Hall.
- "Principles of Transportation Engineering" by Partha Chakroborty and Animesh Das – PHI Learning.

REFERENCE BOOKS:

- "Highway Capacity Manual (HCM)" – Transportation Research Board, USA.
- IRC Codes: IRC 106 (Guidelines for Capacity of Urban Roads), IRC 93 (Guidelines for Design of Signalized Intersections), IRC 67 (Code for Road Signs), IRC 73 (Geometric Design of Rural Highways).
- "Transportation Engineering: An Introduction" by C. Jotin Khisty and B. Kent Lall – Pearson.
- "Urban Transportation Planning" by Michael D. Meyer and Eric J. Miller – McGraw Hill.

ONLINE RESOURCES:

- NPTEL:
    1. "Transportation Engineering II" by Prof. Dr. Partha Chakroborty (IIT Guwahati).
    2. "Traffic Engineering and Management" by Prof. Dr. K. Ramachandra Rao (IIT Delhi).

PRACTICAL LIST:

Practical Module 1: Traffic Volume and Speed Studies

- Traffic Volume Count and PHF Analysis:
    1. Perform a manual classified volume count (passenger car, bus, truck, 2-wheeler, etc.) at a mid-block section for a 12-hour period (using video/data provided).
    2. Calculate hourly volumes, Peak Hour Factor (PHF), and ADT. Present data in flow fluctuation and composition charts.
- Spot Speed Study and Analysis:
    1. Collect spot speed data using radar gun/enoscope/video (or use provided dataset) for a sample of at least 100 vehicles.
    2. Analyze data: Calculate time-mean speed, standard deviation, plot frequency distribution and cumulative speed curves. Determine pace, 85th percentile speed, and design speed.

Practical Module 2: Intersection Analysis and Parking Study

- Intersection Delay and Level of Service Study:
    1. Conduct a stopped-time delay study at a signalized/unsignalized intersection (using video/field simulation).
    2. Calculate average control delay per vehicle and determine the Level of Service (LOS) as per HCM/IRC.
- Parking Inventory and Analysis:
    1. Perform an inventory and usage survey for a given parking lot (on-street/off-street). Record accumulation, duration, and turnover.
    2. Calculate parking index, efficiency, and propose improvements based on demand-supply analysis.

Practical Module 3: Intersection and Signal Design

- Design of a Signalized Intersection Timing Plan:
    1. For given approach volumes and geometric layout, design a fixed-time signal plan using Webster's method/IRC guidelines.
    2. Determine optimal cycle time, green splits, and pedestrian crossing time. Check for clearance intervals.
- Design of an At-Grade Intersection (Channelization):
    1. For a four-legged intersection with given traffic volumes and turning movements, propose

a channelization plan.
2. Design turning radii, lane configurations, and island placement. Prepare a scaled layout drawing.

Practical Module 4: Planning and Simulation

- Trip Generation and Distribution Mini-Project:
  1. For a small study area (e.g., a university campus zone), conduct a trip generation estimation using category analysis/regression.
  2. Apply the gravity model for trip distribution between zones. Present origin-destination (O-D) matrix.
- Traffic Simulation (Software-based Exercise):
  1. Build a simple network (a corridor with an intersection) in a traffic simulation software (e.g., PTV Vissim demo).
  2. Input traffic volumes, signal timing, and geometric data. Run simulation to evaluate performance measures (delay, queue length) and propose improvements.

*** Field visits to a Traffic Management Centre (TMC) or a major signalized intersection are highly recommended. Collaboration with local traffic police/civic authorities for real-world data is encouraged.

SUBJECT CODE: BTCE803
SUBJECT NAME: SUSTAINABLE AND GREEN BUILDING

Course Objectives:

- Understand the fundamental principles, metrics, and global context of sustainable development in the built environment.
- Analyze the environmental impacts of building materials and construction processes, and select appropriate green materials.
- Apply passive design strategies and active systems for energy efficiency, water conservation, and indoor environmental quality (IEQ).
- Navigate major green building rating systems (LEED, GRIHA, IGBC) and apply their criteria to building design.
- Design and evaluate building systems and sites for sustainability, resilience, and life cycle performance.

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

CO1	Explain the drivers for sustainability, key concepts (ecological footprint, embodied energy, life cycle thinking), and relevant policies.
CO2	Evaluate and specify low-impact, recycled, and local building materials and assess their life cycle.
C03	Formulate integrated design solutions for energy efficiency (passive solar, envelope design), water management (rainwater, greywater), and waste reduction.
C04	Apply the credit framework of a chosen green building rating system (e.g., GRIHA) to a simple building project.

Unit	Content	Credit	Weightage
I	**Foundations of Sustainable Construction** • **Introduction:** Global environmental challenges	1	25%

	(climate change, resource depletion), the role of the built environment, and the concept of sustainable development. • **Policies & Standards:** Overview of international agreements (Paris Agreement), national policies (ECBC, National Mission on Sustainable Habitat), and green building mandates. • **Sustainability Metrics:** Ecological footprint, carbon footprint, embodied vs. operational energy, Life Cycle Assessment (LCA) principles. • **The Integrated Design Process (IDP):** Collaborative, whole-systems approach to green building design.		
II	**Sustainable Materials & Resources** • **Environmental Impact of Materials:** Resource extraction, manufacturing energy, transportation, and end-of-life scenarios. • **Green Material Selection:** Criteria: local & natural materials, recycled content (fly ash, slag), rapidly renewable materials (bamboo, cork), low-VOC products. • **Construction & Demolition (C&D) Waste Management:** Waste audit, reduction strategies, on-site sorting, recycling, and reuse. • **Innovative Materials & Technologies:** Introduction to phase change materials (PCMs), bio-based composites, and 3D printed construction.	1	25%

III	**Energy, Water, and Indoor Environment**
	• **Energy Efficiency:**
	  ○ **Passive Design:** Building orientation, climate-responsive form, shading devices, natural ventilation strategies, high-performance building envelope (walls, roofs, glazing).
	  ○ **Active Systems:** Introduction to high-efficiency HVAC, solar thermal, and building-integrated photovoltaics (BIPV).
	• **Water Efficiency:** Water conservation fixtures, rainwater harvesting system design, greywater recycling basics, and water-efficient landscaping (xeriscaping).
	• **Indoor Environmental Quality (IEQ):** Daylighting design, glare control, indoor air quality (IAQ) management, thermal and acoustic comfort.
		1	25%

IV	**Green Building Systems & Certification**	1	25%

	• **Sustainable Site Planning:** Site selection, urban heat island mitigation (green roofs, cool pavements), stormwater management (pervious pavements, bioswales), biodiversity conservation.
	• **Green Building Rating Systems:** Structure, intent, and credit categories of:
	  ○ LEED (Leadership in Energy & Environmental Design)
	  ○ GRIHA (Green Rating for Integrated Habitat Assessment)
	  ○ IGBC (Indian Green Building Council) Rating System
	• **Resilience & Future Trends:** Designing for climate resilience, net-zero energy/water buildings, and circular economy principles in construction.
	• **Introduction to Building Performance Simulation:** Role of energy modeling (e.g., Energy Plus, Climate Consultant) in design.		

TEXT BOOKS:

- "Sustainable Construction: Green Building Design and Delivery" by Charles J. Kibert – Wiley.
- "Green Building with Concrete: Sustainable Design and Construction" by Gajanan M. Sabnis – CRC Press.
- "Handbook of Green Building Design and Construction: LEED, BREEAM, and Green Globes" by Sam Kubba – Butterworth-Heinemann.

REFERENCE BOOKS:

- "GRIHA Manuals (Latest Version) – TERI Publications.
- "IGBC Green New Buildings Rating System – Abridged Reference Guide.
- "Ecohouse: A Design Guide" by Sue Roaf – Architectural Press.
- "The Integrative Design Guide to Green Building" by 7 Group and Bill Reed – Wiley.
- "Cradle to Cradle: Remaking the Way We Make Things" by William McDonough & Michael Braungart.

ONLINE RESOURCES:

- NPTEL / SWAYAM:
  1. "Sustainable Building Technologies" by Prof. Avlokita Agrawal (IIT Roorkee).
  2. "Energy Efficient and Sustainable Buildings" by Prof. M. K. Singhal (IIT Delhi).

PRACTICAL LIST:

Practical Module 1: Context Analysis & Passive Design

- Climate Analysis & Site Assessment:
  1. Use Climate Consultant software (or psychrometric chart analysis) to analyze the climate data of a given location.
  2. Identify dominant passive design strategies (e.g., passive solar heating, natural ventilation). Produce a bioclimatic chart and a report recommending 5 key passive strategies.
- Passive Solar Design Exercise:
  1. For a given simple building footprint (e.g., a small residence), determine optimal

orientation, window-to-wall ratio (WWR), and design shading devices (overhangs/fins) for south and west facades.

Practical Module 2: Material Selection & Water Systems

- Green Material Selection & Embodied Carbon Estimation:
    1. Select primary structural (concrete/steel) and envelope (wall, roof) materials for a given building. Compare a conventional and a "green" alternative for each (e.g., conventional concrete vs. fly-ash concrete).
    2. Prepare a comparative table listing material properties, local availability, recycled content, and a simple qualitative assessment of embodied energy/carbon.
- Rainwater Harvesting System Design:
    1. Design a complete rooftop rainwater harvesting system for a building with a given catchment area and local rainfall data.
    2. Calculate catchment yield, storage tank capacity, and propose treatment and recharge methods.

Practical Module 3: Energy & IEQ Simulation

- Daylighting Analysis:
    1. Using a simple physical model (cardboard) or a free software tool (like Sefaira plugin or DIVA-for-Rhino demo), analyze daylight availability in a standard room.
    2. Vary window size and placement to achieve target daylight factors and avoid glare. *(Deliverable:* Analysis images/screenshots and a summary of findings).
- Introductory Energy Modeling:
    1. Use a simplified online tool (like Cove.tool or the ENERGY STAR Portfolio Manager) or a guided EnergyPlus run to model the energy consumption of a basic building.
    2. Change one parameter (e.g., insulation level, glass type) and observe its impact on annual energy use.

Practical Module 4: Green Building Certification & Integrated Project

- GRIHA / IGBC Pre-Assessment:
    1. Take a provided case study building (plans and specs) and perform a preliminary rating assessment using the GRIHA or IGBC Abridged checklist.
    2. Identify achievable credits, mandatory requirements, and propose modifications to gain additional points.
    (Deliverable: Completed checklist with a summary of the projected rating and key recommendations).

*** A field visit to a certified green building (Platinum/Gold rated) is essential.