GIRIJANANDA CHOWDHURY UNIVERSITY
Hathkhowapara, Azara, Guwahati 781017, Assam

School of Engineering & Technology

DEPARTMENT OF CIVIL ENGINEERING

B.Tech - Civil Engineering

Semester VII

Sl. No	Course Code	Course Name	Hours per week			Credits
			L	T	P	
1.	BCE23701T	Robotics and Automation	2	0	0	2
2.	BCE237PE4**	Program Elective Course -4	3	0	0	3
3.	BCE237PE5**	Program Elective Course -5	3	0	0	3
4	BCE237PE6**	Program Elective Course -6	3	0	0	3
5.	BCE237PE7**	Program Elective Course -7	3	0	0	3
6.	MOPEC-03	Multidisciplinary Open Elective Course	2	0	0	2
7.	BCE237PR1	Design Project	0	0	4	2
8.	BCE-SI-03	Summer Internship-03*	0	0	4	2
		Total	**16**	**0**	**8**	**20**
9.		Minor/Honours/Value Added Courses (Optional)	3	0	0	3

*Summer Internship should be undergone during the month of July every year (after 6th sem examination & before reopening 7th sem classes).

Program Elective Courses

TRACK I: Structural Engineering
TRACK II: Geotechnical Engineering
TRACK III: Environmental Engineering
TRACK IV: Water Resources Engineering
TRACK V: Transportation Engineering

Program Elective	VII Semester		
	Track	Course Code	Course Name
4	I	BCE237PE41T	Prestressed Concrete
4	II	BCE237PE42T	Ground Improvement Techniques
4	III	BCE237PE43T	Industrial Waste Water Management
4	IV	BCE237PE44T	Urban Water Infrastructure
4	V	BCE237PE45T	Airport Planning & Design
5	**I**	**BCE237PE51T**	**Earthquake Engineering**
5	**II**	**BCE237PE52T**	**Geotechnical Design**
5	**III**	**BCE237PE53T**	**Water Quality Management**
5	**IV**	**BCE237PE54T**	**Watershed Conservation & Management**
5	**V**	**BCE237PE55T**	**Port & Harbour Engineering**
6	I	BCE237PE61T	Rehabilitation/Restoration of Structures
6	II	BCE237PE62T	Tunnel Engineering
6	III	BCE237PE63T	Air & Noise Pollution Control
6	IV	BCE237PE64T	Irrigation and River Engineering
6	V	BCE237PE65T	Traffic Engineering & Management
7	I	BCE237PE71T	Bridge Engineering
7	II	BCE237PE72T	Earth Retaining Structures
7	III	BCE237PE73T	Solid and Hazardous Waste Management
7	IV	BCE237PE74T	Ground Water Engineering
7	V	BCE237PE75T	Smart Cities

MOEC	Course Code	Course Name
		Bio mimicry in Architecture – NS
		Visual Sociology – S&SW
		Disaster Management – Civil
		Organisational Behaviour – MBA
		Utilization of Solar Energy in Everyday life – EEE
		Computational Thinking – CSE
		Renewable Energy - EE
		Any other from time to time

BCE23701T	ROBOTICS AND AUTOMATION	L	T	P	C
		2	0	0	2

Pre-requisite: Nil

Course Objectives:

The course aims to:

1. Understand the fundamental concepts of robotics, automation, robot kinematics, sensors, actuators, and robotic systems.
2. Learn the principles of robot control, automation, embedded systems, communication protocols, and intelligent electronic systems
3. Explore artificial intelligence, machine learning, computer vision, Robot Operating System (ROS), and autonomous robotic systems for intelligent decision-making.
4. Analyze the applications of robotics and automation in Civil Engineering, including autonomous construction equipment, robotic construction, 3D concrete printing, aerial surveying, inspection, and smart infrastructure for improving productivity, safety, and sustainability.

Expected Course Outcome:

Upon completion of this course, the student will be able to

1. Explain the fundamentals of robot anatomy, kinematics, sensors, actuators, and robotic mechanisms used in engineering applications.
2. Apply robot control techniques, embedded controllers, communication protocols, and automation systems for robotic applications.
3. Analyze AI-based robotic systems using machine learning, computer vision, ROS, localization, and path-planning techniques for intelligent automation.
4. Evaluate the implementation of robotics and automation technologies in Civil Engineering applications such as autonomous construction equipment, robotic fabrication, infrastructure inspection, and smart construction practices.

Module 1: ***Robotics and Automation in Civil Engineering*** — **5 hours**

Autonomous Earthmoving, 3D Concrete Printing, Robotic Bricklaying & Rebar Tying, Aerial Surveying and Inspection, Off-Site Prefabrication, Enhanced Safety, Reduced Material Waste, 24/7 Operations, Embrace new tools, Connect digital and physical, Adapt with ongoing learning.

Module 2: ***Robotics and Automation in Mechanical Engineering*** — **6 Hours**

History of robotics; Classification and usages of robot; Robot anatomy: Links, Grippers, Actuators, Sensors; Degrees of Freedom; Robot coordinates & reference frames; Workspace. Encoders; Sensors: Position sensors, Acceleration sensors, Force & pressure sensors, Touch & tactile sensors, Proximity sensors, Range finders; Vision Systems; Hydraulic Actuation; Pneumatic Actuation; Electric Motors: AC & DC type motors, Brushless DC motors, Direct drive motors, Servomotors, Stepper motors

Module 3: ***Robotics & Automation in Electrical Engineering*** — **5 hours**

Control of robots: Independent joint control, Actuator dynamics, PD, PID compensator, Saturation, feed forward controller and computed torque; Multivariable control, Force control, and geometric nonlinear control, computer vision, and vision-based control.

Module 4: ***Electronics and Embedded Intelligence for Robotics*** — **6 hours**

Architecture of robotic electronic systems; Embedded controllers (Arduino, STM32, ESP32, Raspberry Pi); Robot sensors (position, proximity, ultrasonic, infrared, IMU, LiDAR, vision sensors) and signal conditioning; Actuators and motor drivers (DC, Servo, Stepper); Embedded communication protocols (UART, SPI, I^2C, CAN, Ethernet, Wi-Fi, Bluetooth Low Energy, ZigBee); Applications in autonomous mobile robots, drones, smart manufacturing, healthcare robotics, agricultural robotics, and semiconductor manufacturing automation.

Module 5: ***Introduction to AI in Robotics***	**8 hours**
Role of AI in robotics, intelligent vs. traditional robots, applications in manufacturing, healthcare, agriculture, logistics, autonomous vehicles. Machine Learning for Robotics: Supervised, unsupervised and reinforcement learning concepts, robot navigation, obstacle avoidance, predictive maintenance, path optimization. Robot Operating System (ROS) – Overview: Introduction to ROS, ROS architecture, nodes, topics, services, packages, simulation using Gazebo/RViz (conceptual overview). Intelligent Autonomous Systems: Autonomous mobile robots, SLAM (concept), localization, path planning (A*, Dijkstra), human–robot interaction, ethical issues in AI-enabled robotics, future trends.	
Total Lecture hours	**30 hours**

Text Book(s)

1.	G.K. McMillan, “Process/Industrial Instruments and Controls Handbook,” McGraw-Hill, 1999.
2.	Saeed B. Niku; Introduction to Robotics: Analysis, Control, Applications,3rd Edition Wiley
3.	S. Mukherjee, “Essentials of Robotics Process Automation”, Khanna Book Publishing, 2021.
4.	1. Mark W. Spong, Seth Hutchinson, M. Vidyasagar, “Robot Modelling and Control”, John Willey and Sons.
5.	2. S.K. Saha, “Introduction to Robotics”, 2nd edition, TMH.
6.	Saeed B. Niku, Introduction to Robotics: Analysis, Control and Applications, John Wiley & Sons.
7.	Mikell P. Groover, Automation, Production Systems and Computer-Integrated Manufacturing, Pearson Education.
8.	Artificial Intelligence for Robotics – Francis X. Govers.
9.	Learning Robotics Using Python – Lentin Joseph.
10.	Bock, T., & Linner, T. (2015). Robot-Oriented Design: Design and Management Tools for the Deployment of Automation and Robotics in Construction. Cambridge University Press.
11.	Bock, T., & Linner, T. (2016). Construction Robots: Elementary Technologies and Single-Task Construction Robots. Cambridge University Press.

Mode of Assessment: Continuous Assessment Test, Quizzes, Assignments, Final Assessment Test			
Recommended by Board of Studies			
Approved by Academic Council		Date	

BCE237PE41T	**PRESTRESSED CONCRETE**	**L**	**T**	**P**	**C**
		3	**0**	**0**	**3**

Pre-requisite: Solid Mechanics & Concrete Technology

Course Objectives:

1. To understand the fundamentals and analysis of prestressed concrete members.
2. To evaluate the losses of prestress in pre-tensioned and post-tensioned members.
3. To analyse and design prestressed concrete members for flexure and shear as per IS codes.
4. To assess the short-term and long-term deflections of prestressed concrete beams.

Expected Course Outcome:

Upon completion of this course, the student will be able to

1. Explain the fundamentals and behaviour of prestressed concrete members.
2. Determine the losses of prestress in pre-tensioned and post-tensioned members.
3. Analyse and design prestressed concrete members for flexure and shear as per IS provisions.
4. Evaluate the deflection behaviour of prestressed concrete beams under service loads.

Module:1 *Introduction*	**8 hours**

Concept of Prestressed concrete, Advantages & Limitations of Prestressing; Types of Prestressing; Analysis of Prestress- resultant stress at section, thrust line, load balancing concept, stress in tendons.

Module:2 *Losses of Prestress*	**10 hours**

Loss of pre-stress in pre tensioned and post tensioned members due to various causes like elastic shortage of concrete, shrinkage of concrete, creep of concrete, Relaxation of steel, slip in anchorage bending of member and frictional losses.

Module:3 *Analysis and Design for Flexure and Shear*	**10 hours**

Design of Members: For flexure; Detailing requirements; Modes of failure; IS Specifications
Analysis for Shear: Stress in an uncracked beam; types of cracks; Modes of failure; Limit state of collapse for shear; Design steps; Design of transverse reinforcement; Detailing requirement for shear.

Module:4 *Deflections of Prestressed Concrete Beams*	**8 hours**

Importance of control of deflections – factors influencing deflections – short term deflections of uncracked members, prediction of long-term deflections; calculation of deflection.

Total Lecture hours	**36 hours**

Text Book(s)

1. Krishna Raju (2007). Prestressed Concrete, Tata McGraw-Hill Publications, 4th Edition.
2. Lin, T. Y., & Burns, N. H. (1981). Design of prestressed concrete structures.

Reference Books

1. Rajagopalan, N. (2002). Prestressed concrete. CRC Press.
2. Nawy, E. G. (1996). Prestressed concrete. A fundamental approach.
3. IS: 1343- Code of Practice for Pre-stressed Concrete.

Mode of Assessment: Continuous Assessment Test, Quizzes, Assignments, Final Assessment Test

Recommended by Board of Studies			
Approved by Academic Council		Date	

BCE237PE42T	Ground Improvement Technique	L	T	P	C
		3	0	0	3

Course Objectives:

The course aims to:

1) Develop an understanding of the need for ground improvement and the selection of suitable techniques based on soil conditions and engineering requirements.
2) Familiarize students with conventional and advanced ground improvement methods used to enhance the engineering properties of problematic soils.
3) Introduce the principles, materials, design concepts, and applications of geosynthetics in geotechnical engineering.
4) Enable students to analyze, design, and select appropriate ground improvement techniques for transportation, environmental, and foundation engineering applications

Expected Course Outcome:

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

CO1: Explain the principles of ground improvement and select appropriate techniques based on soil characteristics and project requirements.
CO2: Analyze and design ground improvement systems using densification, consolidation, drainage, and soil reinforcement methods.
CO3: Evaluate the properties, functions, and design applications of geosynthetics for geotechnical and environmental engineering projects.
CO4: Apply conventional and advanced ground improvement techniques, including grouting, deep mixing, stabilization, and vacuum consolidation, to solve practical geotechnical engineering problems.

Module:1 Fundamentals of Ground Improvement	**10 hours**
Introduction to ground improvement, Need and objectives of ground improvement, Selection of suitable ground improvement techniques, Mechanical and hydraulic modification methods, Vibro-compaction, Vibro-replacement, Stone columns, Dynamic compaction, Compaction grouting, Applications and limitations	
Module:2 Ground Improvement by Consolidation and Reinforcement	**10 hours**
Preloading and surcharge techniques, Vertical drains, Prefabricated Vertical Drains (PVDs), Vacuum consolidation, Ground improvement using reinforced earth, Soil reinforcement principles, Reinforced earth walls, Reinforced embankments, Design considerations and case studies	
Module:3 Geosynthetics in Ground Improvement	**12 hours**
Introduction to geosynthetics, Classification and properties of geosynthetics, Geotextiles, Geogrids, Geonets, Geomembranes, Geocells and Geotubes, Functions of geosynthetics, Design methods using geosynthetics, Applications in roads, railways, retaining walls, landfills, drainage, and erosion control	
Module:4 Advanced Ground Improvement Techniques	**10 hours**
Grouting techniques, Chemical grouting, Cement grouting, Jet grouting, Deep soil mixing, Soil stabilization using lime, cement, and industrial by-products, Ground improvement for soft soils, Quality control and performance evaluation, Recent advances and sustainable ground improvement techniques, Case studies	
Total Lecture hours	**42 hours**

Text Book(s)

1.	P. Purushothama Raj**,** *Ground Improvement Techniques*, Laxmi Publications, New Delhi, 2005.

Reference Books

1.	M.P. Moseley, K. Kirsch and A. Karstunen, *Ground Improvement*, 2nd Edition, CRC Press, Taylor & Francis, 2018.
2.	Nihar Ranjan Patra, *Ground Improvement Techniques*, Vikas Publishing House Pvt. Ltd., New Delhi, 2012..
3.	B. M. Das and K. Sobhan, *Principles of Foundation Engineering*, 9th Edition, Cengage Learning, 2019..
4.	IS 15284 (Parts 1 & 2): 2003, *Design and Construction for Ground Improvement—Guidelines*, Bureau of Indian Standards**.**

5.	IRC: SP:89, *Guidelines for Soil and Granular Material Stabilization Using Cement, Lime and Fly Ash*, Indian Roads Congress.		
Mode of Assessment: Continuous Assessment Test, Quizzes, Assignments, Final Assessment Test			
Recommended by Board of Studies			
Approved by Academic Council		Date	

BCE237PE43T	**Industrial Wastewater Management**	L	T	P	C
		3	0	0	3

Pre-requisite: Nil

Course Objectives:

This course aims to provide students with an understanding of the sources, characteristics, treatment, management, and reuse of industrial wastewater. It develops knowledge of physical, chemical, and biological treatment processes, environmental regulations, sludge management, and sustainable wastewater management practices for various industries.

Expected Course Outcome:

Upon completion of this course, the student will be able to

- Explain the sources, characteristics, and impacts of industrial wastewater.
- Select appropriate physical, chemical, and biological treatment processes for industrial wastewater.
- Apply environmental standards for wastewater treatment, sludge management, and disposal.
- Evaluate industrial wastewater reuse, Zero Liquid Discharge (ZLD), and effluent treatment systems.
- Develop suitable treatment flow sheets and source reduction strategies for major industries.

Module:1 ***Introduction and Characterization*** **6 hours**

Industrial activities and the environment, Water use in industries , Sources and types of industrial wastewater , Characteristics and general properties of industrial effluents, Impact of industrial wastewater on receiving water bodies.

Module:2 ***Treatment Of Industrial Waste Water*** **10 hours**

Flow and Load Equalization – Solids Separation – Removal of Fats, Oil & Grease - Neutralization Removal of Inorganic Constituents – Precipitation, Heavy metal removal, Ion exchange, Adsorption, Membrane Filtration, Electro dialysis & Evaporation, Removal of Organic Constituents, Nitrogen & Phosphorous removal – Biological treatment Processes, Chemical Oxidation Processes.

Module:3 ***Wastewater Processing and Management*** **10 hours**

Environmental Standards & Regulatory limits for industrial effluent, Disposal of treated wastewater on water and land – Residuals from industrial wastewater treatment, Quantification and characteristics of Sludge and its Thickening, digestion, conditioning, dewatering and disposal of sludge.

Module:4 ***Wastewater Reuse*** **6 hours**

Reuse of industrial wastewater & Advantages, Quality requirements for reuse, Zero liquid discharge systems, Individual effluent treatment plants and common effluent treatment plants, Resource recovery from industrial wastewater and treatment residuals.

Module:5 ***Case Studies*** **4 hours**

Source reduction and cleaner production options, Waste treatment flow sheet for Textiles , Tanneries, Pulp and paper, metal finishing Industries, Sugar and Distilleries.

Total Lecture hours **36 hours**

Text Book(s)

1. Metcalf & Eddy, Inc. *Wastewater Engineering: Treatment and Resource Recovery*, 5th Edition, McGraw-Hill Education.

Reference Books

1. B. C. Punmia, Ashok Kumar Jain and Arun Kumar Jain, *Environmental Engineering–II: Wastewater Engineering*, Laxmi Publications.
2. S. K. Garg, *Environmental Engineering (Vol. II): Sewage Disposal and Air Pollution Engineering*, Khanna Publishers
3. IS 3025 (Various Parts) – Methods of Sampling and Test (Physical and Chemical) for Water and Wastewater.,IS 2490 (Part 1 & Part 2) – Tolerance Limits for Industrial Effluents. CPCB – *Guidelines for Common Effluent Treatment Plants (CETPs).* CPCB – *Guidelines for Zero Liquid Discharge (ZLD) Systems.*

Mode of Assessment: Continuous Assessment Test, Quizzes, Assignments, Final Assessment Test

Recommended by Board of Studies			
Approved by Academic Council		Date	

BCE237PE44T	URBAN WATER INFRASTRUCTURE	L	T	P	C
		3	0	0	3

Pre-requisite: Nil

Course Objectives:

1. To explain the components, functions and planning principles of urban water infrastructure systems.
2. To apply engineering principles for the design and operation of urban water supply, distribution, drainage and sewerage systems.
3. To examine river engineering practices and hydraulic structures used for urban flood management and water resources development.
4. To evaluate sustainable and resilient strategies for effective urban water management under changing environmental and climatic conditions.

Expected Course Outcome:

Upon completion of this course, the student will be able to

1. To understand the principles and components of urban water infrastructure systems.
2. To apply engineering principles and design methodologies for urban water supply, drainage and sewerage networks.
3. To analyze river engineering and hydraulic structure concepts for urban flood mitigation and water management.
4. To evaluate sustainable urban water management practices including wastewater reuse and smart water systems.

Module:1 *Introduction to Urban Water Infrastructure*	**3 hours**
Urbanization and water challenges, Urban hydrologic cycle, Components of urban water infrastructure, Integrated Urban Water Management (IUWM), Water demand forecasting, Population estimation methods, Sources of urban water supply, Urban water resource planning.	
Module:2 *Urban Water Supply Systems*	**4 hours**
Water intake structures, Conveyance systems, Water treatment fundamentals, Service reservoirs, Distribution network components, Design considerations for water distribution systems, Pumps and pumping stations, Operation and maintenance of urban water supply systems.	
Module:3 *Urban Drainage and Sewerage Systems*	**3 hours**
Urban runoff characteristics, Stormwater drainage systems, Design of storm sewers and culverts, Combined and separate sewer systems, Sewer appurtenances, Wastewater collection and conveyance, Urban flood management.	
Module:4 *River Engineering for Urban Areas*	**10 hours**
River morphology and river behavior, Urban river management, River training works, Riverbank protection measures, Floodplain management, Sedimentation and erosion control, River restoration and rejuvenation, Case studies of urban river projects.	
Module:5 *Hydraulic Structures in Urban Water Infrastructure*	**10 hours**
Weirs, Barrages, Intake structures, Spillways, Energy dissipators, Detention and retention basins, Urban reservoirs, Canal Design, Hydraulic design considerations, Applications of hydraulic structures in urban water supply and flood control.	
Module:6 *Sustainable Urban Water Management*	**3 hours**
Rainwater harvesting, Groundwater recharge techniques, Water conservation measures, Sustainable Urban Drainage Systems (SUDS), Low Impact Development (LID), Climate change impacts on urban water systems.	
Module:7 *Wastewater Reuse and Smart Water Systems*	**3 hours**
Wastewater treatment and reuse, Reclaimed water applications, Circular water economy, Smart water infrastructure, SCADA and sensor-based monitoring, Digital water management, Resilient urban water systems.	
Total Lecture hours	**36 hours**

Text Book(s)

1.	Introduction to Urban Water Distribution ---Nemanja Trifunovic, CRC Press/ Balkema (Taylor and Francis Group), 2020.

Reference Books			
1.	Urban Water Engineering and Management ---M Karamouz and A Moridi, CRC Press (Taylor and Francis Group) PHI, 2025.		
2.	Irrigation & Hydraulic Structures --- S. R. Sahasrabudhe, KATSON Books.		
3.	Mechanics of Sediment Transport and Alluvial Stream--- Garde R. J. and Ranga Raju K.G., Wiley Eastern Ltd., New Delhi.		
Mode of Assessment: Continuous Assessment Test, Quizzes, Assignments, Final Assessment Test			
Recommended by Board of Studies			
Approved by Academic Council		Date	

BCE237PE45T	**Airport Planning & Design**	L	T	P	C
		3	0	0	3

Pre-requisite: Nil

Course Objectives:

1. To understand the fundamentals of planning and design of Airport structures.
2. To know the design of runway at Airport
3. To know the design of taxiways at Airport
4. To understand the grading, drainage and air traffic operations at Airport.

Expected Course Outcome:

Upon completion of this course, the student will be able to

1. To understand the fundamentals of planning and design of Airport structures.
2. To apply the concepts of design of runway at Airport
3. To analyze the elements related to design of taxiways and terminal area of Airport
4. To justify the grading, drainage and air traffic operations at Airport.

Module:1 *Introduction*	**4 hours**

History, development, policy of air transport, aircrafts, aerodromes, air transport authorities, air transport activities, aircrafts and its characteristics, airport classifications as per ICAO.

Module:2 *Airport Planning*	**8 hours**

Regional planning-concepts and advantages, location and planning of airport as per ICAO and F.A.A. recommendations, airport Elements -airfield, terminal area, obstructions, approach zone, zoning laws, airport capacity, airport size and site selection, estimation of future air traffic, development of new airport, requirements of an ideal airport layout.

Module:3 *Run Way Design*	**8 hours**

Wind rose and orientation of runway, wind coverage and crosswind component, factors affecting runway length, basic runway length, and corrections to runway length, runway geometrics and runway patterns (configurations). Run way marking, threshold limits cross section of runway.

Module:4 *Taxiway and Terminal Area Design*	**8 hours**

Controlling factors, taxiway geometric elements, layout, exit taxiway, location and geometrics, holding apron, turnaround facility. Aprons - locations, size, gate positions, aircraft parking configurations and parking systems, hanger-site selection, planning and design considerations, Fuel storage area, blast pads, wind direction indicator.

Terminal area elements and requirements, terminal building functions, space requirements, location planning concepts, vehicular parking area and Circulation network. passenger requirements at terminal building

Module:5 *Grading and Drainage*	**4 hours**

Airport grading-importance - operations, airport drainage aims, functions, special characteristics, basic requirements, surface and subsurface drainage systems.

Module:6 *Air Traffic Control and Visual Aids*	**4 hours**

Air traffic control, objectives, control system, control network-visual aids-landing information system, airport markings and lighting.

Total Lecture hours	**36 hours**

Text Book(s)

1. Dr. S. K. Khanna, M. G. Arora and S. S. Jain, Airport Planning & Design, Nem Chand & Bros., Roorkee.

Reference Books

1. G.V. Rao Airport Engineering, Tata McGraw Hill Pub. Co., New Delhi.

Mode of Assessment: Continuous Assessment Test, Quizzes, Assignments, Final Assessment Test

Recommended by Board of Studies			
Approved by Academic Council		Date	

BCE237PE51T	EARTHQUAKE ENGINEERING	L	T	P	C
		3	0	0	3

Prerequisite: Solid Mechanics, Structural Analysis, Design of Reinforced Concrete Structure.

Course Objectives:

The objectives of this course are to:

1. Introduce the fundamentals of engineering seismology, earthquake hazards, and the dynamic behaviour of structures subjected to seismic loading.
2. Develop an understanding of seismic analysis methods and the response of structural systems to earthquake effects.
3. Familiarize students with the principles and codal provisions of earthquake-resistant design and ductile detailing of structures.
4. Expose students to software-based seismic analysis, retrofitting techniques, and geotechnical aspects relevant to earthquake engineering.

Course Outcome:

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

CO1: Explain the fundamentals of seismology, seismic hazards, and the dynamic behaviour of structures during earthquakes.

CO2: Analyze the seismic response of SDOF/MDOF systems and evaluate lateral load effects on buildings.

CO3: Apply the provisions of IS 1893 and IS 13920 for earthquake-resistant analysis and design of structures using conventional and software-based methods.

CO4: Evaluate seismic performance improvement measures through ductile detailing, retrofitting, and geotechnical considerations.

Module:1 Seismology and Earthquake	**5 hours**

Internal structure of the earth, continental drift and plate tectonics, Faults, Elastic rebound theory,seismic waves and characteristics, earthquake size, Magnitude and Intensity, Ground Motions, Site effects, Sensors, strong ground motion, seismic zoning map of India, Seismic hazard assessment, damages caused during past earthquakes (worldwide).

Module:2 Fundamentals of Earthquake Vibrations of buildings	**8 hours**

Static load v/s Dynamic load (force control and displacement control), simplified single degree of freedom system, mathematical modelling of buildings, natural frequency, resonance v/s increased response, responses of buildings to different types of vibrations like free and forced, damped and un-damped vibration, response of building to earthquake ground motion, Response to multi degree (maximum three) of freedom systems up to mode shapes.

Module:3 Design Philosophy	**8 hours**

Philosophy of earthquake resistant design, earthquake proof v/s earthquake resistant design, four virtues of earthquake resistant structures (strength, stiffness, ductility and configuration), seismic structural configuration, Introduction to IS: 1893 (Part I)-2016. Seismic load: Seismic Coefficient Method – base shear and its distribution along height. Introduction to Response spectrum, IS code provisions.

Module:4 Lateral Loads on Buildings	**6 hours**

Lateral Load Distribution (SDOF): Rigid diaphragm effect, centers of mass and stiffness, torsionally coupled and uncoupled system.

Lateral Load Analysis: Analysis of frames using approximate methods like portal & cantilever methods

Module:5 Modeling, Analysis and Design of Structures	**8 hours**

Seismic analysis and design of RC structures using software - static and dynamic methods – equivalentstatic, response spectrum and time history methods, Retrofitting and strengthening of Buildings and Bridges.

Module:6 Ductile Detailing		**5 hours**
Concepts of Detailing of various structural components as per IS: 13920-2016 provisions		
Module:7 Geotechnical aspects		**5 hours**
Dynamic properties of soil, dynamic earth pressures, Liquefaction and ground improvement techniques		
Total hours		**60 hours**
Text Book		
1.	Pankaj Agarwal and Manish Shrikhande., (2010), Earthquake resistant design of structures, Prentice-Hall India Pvt. Ltd., New Delhi.	
2.	Ashok K. Jain, (2023), Dynamics of Structures with Earthquake Engineering, Pearson India Education Services Pvt. Ltd, Noida.	
Reference Books		
1.	Clough and Penzien (2015), Dynamics of Structures, CBS Publishers and Distributors, New Delhi.	
2.	Chopra. A. K. (2011), Dynamics of Structures - Theory and Applications to Earthquake Engineering, 4th edition, Prentice Hall, London.	
3.	Roy R.Craig, Jr. Andrew J. Kurdila (2011), Fundamentals of Structural Dynamics, John Wiley	
	and Sons, London.	
4.	T. Paulay and M.S.N. Priestley, Seismic Design of Reinforced Concrete and Masonry Buildings,John Wiley and Sons, 1992.	
5.	M. N. S. Priestley, F. Seible and G.M. Calvi, Seismic Design and Retrofit of Bridges, John Wiley and Sons, 1996.	
6.	Mario Paz and William Leigh (2010), Structural Dynamics - Theory and Computation, Springer.	
7.	D. J. Dowrick, Earthquake Resistant Design for Engineers and Architects, John Wiley and Sons, 1987.	
8.	IS: 1893:2016 (Part 1), Criteria for earthquake resistant design of structures.	
9.	IS:13920: 2016, Ductile detailing of reinforced concrete structures subjected to seismic forces.	
10.	Code of Practice for earthquake resistant design & Construction of buildings – IS 4326 (1993).	
11.	Code of Practice for Improving Earthquake Resistance of Earthen Buildings - IS 13827(1993)	
12.	Guidelines for Improving Earthquake Resistance low strength masonry buildings - IS 13828 (1993)	
13.	C V R Murthy - Earthquake Tips, NICEE	
14.	IITK-GSDMA EQ26 – V -3.0 Design Example of a Six Storey Building	

BCE237PE52T	Geotechnical Design	L	T	P	C
		3	0	0	3

Pre-requisite: a) Soil Mechanics
b) Foundation Engineering

Course Objectives:

The course aims to:

1. Provide knowledge of subsurface investigation techniques and geotechnical site characterization for the planning and design of civil engineering infrastructure.
2. Develop an understanding of the engineering properties of soils and construction materials, and their improvement using suitable stabilization and ground improvement techniques.
3. Equip students with the principles and methodologies for the design of retaining structures and foundation systems in accordance with geotechnical engineering practices and relevant Indian Standards.
4. Enable students to apply geotechnical design concepts to transportation and hydraulic infrastructure, including highways, airport pavements, embankments, and drainage systems.

Expected Course Outcome:

Upon completion of this course, the student will be able to

CO1: Conduct and interpret subsurface site investigations and characterize ground conditions for the design of civil engineering infrastructure.

CO2: Evaluate the engineering properties of soils and construction materials, and recommend appropriate stabilization and ground improvement techniques for geotechnical applications.

CO3: Analyze and design retaining structures and shallow and deep foundation systems by applying earth pressure theories, bearing capacity, settlement analysis, and relevant IS codes.

CO4: Apply geotechnical design principles to transportation and hydraulic infrastructure, including pavement foundations, airport runways, embankments, and seepage control systems.

Module:1 Subsurface Investigation and Site Characterization	**6 hours**
Objectives of site investigation, Geological and geotechnical site reconnaissance, Borehole investigations, Sampling techniques and sample disturbance, Standard Penetration Test (SPT), Cone Penetration Test (CPT), Plate Load Test, Geophysical exploration methods.	
Module:2 Geotechnical Materials and Ground Improvement	**6 hours**
Engineering properties of soils and aggregates; Selection of materials for foundations, embankments, and pavements; Compaction requirements and specifications; Stabilized soils- Lime stabilization, Cement stabilization; Fly ash and industrial waste utilization; Ground improvement techniques, Soil reinforcement, Stone columns and grouting.	
Module:3 Design of Retaining Structures and Earth Retention Systems	**8 hours**
Earth pressure theories -Active, passive, and at-rest earth pressures; Design of gravity retaining walls; Cantilever retaining walls; Sheet pile walls; Stability checks - Sliding, Overturning, Bearing capacity; Drainage considerations	
Module:4 *Foundation Design*	**12 hours**
Design philosophy and limit state concepts, Bearing capacity considerations, Settlement analysis, Design of shallow foundations - Isolated footings, Combined footings, Strap footings, Raft foundations. Design of deep foundations - Single piles, Pile groups, Under-reamed piles, Well foundations, Foundation design as per IS codes, Foundation selection criteria	
Module:5 *Geotechnical Design for Transportation and Hydraulic Infrastructure*	**6 hours**
Subgrade evaluation for highways and airports; CBR and resilient modulus concepts; Pavement material characterization; Geotechnical aspects of flexible and rigid pavements; Seepage and drainage control; Geotechnical considerations for airport runways	
Total Lecture hours	**38 hours**

Text Book(s)

1.	Swami Saran, Analysis and Design of Substructures: Limit State Design.

Reference Books

1.	Bowles, J.E., Foundation Analysis and Design.

2.	Coduto, D.P., Foundation Design: Principles and Practices.		
3.	Das, B.M. and Sivakugan, N., Principles of Foundation Engineering.		
4.	IRC and IS Codes relevant to geotechnical investigations and foundation design.		
Mode of Assessment: Continuous Assessment Test, Quizzes, Assignments, Final Assessment Test			
Recommended by Board of Studies			
Approved by Academic Council		Date	

BCE237PE53T	Water Quality Management	L	T	P	C
		3	0	0	3

Pre-requisite: Nil

Course Objectives:

- Understand the physical, chemical and biological characteristics of water and their significance in assessing water quality.
- Develop knowledge of water pollution sources, impacts and techniques for water quality monitoring and assessment.
- Learn principles of surface water and groundwater quality management, including conservation, reuse and sustainable utilization of water resources.
- Familiarize with water quality standards, environmental legislation and governance frameworks for effective water resource management.

Expected Course Outcome:

Upon completion of this course, the student will be able to

1. Explain water quality characteristics and assess water quality using standard parameters, monitoring techniques and water quality indices.
2. Identify major sources of water pollution and evaluate their impacts on surface water and groundwater systems.
3. Apply principles of water conservation, water reuse and integrated water resources management for sustainable water resource utilization.
4. Interpret water quality standards, environmental regulations and governance mechanisms related to water resource management.

Module:1 *Water Quality Fundamentals and Assessment* — **9 hours**

Water resources and water quality requirements for domestic, industrial and agricultural uses. Physical, chemical and biological characteristics of water including temperature, turbidity, colour, total dissolved solids, pH, alkalinity, hardness, dissolved oxygen (DO), biochemical oxygen demand (BOD), chemical oxygen demand (COD), nutrients and indicator organisms. Water sampling techniques, monitoring programmes, laboratory analysis and interpretation of water quality data. Water Quality Index (WQI) and its applications.

Module:2 *Water Pollution and Aquatic Systems* — **9 hours**

Sources and effects of water pollution including domestic wastewater, industrial effluents, agricultural runoff and emerging contaminants. Self-purification of streams, dissolved oxygen balance and oxygen sag concept. Eutrophication of lakes and reservoirs. Water quality issues in rivers, lakes and groundwater. Groundwater contamination including fluoride, arsenic, iron and saltwater intrusion.

Module:3 *Water Quality Management and Sustainability* — **10 hours**

Water conservation strategies, water auditing and water footprint assessment. Wastewater reuse, greywater management and industrial water recycling. Principles of Integrated Water Resources Management (IWRM). Watershed management approaches for water quality protection. Climate change impacts on water resources and adaptation measures.

Module:4 *Water Standards, Legislation and Governance* — **8 hours**

Drinking water quality standards (IS 10500), surface water quality criteria, irrigation water quality standards and industrial discharge standards. Water (Prevention and Control of Pollution) Act, 1974, Environment (Protection) Act, 1986, functions of CPCB and SPCBs, National Water Policy and Sustainable Development Goal 6 (SDG-6). Environmental compliance, water governance and stakeholder participation in water resource management.

Total Lecture hours — **36 hours**

Text Book(s)

1. *Water Supply Engineering*, S. K. Garg, Khanna Publishers, New Delhi.
2. *Water Quality Engineering in Natural Systems*, David A. Chin, John Wiley & Sons, New York.

Reference Books

1. *Water Resources Engineering*, Larry W. Mays, John Wiley & Sons.
2. *Environmental Engineering*, H.S. Peavy, D.R. Rowe and G. Tchobanoglous, McGraw-Hill International Editions.
3. *Water and Wastewater Technology*, Mark J. Hammer and Mark J. Hammer Jr., Pearson Education.
5. *Environmental Engineering: A Design Approach*, A.P. Sincero and G.A. Sincero, Prentice Hall.

Mode of Assessment: Continuous Assessment Test, Quizzes, Assignments, Final Assessment Test

BCE237PE54T	WATERSHED CONSERVATION AND MANAGEMENT	L	T	P	C
		3	0	0	3

Pre-requisite: Nil

Course Objectives:

1. To understand the concepts, characteristics, delineation and prioritization of watersheds for sustainable resource management.
2. To demonstrate knowledge of soil and water conservation practices, watershed planning and project implementation strategies.
3. To examine rainwater harvesting techniques, watershed development measures and economic aspects of watershed management.
4. To evaluate modern tools such as Remote Sensing, GIS and Decision Support Systems for watershed analysis, planning and management.

Expected Course Outcome:

Upon completion of this course, the student will be able to

1. To explain watershed characteristics, geomorphological factors and integrated watershed management principles.
2. To apply watershed development projects incorporating soil and water conservation measures and community participation.
3. To analyze rainwater harvesting techniques and watershed management practices for sustainable utilization of land and water resources.
4. To evaluate Remote Sensing, GIS and Decision Support Systems for watershed assessment, planning and decision-making.

Module:1 *Watershed Concepts*	**7hours**
Watershed -Need for an Integrated Approach -Influencing Factors: Geology –Soil Morphological Characteristics -Toposheet -Delineation –Codification –Prioritization of Watershed –Indian Scenario.	
Module:2 *Soil Conservation Measures*	**8 hours**
Site selection criteria, benchmark survey, people's participation concept, project evaluation and monitoring.	
Module:3 *Water Harvesting and Conservation*	**8 hours**
Water Harvesting Techniques –Micro-Catchments -Design of Small Water Harvesting Structures-Farm Ponds –Percolation Tanks –Yield from a Catchment	
Module:4 *Watershed Management*	**7 hours**
Project Proposal Formulation -Watershed Development Plan –Entry Point Activities –Estimation-Watershed Economics -Agroforestry –Grassland Management –Wasteland Management –Watershed Approach in Government Programmes –Developing Collaborative know how –People's Participation –Evaluation of Watershed Management.	
Module:5 *GIS for Watershed Management*	**6 hours**
Applications of Remote Sensing and Geographical Information System -Role of Decision Support System –Conceptual Models and Case Studies.	
Total Lecture hours	**36 hours**

Text Book(s)

1. Ghanashyam Das, Hydrology and Soil Conservation engineering, Prentice Hall of India Private Limited, New Delhi, 2000.

Reference Books

1. Glenn O Schwab. et al, Soil and Water Conservation engineering, Wiley India Private Limited, 2009.
2. Heathcote, I. W. Integrated Watershed Management: Principles and Practice. John Wiley and Sons, Inc., New York, Second Edition 2009.
3. Vir Singh, Raj, Watershed Planning and Management, Yash Publishing House, Bikaner, 2000.

Mode of Assessment: Continuous Assessment Test, Quizzes, Assignments, Final Assessment Test

Recommended by Board of Studies			
Approved by Academic Council		Date	

BCE237PE55T	**Port and Harbor Engineering**	L	T	P	C
		3	0	0	3

Pre-requisite: Nil

Course Objectives:

The course aims to develop knowledge of port and harbour planning, design, and operations. It covers harbour structures, coastal effects, navigation facilities, maintenance, safety, and sustainable port development

Expected Course Outcome:

- Understand the basics of water transportation, ports, and harbours.
- Analyze the impact of waves, tides, wind, and sediment movement on harbour design.
- Apply concepts of port planning, facilities, and operations.
- Understand the design and functions of harbour structures.
- Explain maintenance, coastal protection, dredging, and navigational aids.

Module:1 ***Introduction to Water Transportation*** **4 hours**

History, Scope and Merits of Water Transportation, Water Transportation in India, Inland water transportation, Harbor, Port & Dock. Development of Ports & Harbors, Classification of ports and Harbours.

Module:2 ***Natural Phenomena*** **6 hours**

Wind, Tides, Water waves, Wind rose and wave rose diagrams, wave diffraction, breaking, reflection, and Littoral drift. Sediment transport, Effects on Harbor and structure design.

Module:3 ***Port Planning, Amenities and Operations*** **10 hours**

Characteristics of good seaport and principles of seaport planning, size of seaport, site selection criteria and layout of seaport, Dry ports, Bulk cargo, Transshipment ports, Port of call. Surveys to be carried out for seaport planning. Ferry, Transfer bridges, floating landing stages, transit sheds, warehouses, cold storage, aprons, cargo handling equipment, Purpose and general description: stack area, single point mooring IS provisions

Module:4 ***Harbor Infrastructures*** **10 hours**

Ship characteristics. Design of Harbor entrance, channel, turning basin, IS provisions, Breakwaters - function, types, general design principles Wharves, quays, jetties, piers, pier heads, dolphin, fenders, Mooring accessories IS provisions. Repair facilities, wet docks, lift docks, dry docks, gates for graving docks, floating docks, slipways, locks and gates

Module:5 ***Maintenance and Navigational Aids*** **6 hours**

Coastal protection-purpose and devices, sea wall protection- seawall revetment, bulkhead. Dredging, dredgers-types and suitability, usage of dredged materials. Channel and entrance demarcation, buoys, beacons, light house electronic communication devices.

Total Lecture hours **36 hours**

Text Book(s)

1	Harbour, Dock and Tunnel Engineering — S. P. Bindra, *Dhanpat Rai & Sons, New Delhi*

Reference Books

1	Dock and Harbour Engineering — R. Agarwal — **Khanna Publishers**
2	Port and Harbour Engineering — S. P. Chandola, *Dhanpat Rai & Sons, New Delh*
3	A Course in Civil Engineering: Harbour and Dock Engineering — R. Srinivasan, *McGraw Hill Education (India)*

Mode of Assessment: Continuous Assessment Test, Quizzes, Assignments, Final Assessment Test

Recommended by Board of Studies			
Approved by Academic Council		Date	

BCE237PE61T	**Rehabilitation/Restoration of structures**	**L**	**T**	**P**	**C**
		3	**0**	**0**	**3**

Pre-requisite: Nil

Course Objectives:

1. Understand the concepts of maintenance, inspection, and condition assessment of structures.
2. Explain the causes of deterioration, durability, and serviceability of concrete.
3. Apply suitable repair, rehabilitation, retrofitting, and protection techniques.
4. Evaluate damaged structures and recommend appropriate repair methods

Expected Course Outcome:

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

1. Explain maintenance, inspection, condition assessment, and NDT techniques.
2. Describe the causes of deterioration, durability of concrete, and repair materials.
3. Select appropriate repair, rehabilitation, retrofitting, and corrosion protection methods.
4. Assess structural damage and recommend suitable repair and strengthening techniques.

Module:1 MAINTENANCE AND REPAIR STRATIGES — **8 hours**

Basic concepts and importance of maintenance; types of maintenance; inspection of structures; condition assessment and identification of structural damage; causes of structural deterioration; assessment of damaged structures; basics of Non-Destructive Testing (NDT) and Non-Destructive Evaluation (NDE); repair, rehabilitation, retrofitting, strengthening, and upgradation of structures; selection of suitable repair materials and repair techniques

Module:2 Serviceability and Durability of Concrete — **6hours**

Quality, strength, durability, and thermal properties of concrete; types and causes of cracks; effects of weather, temperature, corrosion, and concrete cover; basic methods of crack repair; surface preparation; reinforcement repair; shot creting, grouting, dry packing, and polymer-based repair techniques.

Module:3 Materials for Repair — **5 hours**

Special concretes and mortars; repair chemicals; accelerated strength-gain materials; expansive cement; polymer concrete; sulphur-infiltrated concrete; ferrocement; fibre-reinforced concrete; high-strength concrete; high-performance concrete; self-compacting concrete; geopolymer concrete; and concrete made with industrial waste materials.

Module:4 Techniques for Repair and Protection — **6 hours**

Repair methods for damaged structures, including epoxy injection, mortar repair, dry packing, shotcreting, foamed concrete, shoring, and underpinning; corrosion protection methods such as corrosion inhibitors, protective coatings, corrosion-resistant steel, and cathodic protection; basics of non-destructive testing (NDT); and engineered demolition of unsafe structures with case studies.

Module:5 Repair, Rehabilitation and Retrofitting of Structures — **5 hours**

Repair of damaged structural members; methods to improve strength and reduce deflection and cracking; repair of structures affected by corrosion, weathering, chemical attack, wear, fire, leakage, and marine exposure; rehabilitation and retrofitting techniques to improve structural performance.

Total Lecture hours — **30 hours**

Text Book(s)

1. Maintenance and Repair of Civil Structures – B. L. Gupta & Amit Gupta.
2. Concrete Structures: Protection, Repair and Rehabilitation – R. Dodge Woodson
3. Concrete Technology – M. S. Shetty
4. Concrete Repair and Maintenance Illustrated – Peter H. Emmons
5. Handbook on Seismic Retrofit of Buildings – S. K. Duggal

Reference Books

1. Concrete Technology: Theory and Practice – M. L. Gambhir
2. Building Materials – S. K. Duggal
3. Non-Destructive Evaluation of Concrete Structures – Christian U. Grosse & Masayasu Ohtsu (Editors)

Mode of Assessment: Continuous Assessment Test, Quizzes, Assignments, Final Assessment Test

Recommended by Board of Studies			
Approved by Academic Council		Date	

BCE 313P	**Building Planning and Computer Aided Civil Engineering Drawings (Laboratory)**	**L**	**T**	**P**	**C**
		0	**0**	**2**	**1**

Pre-requisite: Preliminary knowledge of geometry, graphics and building.

Course Objectives:

1. Gaining the knowledge of preparing
   a. the plan a residential building,
   b. Front elevation,
   c. detailed sectional view,
   d. site plan,
   e. foundation plan with typical door and window.
2. Design of emergency exits and emergency vehicle routes with fire protection symbols.

List of Experiment

1. Preparation of detailed constructional plan of a residential building.
2. Preparation of front elevation, detailed sectional view, site plan, foundation plan and typical door and window and staircase.
3. Fire Protection System: Design of emergency exits and emergency vehicle routes with fire protection symbols.

Text Books

1. Scott Onstott, AutoCAD 2018 and AutoCAD LT 2018 Essentials, Wiley (2017), (ISBN: 9788126569298)
2. M.G.Shah, Kale, Patki, Building Drawing with an Integrated Approach to Built Environment, Tata McGraw-Hill Education India, 5th edition, 2011, (ISBN: 9780071077873, 0071077871).
3. Building Services Environmental And Electro Mechanical Services, Second Revised, 2014, (ISBN: 9788175259805)

BCE237PE62T	**Tunnel Engineering**	L	T	P	C
		3	0	0	3

Pre-requisite: Nil

Course Objectives:

1. To understand the fundamentals of tunnel design.
2. To know the site and ground information required for tunnel design
3. To know the analyses and design related techniques for tunnel construction
4. To understand the health and safety, and risk management involved in tunnel construction.

Expected Course Outcome:

Upon completion of this course, the student will be able to

1. To understand the philosophy behind tunnel design
2. To apply the site and ground information for analyzing tunnel design related parameters
3. To analyze the ground improvement and tunnel construction techniques
4. To justify the health and safety, and risk management involved in tunnel construction.

Module:1 *Introduction* — **4 hours**

Philosophy of tunnelling, Historical context, General Description of Various Tunnels and other underground structures, Components of a tunnel.

Module:2 *Site Investigation* — **6 hours**

Site investigation during a project, Site reconnaissance, Ground investigation, Field investigations, Laboratory tests, Hydrogeological model, Ground characteristics/parameters, Influence of layering on Young's modulus, Squeezing and swelling ground, Typical ground parameters for tunnel design, Ground (rock mass) classification

Module:3 *Preliminary Analyses for Tunnel Design* — **6 hours**

Primary stress pattern in the ground, Stability of ground, Lateral earth pressure, Preliminary analytical methods, Bedded-beam Spring method, Continuum method, Tunnel support resistance method, Basics of numerical modelling, Choice of ground and lining constitutive models.

Module:4 *Ground Improvement Techniques and Lining Systems* — **8 hours**

Ground improvement and stabilization techniques, Ground freezing, Lowering of the groundwater table, Grouting, Ground reinforcement, Tunnel lining systems

Module:5 *Tunnel Construction Techniques* — **8 hours**

Open face construction without a shield, Partial face boring machine (road header), Tunnelling shields, Tunnel boring machines, Drill and blast tunnelling, New Austrian Tunnelling Method, Cut-and-cover tunnels, Immersed tube tunnels, Jacked box tunnelling, Pipe jacking and micro-tunnelling, Horizontal directional drilling

Module:6 *Health And Safety, and Risk Management in Tunnelling* — **6 hours**

Health and safety hazards of tunnel construction, Hazards in tunnelling, Techniques for risk management, Role of the client, designer and contractors, Tunnel transport, Tunnel atmosphere and ventilation, Explosives, Fire, flood rescue and escape, Risk management in tunnelling projects

Total Lecture hours — **38 hours**

Text Book(s)

1. David Chapman, Nicole Metje, Alfred Stärk, Introduction to Tunnel Construction. 2018, CRC Press

Reference Books

1. B. Maidl, M. Thewes, U. Maidl, Handbook of Tunnel Engineering, 2013, Ernst & Son (Wiley).

Mode of Assessment: Continuous Assessment Test, Quizzes, Assignments, Final Assessment Test

Recommended by Board of Studies			
Approved by Academic Council		Date	

BCE237PE63T	Air & Noise Pollution Control	L	T	P	C
		3	0	0	3

Pre-requisite: Nil

Course Objectives:

- Understand sources, characteristics, impacts, and dispersion of air and noise pollutants.
- Learn techniques for monitoring, assessment, and control of air and noise pollution.
- Develop knowledge of pollution control equipment and environmental regulations.
- Apply engineering principles for designing and evaluating pollution mitigation strategies.

Expected Course Outcome:

Upon completion of this course, the student will be able to

1. Explain the sources, characteristics, and impacts of air and noise pollution.
2. Assess air quality and noise levels using standard monitoring techniques.
3. Evaluate atmospheric factors influencing pollutant dispersion.
4. Select appropriate air and noise pollution control technologies for different situations.
5. Apply environmental standards and regulations for pollution management.

Module:1 *Fundamentals of Air Pollution* — **7 hours**

Introduction to Air Pollution: Atmosphere and its structure, Air quality and air pollutants, Primary and secondary pollutants, Sources of air pollution: Natural sources, Anthropogenic sources , Criteria air pollutants
Air Pollutants and Effects: Particulate matter (PM_{10}, $PM_{2.5}$), Sulphur oxides (SOx), Nitrogen oxides (NOx), Carbon monoxide (CO), Ozone (O_3), Volatile organic compounds (VOCs), Greenhouse gases
Effects of Air Pollution: Human health impacts, Effects on vegetation, Climate change and global warming, Acid rain and ozone depletion

Module:2 *Air Pollution Monitoring and Dispersion* — **8 hours**

Meteorology and Air Pollution: Atmospheric stability, Temperature inversion, Wind speed and direction
Air Quality Monitoring: Ambient air quality monitoring, Sampling methods, Monitoring instruments, Air Quality Index (AQI), National Ambient Air Quality Standards (NAAQS)
Air Pollution Dispersion: Transport and dispersion of pollutants, Gaussian plume concept, Stack emissions, Factors affecting dispersion

Module:3 *Air Pollution Control Engineering* — **10 hours**

Control of Particulate Pollutants: Settling chambers, Cyclone separators, Fabric filters (Bag filters), Electrostatic precipitators (ESP), Wet scrubbers,
Control of Gaseous Pollutants: Absorption, Adsorption, Condensation, Combustion and incineration, Catalytic converters,
Industrial and Vehicular Emission Control: Vehicular pollution control technologies, Bharat Stage emission norms, Indoor air pollution and control

Module:4 *Noise Pollution and Control* — **7 hours**

Fundamentals of Noise Pollution: Sound and noise, Characteristics of sound, Units and measurements, Frequency and intensity, Decibel scale
Sources and Effects of Noise: Transportation noise, Industrial noise, Construction noise, Community noise, Health effects of noise
Noise Assessment and Control: Noise measurement techniques, Noise standards, Noise mapping, Noise control at source, path, and receiver, Acoustic barriers and insulation, Occupational noise control

Module:5 *Environmental Legislation and Standards* — **4 hours**

Air Pollution Legislation: Evolution of environmental legislation in India, Air (Prevention and Control of Pollution) Act, 1981, Environment (Protection) Act, 1986, Functions of CPCB and SPCBs, National Clean Air Programme (NCAP), **Air Quality Standards:** National Ambient Air Quality Standards (NAAQS), Emission standards for industries, Vehicular emission standards (Bharat Stage Norms), **Noise Pollution Regulations:** Noise Pollution (Regulation and Control) Rules, 2000, Noise standards for industrial, commercial, residential and silence zones, Environmental Impact Assessment (EIA) related to air and noise pollution

Total Lecture hours — **36 hours**

Text Book(s)

1. *Air Pollution*, M. N. Rao and H. V. N. Rao, Tata McGraw-Hill Education (India)
2. *Air Pollution and Control*, Keshav Kant, Rajni Kant, Khanna Book Publishing Co., New Delhi.

Reference Books

1. *Fundamentals of Air Pollution*, Daniel A. Vallero, Academic Press (Elsevier)
2. *Environmental Pollution Control Engineering*, C. S. Rao, New Age International (P) Ltd.
3. *Environmental Engineering*, H.S. Peavy, D.R. Rowe and Tchobanoglous, G., McGraw-Hill.
5. *Elements of Environmental Pollution Control Engineering*, O.P. Gupta, Khanna Publishing House, New Delhi

Mode of Assessment: Continuous Assessment Test, Quizzes, Assignments, Final Assessment Test

BCE237PE64T	IRRIGATION AND RIVER ENGINEERING	L	T	P	C
		3	0	0	3

Pre-requisite: Nil

Course Objectives:

1. To explain the principles, components and planning aspects of irrigation systems and crop water requirements.
2. To apply engineering principles for the design and analysis of canal irrigation systems, cross-drainage works and hydraulic structures.
3. To examine river behaviour, sediment transport processes and river training works for effective river management.
4. To evaluate the planning, design and stability of dams for sustainable irrigation and water resources development.

Expected Course Outcome:

Upon completion of this course, the student will be able

1. To understand the principles of irrigation engineering, crop water requirements and irrigation systems.
2. To apply engineering principles and design methodologies for canal irrigation systems, cross-drainage works and hydraulic structures.
3. To analyze river behaviour, sediment transport mechanisms and river training measures for effective river management.
4. To evaluate the suitability, design considerations and stability of dams for sustainable water resources development.

Module:1 *Introduction* — **2 hours**

Definition –Irrigation. Advantages, Disadvantages and Ill-Effects of Irrigation. Necessity and Development of Irrigation in Assam. Types of Irrigation, Techniques of water distribution in farms.

Module:2 *Water Requirements of Crops* — **7 hours**

Duty, Delta and Base Period, Factors affecting Duty. Definitions –Rabi crops, Kharif crops, Cash crop, Crop ratio, Kor watering, Kor period, Kor depth, Crop rotation, Intensity of irrigation, Gross Commanded Area, Cultural Commanded Area, Capacity factor, Full supply coefficient, Nominal Duty, Irrigation Efficiencies. Consumptive Use –Estimation of consumptive use, Net Irrigation Requirement, Numerical Problems. Soil –Moisture Relationship, Different Water holding capacities at root zone. Numerical Problems.

Module:3 *Canal Irrigation* — **7 hours**

Alignment of canals –Ridge canal, Contour canal, Side –Slope canal. Distribution system in canal Irrigation. Canal Head Works –Layout with major components, Brief Descriptions of all Major components. Design of Irrigation canal in Alluvial soil- Kennedy's Theory and Lacey's Theory for the Design of canals. Numerical Problems, Regimes of flow.

Module:4 *Cross Drainage Works* — **2 hours**

Definition-Cross-Drainage Works. Aqueduct, Super passage, Level Crossing, Inlet –outlet.

Module:5 *Introduction to River Engineering* — **4 hours**

River course-upper, middle and deltaic reaches; Himalayan and Peninsular rivers, principal river systems of India, Types of Rivers- Perennial, flashy and virgin rivers, incised and boulder rivers, rivers in the flood plains, deltaic rivers, braided rivers, tidal rivers, aggrading and degrading types of rivers. River Behaviour- Behavior of rivers in straight reaches and bends; river meandering-causes and general features, factors affecting meandering, meandering parameters; cut-off, development and effects of cut-off, causes of braiding and delta formation.

Module:6 *Origin, Formation and Transport of Sediments* — **4 hours**

Nature of sediment problems; stream erosion and deposition, wind erosion and deposition, wind erosion and deposition. Sediment-bed load, suspended load and wash load; incipient motion of sediments, mode of sediment transport-rolling, sliding, saltation and suspension; introduction to theories of sediment transport including Shield's theory.

Module:7 *River Training* — **4 hours**

Definition, objectives classification-high water, low water and mean water river training; types of river training works-marginal embankments, spurs, guide banks, porcupines, bank pitching and revetments, cut-off, pitched island, sills and bottom panelling, bandalling; river training works in Assam.	
Module:8 *Dams*	**6 hours**
General, Classification of dams, Selection of site and choice of dams, Gravity dam –forces acting, stability analysis, Embankment dam, Arch dam and Buttress dam.	
Total Lecture hours	**36 hours**

Text Book(s)

1.	Irrigation and Water Power Engineering ---B. C. Punmiya Laxmi Publications, 2016.

Reference Books

1.	Garde R. J. and Ranga Raju K.G., "Mechanics of Sediment Transport and Alluvial Stream", Publisher: Wiley Eastern Ltd., New Delhi.
2.	*Chang H.H., "Fluvial Processes in River Engineering", Publisher: John Wiley & Sons*.
3.	Hydropower Structures –R.S. Varshney –N. C. Jain, Roorkee.

Mode of Assessment: Continuous Assessment Test, Quizzes, Assignments, Final Assessment Test			
Recommended by Board of Studies			
Approved by Academic Council		Date	

BCE237PE65T	Traffic Engineering and Management	L	T	P	C
		3	0	0	3

Course Objectives:

The course aims to:

1) Understand the principles of traffic flow, travel demand forecasting, and highway capacity analysis.
2) Analyze traffic characteristics under mixed traffic conditions and evaluate the performance of highway facilities.
3) Apply traffic flow theories, probabilistic models, and accident analysis techniques to solve transportation engineering problems.
4) Develop simulation models for traffic systems and evaluate alternative traffic management strategies.

Expected Course Outcome:

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

CO1: Explain the principles of traffic forecasting and determine design traffic volume using appropriate forecasting methods and PCU concepts.

CO2: Evaluate the operational performance and capacity of highway facilities, including signalized and unsignalized intersections, and analyze traffic safety using accident data.

CO3: Apply traffic flow theories, queuing models, shock wave analysis, and probabilistic methods to analyze traffic operations under mixed traffic conditions.

CO4: Develop and interpret traffic simulation models for transportation systems and recommend effective traffic management strategies based on simulation outcomes.

Module:1 Traffic Forecasting and Design Traffic Volume	**10 hours**

Introduction to traffic engineering and travel demand forecasting, General principles of traffic forecasting, Traffic forecasting methods: Mechanical methods and Analytical methods, Demand relationships and demand functions, Methods of future traffic projection, Design hourly volume, Critical hour concept., Design vehicle units, Passenger Car Unit (PCU) determination under mixed traffic conditions, Price-volume relationships.

Module:2 Highway Capacity and Traffic Safety	**10 hours**

Highway capacity concepts, Factors affecting highway capacity, Level of Service (LOS), Capacity analysis of: Two-lane highways , Multilane highways, Signalized intersections and Unsignalized intersections, Capacity problems under mixed traffic conditions, Traffic accident analysis, Accident statistics and accident rates, Factors affecting traffic accidents, Influence of roadway and traffic conditions on safety, Accident coefficients and driver strain.

Module:3 Traffic Flow Theory and Probabilistic Models	**11 hours**

Fundamental traffic flow characteristics, Speed–flow–density relationships, Traffic flow theories and applications, Shock wave analysis, Queuing theory and applications, Vehicle arrival characteristics. Probability distribution models, Headway and gap distribution models, Gap acceptance theory., Merging parameters, Delay models and applications.

Module:4 Traffic Simulation and System Modelling	**10 hours**

Fundamentals of traffic simulation, Types of simulation models, Microscopic, mesoscopic and macroscopic simulation, Steps in simulation model development, Formulation of traffic system models, Calibration and validation of simulation models, Applications of simulation in traffic engineering, Case studies on traffic management and operational analysis.

Total Lecture hours	**42 hours**

Text Book(s)

1. Traffic Engineering and Transportation Planning – L. R. Kadiyali, Khanna Publishers, New Delhi, Latest Edition.
2. Traffic Flow Fundamentals – Adolf D. May, Prentice Hall, 1990.
3. Traffic Engineering – Roger P. Roess, Elena S. Prassas and William R. McShane, Pearson Education, 5th Edition.

Mode of Assessment: Continuous Assessment Test, Quizzes, Assignments, Final Assessment Test

Recommended by Board of Studies			
Approved by Academic Council		Date	

BCE237PE71T	BRIDGE ENGINEERING	L	T	P	C
		3	0	0	3

Prerequisite: Solid Mechanics, Structural Analysis, Design of Reinforced Concrete Structure.

Course Objectives:

The objectives of this course are to:

1. Introduce the fundamentals of engineering seismology, earthquake hazards, and the dynamic behaviour of structures subjected to seismic loading.
2. Develop an understanding of seismic analysis methods and the response of structural systems to earthquake effects.
3. Familiarize students with the principles and codal provisions of earthquake-resistant design and ductile detailing of structures.
4. Expose students to software-based seismic analysis, retrofitting techniques, and geotechnical aspects relevant to earthquake engineering.

Course Outcome:

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

CO1: Explain the fundamentals of seismology, seismic hazards, and the dynamic behaviour of structures during earthquakes.

CO2: Analyze the seismic response of SDOF/MDOF systems and evaluate lateral load effects on buildings.

CO3: Apply the provisions of IS 1893 and IS 13920 for earthquake-resistant analysis and design of structures using conventional and software-based methods.

CO4: Evaluate seismic performance improvement measures through ductile detailing, retrofitting, and geotechnical considerations.

Module:1 General Consideration of Bridges	**4 hours**
Components, Materials, Forms, Evolutions and Classifications of Bridges, Site Selection, Subsoil Exploration and Traffic Projections for Bridges	
Module:2 Bridge Hydrology	**3 hours**
Hydraulic Characteristics, Economical Span and Choice of Bridge Type	
Module:3 Loading Standards	**3 hours**
Standard Specifications for Road Bridges, Standard Specifications for Rail Bridges	
Module:4 Design of Super-Structure	**6 hours**
Design of T-Beam and Slab Bridge, Voided Slab Bridges, Skew Slab Culverts and Curved Bridge Decks, Design of Box Culverts, Design of Pipe Culverts, Design of Steel Truss Bridges, Design of Plate Girder Bridges, Continuous Girder Bridges.	
Module:5 Bridge Types	**5 hours**
Masonry Arch Bridges, Concrete Arch Bridges, Suspension Bridges, Cable-Stayed Bridges, Balanced Cantilever Bridges, Prestressed Concrete Bridges, Composite Bridges, Rigid Frame Bridges	
Module:6 Bridge Bearings	**5 hours**
Bridge Bearings, Bridge Joints, Bridge Appurtenances	
Module:7 Geotechnical Investigation for Bridges	**6 hours**
Bridge Piers, Bridge Abutments, Pile Foundations for Bridges, Well and Pneumatic Caisson Foundations for Bridges	
Module:8 Seismic Design and Construction	**8 hours**
Bridge Construction, Maintenance and Rehabilitation of Bridges, Rebuilding of Bridges, Dynamic Response of Bridge Decks, Seismic Design of Highway Bridges, Seismic Design of Railway Bridges, Lessons from Bridge Failures	

Module:9 Materials in Bridge Construction	**5 hours**
Fatigue and Fracture of Bridges, Use of Shape memory Alloys in Bridges, Use of Engineered Cementitious Composite (ECC) in Bridges, 3D Printing of Bridges, High Speed Railway Bridges	
Total hours	**45 hours**
Text Book	
1. N. Krishna Raju, Design of Bridges, Oxford & IBH Publishing Co. Pvt. Ltd.	
Reference Books	
1. D.J. Victor, Essentials of Bridge Engineering, Oxford & IBH Publishing Co. Pvt. Ltd.	
2. S. Ponnuswamy, Bridge Engineering, McGraw Hill Education.	
3. T.R. Jagadeesh and M.A. Jayaram, Design of Bridge Structures, PHI Learning Pvt. Ltd.	
4. W.F. Chen, and L. Duan, Bridge Engineering Handbook, CRC Press, Taylor & Francis Group.	
5. G. Parke and N. Hewson, ICE manual of Bridge Engineering, Thomas Telford Publishing.	

BCE237PE72T	EARTH RETAINING STRUCTURES	L	T	P	C
		3	0	0	3

Pre-requisite: Geotechnical Engineering

Course Objectives:

1. To understand the concepts of earth pressures and seepage in retained soil masses.
2. To analyse and design rigid retaining structures considering earth pressures and stability requirements.
3. To evaluate the behaviour and design principles of flexible retaining structures.
4. To introduce braced excavations and modern retaining systems used in geotechnical engineering.

Expected Course Outcome:

Upon completion of this course, the student will be able to

1. Explain the concepts of earth pressures, stress distribution, and seepage in retained soils.
2. Analyse and design rigid retaining structures and perform stability checks.
3. Analyse flexible retaining systems, including sheet pile walls and their stability.
4. Evaluate the performance of braced excavations and modern retaining systems such as MSE walls, reinforced soil walls, and geosynthetics.

Module:1 *Introduction*	**12 hours**

Introduction – State of stress in retained soil mass; Active, passive and at-rest earth pressures; Rankine's and Coulomb's earth pressure theories; Earth pressure computation for cohesive and cohesionless backfills; Surcharge loading, inclined backfills, submerged and stratified backfills. Seepage analysis and control – seepage through dam and foundations – control of seepage in earth dam and foundation.

Module:2 *Rigid retaining structures*	**12 hours**

Computation of earth pressures against gravity retaining walls – earth pressure for submerged, partly submerged backfills and perched water table. Drainage provisions and weep holes.
Graphical methods of earth pressure computation.
Design and stability checks of gravity retaining walls and cantilever retaining walls.

Module:3 *Flexible retaining structure*	**6 hours**

Type and methods of construction – design strength parameters – safety factor for sheet pile walls – computation of earth pressures against cantilever sheet piles in cohesionless and cohesive soils – anchored sheet piles – free earth method – fixed earth method – Rowe's moment reduction method – stability of sheet piling.

Module:4 *Braced Excavations and Modern Retaining Systems*	**6 hours**

Types and construction methods of braced excavations; pressure distribution in sands and clays; stability -bottom heave, seepage, ground deformation. Introduction to mechanically stabilized earth (MSE) walls and reinforced soil walls. Introduction to geosynthetics in retaining structures.

Total Lecture hours	**36 hours**

Text Book(s)

1. Bowles, J. E. (2001). *Foundation analysis and design* (6th Ed). McGraw Hill. Companies, Inc.
2. Clayton, C. R., Woods, R. I., Bond, A. J., & Milititsky, J. (2014). *Earth pressure and earth-retaining structures*. CRC press.

Reference Books

1. Saran, S. (2018). *Analysis and design of substructures: limit state design*. Oxford and IBH Publishing.
2. Clayton, C. R., Woods, R. I., Bond, A. J., & Milititsky, J. (2014). *Earth pressure and earth-retaining structures*. CRC press.
3. Shukla, S. K., & Shukla, S. K. (Eds.). (2002). *Geosynthetics and their applications* (p. 421). London: Thomas Telford.

Mode of Assessment: Continuous Assessment Test, Quizzes, Assignments, Final Assessment Test

Recommended by Board of Studies			
Approved by Academic Council		Date	

BCE237PE73T	**Solid and Hazardous Waste Management**	L	T	P	C
		3	0	0	3

Pre-requisite: Nil

Course Objectives:

This course aims to provide students with knowledge of the sources, characteristics, and environmental impacts of solid and hazardous wastes. It focuses on waste minimization, segregation, collection, treatment, disposal, and resource recovery techniques. The course also develops an understanding of landfill management, waste regulations, and sustainable waste management practices.

Expected Course Outcome:

- Understand the sources, types, characteristics, and environmental impacts of solid and hazardous wastes.
- Apply waste reduction, segregation, collection, storage, and transportation practices.
- Evaluate biological, thermal, and energy recovery technologies for waste processing.
- Analyze landfill design, operation, leachate control, and waste disposal methods.
- Apply legal regulations and sustainable waste management approaches such as LCA and EPR.

Module:1 ***Introduction to Solid and Hazardous Wastes***	**10 hours**

Types and sources of solid and hazardous wastes, Need for solid and hazardous waste management, Waste generation rates and composition, Waste sampling and Characterization assessment-Physical Characteristics, Chemical & Biological Characteristics: Calorific value, carbon-to-nitrogen (C ÷ N) ratios, carbohydrates, and proteins.

Module:2 ***Waste Reduction and Management Strategies***	**6 hours**

Source reduction of wastes, Recycling and reuse practices, Handling and segregation of wastes at the source, Storage and collection of municipal solid wastes, Importance of transfer and transport, including transfer stations, Labeling and handling of hazardous wastes.

Module:3 ***Waste Processing Technologies***	**10 hours**

Overview of waste processing technologies, Biological Treatments: Composting (aerobic/anaerobic), vermi-composting, and bio-methanation, Thermal Treatments: Incineration, pyrolysis, gasification, and Refuse-Derived Fuel (RDF) systems, Energy Recovery: Waste-to-energy mechanisms and chemical stabilization of organic wastes.

Module:4 ***Landfill Management***	**6 hours**

Disposal in landfills: site selection, operation of sanitary landfills, landfill bioreactors, Leachate and landfill gas management, Landfill closure, environmental monitoring, and remediation.

Module:5 ***Solid and Hazardous waste Legislation***	**4 hours**

Legal Framework: Overview of local and national regulations, International treaties and regulations on the movement of hazardous wastes, Integrated Waste Management: Life Cycle Assessment (LCA), Extended Producer Responsibility (EPR), and economic evaluations.

Total Lecture hours	**36 hours**

Text Book(s)

1	**P. M. Cherry**, *Solid and Hazardous Waste Management*, **CBS Publishers & Distributors Pvt. Ltd.**

Reference Books

1	Solid and Hazardous Waste Management by S.C. Bhatia, (Atlantic Publishers).
2	IS 16089:2013 – Solid Waste Management—Requirements for Segregation, Collection, Storage, Transportation, Processing, and Disposal, IS 12647:1989 – Recommendations for Management of Municipal Solid Waste (where applicable).
3	Solid Waste Management Rules, 2016 (and amendments).
4	Hazardous and Other Wastes (Management and Transboundary Movement) Rules, 2016.
5	CPCB – Guidelines for Management of Hazardous Waste, Guidelines for Biomedical Waste Management, Guidelines for Plastic Waste Management, Guidelines for E-Waste Management.

Mode of Assessment: Continuous Assessment Test, Quizzes, Assignments, Final Assessment Test

Recommended by Board of Studies			
Approved by Academic Council		Date	

BCE237PE74T	GROUND WATER ENGINEERING	L	T	P	C
		3	0	0	3

Pre-requisite: Nil

Course Objectives:

1. To explain the occurrence, movement and properties of groundwater in various geological formations.
2. To demonstrate groundwater exploration techniques and methods for groundwater resource assessment.
3. To examine the principles of well hydraulics and groundwater development for water supply and irrigation.
4. To assess groundwater recharge techniques, contamination mitigation measures and sustainable groundwater management practices.

Expected Course Outcome:

Upon completion of this course, the student will be able to

1. To understand the occurrence, distribution and movement of groundwater in aquifer systems.
2. To apply groundwater investigation and exploration techniques for resource assessment.
3. To analyze well hydraulics principles in the design and development of wells and tubewells.
4. To evaluate groundwater recharge, contamination prevention and sustainable groundwater management strategies.

Module:1 *Introduction to Groundwater Engineering*	**3 hours**

Hydrologic cycle, occurrence and origin of groundwater, groundwater reservoirs, groundwater basin, groundwater movement, porosity, permeability, transmissivity, storage coefficient, specific yield, aquifers, aquitards, aquicludes, aquifuges, groundwater resources in India.

Module:2 *Groundwater Exploration and Investigation*	**6 hours**

Objectives of groundwater exploration, geological methods, geomorphological methods, remote sensing and GIS applications, geophysical methods, electrical resistivity survey, groundwater prospect mapping, groundwater level monitoring and assessment.

Module:3 *Well Hydraulics*	**8 hours**

Darcy's law and its applications, groundwater flow equations, steady and unsteady flow in aquifers, confined and unconfined aquifers, pumping tests, determination of aquifer parameters, well losses, specific capacity, interference among wells.

Module:4 *Wells and Tubewells*	**8 hours**

Types of wells, open wells, tubewells, cavity wells, radial collector wells, well construction methods, well screens, gravel packing, design of tubewells, selection of pumps, operation and maintenance of wells, groundwater extraction for irrigation and water supply.

Module:5 *Artificial Recharge and Groundwater Management*	**6 hours**

Need for artificial recharge, recharge mechanisms, recharge through spreading basins, recharge wells, percolation tanks, recharge trenches, check dams, subsurface dykes, rainwater harvesting, conjunctive use of surface and groundwater, groundwater management strategies.

Module:6 *Groundwater Quality and Contamination*	**5 hours**

Introduction, Methods of Estimation –Rational method, envelop curves, Empirical formulae, PMP chart, UH method, Flood Frequency Analysis –Gumbel's method, Log-Pearson Type –III Distribution. Groundwater quality parameters, groundwater sampling and analysis, sources of groundwater contamination, saltwater intrusion, contamination by agricultural and industrial activities, groundwater quality standards, groundwater protection measures.

Total Lecture hours	**36 hours**

Text Book(s)

1. Ground Water --- Raghunath, H.M., New Age International Publishers, 2007.

Reference Books

1. Groundwater Hydrology --- Todd, D.K. and Mays, L.W., John Wiley & Sons, 2005.
2. Elements of Hydrology and Groundwater --- Saxena, R.N. and Gupta, D.C., PHI Learning, 2017.
3. The Handbook of Groundwater Engineering --- Delleur, J.W., CRC Press, 2006.

Mode of Assessment: Continuous Assessment Test, Quizzes, Assignments, Final Assessment Test

Recommended by Board of Studies			
Approved by Academic Council		Date	

BCE237PE75T	**Smart Cities**	**L**	**T**	**P**	**C**
		3	**0**	**0**	**3**

Pre-requisite: Nil

Course Objectives:

1. Understand the concepts, principles, and evolution of smart cities, climate resilience, and sustainable urban development.
2. Learn the planning, design, and management of smart infrastructure using sustainable construction practices, renewable energy, and green building concepts.
3. Gain knowledge of intelligent transportation systems, smart urban services, and digital technologies for efficient city management.
4. Develop an understanding of smart water infrastructure, climate adaptation strategies, and governance practices through real-world case studies.

Expected Course Outcome:

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

1. Explain the concepts, components, challenges, and policies related to smart cities and climate change.
2. Apply sustainable planning principles, green building concepts, and infrastructure management techniques in smart city development.
3. Analyze the role of intelligent transportation systems and smart technologies in improving urban mobility and public services.
4. Evaluate water resource management, climate adaptation measures, and governance practices for developing sustainable and resilient smart cities.

Module:1 Fundamentals of Smart Cities and Climate Resilience	**9 hours**

Introduction to Smart Cities: Definition, concept, objectives, need and importance, evolution of smart cities (global and India), Smart Cities Mission, features, characteristics and components, smart structures, challenges and opportunities.

Climate Change Fundamentals: Climate change concepts, causes, urban heat island effect, climate-induced hazards, role of space technology, relationship between climate change and smart city development.

Module:2 Planning, Sustainable Development and Smart Infrastructure	**8 hours**

Principles of smart city planning and design, infrastructure needs assessment, integrated infrastructure management systems, sustainable housing and green buildings, LEED and GRIHA rating systems, renewable energy and solar energy applications, project management, disaster management, cyber security, circular economy, Sustainable Development Goals (SDGs), environmental footprints (carbon, water, ecological), stakeholder participation and sustainability approaches.

Module:3 Intelligent Transportation and Urban Services	**8 hours**

Intelligent Transportation Systems (ITS): Smart mobility, intelligent traffic management, smart vehicles and fuels, GIS/GPS-based navigation, traffic safety, mobility services, and electronic tolling and ticketing systems.

Smart Urban Infrastructure: Infrastructure management challenges in India, energy infrastructure, digital infrastructure, public services, applications of smart technologies for urban management

Module:5 Smart Water Infrastructure, Climate Adaptation and Case Studies	**5 hours**

Water management in smart cities: Water supply and distribution, sanitation and sewerage systems, flood management, water conservation, basics of climate change and its impacts, climate action initiatives, nature-based solutions, smart city policies and governance, and case studies of successful smart cities.

Total Lecture hours	**30 hours**

Text Book(s)

1.	Smart Cities: Big Data, Civic Hackers, and the Quest for a New Utopia Author: Anthony M. Townsend Publisher: W. W. Norton & Company, 2013.

2.	Smart Cities: Foundations, Principles, and Applications Authors: Houbing Song, Ravi Srinivasan, Tamim Sookoor & Sabina Jeschke Publisher: Wiley, 2017.
3.	Sustainable Urban Development Author: M. M. M. Sarcar Publisher: Oxford University Press
4.	Green Building Illustrated Authors: Francis D. K. Ching & Ian M. Shapiro Publisher: Wiley, 2014
Reference Books	
1.	Sustainable Cities and Communities Design Handbook **Author:** Woodrow W. Clark II **Publisher:** Butterworth-Heinemann (Elsevier).
2.	Climate Change 2023: Synthesis Report **Author:** Intergovernmental Panel on Climate Change (IPCC)
3.	Urban Transportation Systems **Author:** Sigurd Grava **Publisher:** McGraw-Hill.
Mode of Assessment: Continuous Assessment Test, Quizzes, Assignments, Final Assessment Test	
Recommended by Board of Studies	
Approved by Academic Council	Date

BCE 313P	**Building Planning and Computer Aided Civil Engineering Drawings (Laboratory)**	**L**	**T**	**P**	**C**
		0	**0**	**2**	**1**

Pre-requisite: Preliminary knowledge of geometry, graphics and building.

Course Objectives:

1. Gaining the knowledge of preparing
   a. the plan a residential building,
   b. Front elevation,
   c. detailed sectional view,
   d. site plan,
   e. foundation plan with typical door and window.
2. Design of emergency exits and emergency vehicle routes with fire protection symbols.

List of Experiment

1. Preparation of detailed constructional plan of a residential building.
2. Preparation of front elevation, detailed sectional view, site plan, foundation plan and typical door and window and staircase.
3. Fire Protection System: Design of emergency exits and emergency vehicle routes with fire protection symbols.

Text Books

1. Scott Onstott, AutoCAD 2018 and AutoCAD LT 2018 Essentials, Wiley (2017), (ISBN: 9788126569298)
2. M.G.Shah, Kale, Patki, Building Drawing with an Integrated Approach to Built Environment, Tata McGraw-Hill Education India, 5th edition, 2011, (ISBN: 9780071077873, 0071077871).
3. Building Services Environmental And Electro Mechanical Services, Second Revised, 2014, (ISBN: 9788175259805)

MOPEC-03	DISASTER MANAGEMENT - CIVIL	L	T	P	C
		2	0	0	2

Pre-requisite: Nil

Course Objectives:

1. **Understand** the fundamental concepts of disasters, hazards, vulnerabilities, risk, and the principles of disaster management and disaster risk reduction.
2. **Develop** knowledge of disaster mitigation, preparedness, response, and recovery strategies for enhancing community resilience and sustainable development.
3. **Analyze** the roles of stakeholders, public awareness, and community participation in disaster preparedness and emergency management.
4. **Apply** disaster management principles and engineering practices to assess and mitigate the impacts of major natural hazards affecting India.

Expected Course Outcome:

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

1. Explain the concepts, terminology, classification, and components of disaster management, including hazard, vulnerability, exposure, capacity, and risk.
2. Apply disaster risk reduction principles to develop appropriate mitigation, preparedness, response, and recovery strategies for different disaster scenarios.
3. Evaluate the role of communities, institutions, and stakeholders in disaster preparedness, awareness, and emergency management for building disaster-resilient societies.
4. Assess the causes, impacts, vulnerabilities, and mitigation measures for major disasters such as earthquakes, floods, cyclones, and landslides, considering climate change and sustainable infrastructure.

Module:1 Fundamentals of Disaster Management — **8 hours**

Introduction to Disaster Management: Definition, concepts, objectives, scope and importance. Classification of disasters—Natural and Human-induced disasters. Hazard, Vulnerability, Capacity, Exposure and Risk; interrelationship among disaster risk components. Types of vulnerabilities (physical, social, economic, environmental). Disaster, emergency and crisis situations. Causes, characteristics and speed of onset of different disasters.

Module:2 Disaster Risk Reduction and Disaster Management Cycle — **8 hours**

Disaster Management Cycle: Components and phases. Mitigation measures—structural and non-structural approaches, hazard mapping, vulnerability and risk assessment, land-use planning, building codes and resilient infrastructure. **Disaster preparedness**—early warning systems, community preparedness, capacity building, emergency operation plans (EOP), evacuation planning, mock drills and disaster management plans. **Disaster response**—search and rescue, relief operations, emergency communication, resource management and coordination. **Disaster recovery**—rehabilitation, reconstruction, livelihood restoration and the concept of Build Back Better (BBB)

Module:3 Community-Based Disaster Management and Public Awareness — **6 hours**

Disaster education and awareness programmes. Community participation in disaster risk reduction. Roles and responsibilities of stakeholders including government agencies, NGOs, local authorities, educational institutions, industries and communities. School, hospital and workplace safety programmes. Community emergency response teams (CERT), disaster preparedness at household level, awareness campaigns, mock drills and volunteer management. Inclusive disaster management for vulnerable populations.

Module:4 Disaster Management for Major Hazards in India — **8 hours**

Earthquakes: causes, seismic hazards, vulnerability assessment, mitigation strategies and preparedness.

Floods: causes, floodplain management, structural and non-structural mitigation, preparedness and response.

Cyclones and Extreme Weather Events: causes, forecasting, coastal vulnerability, mitigation, preparedness and evacuation. **Landslides:** causes, slope instability, hazard zonation, mitigation measures and preparedness. **Climate change and disaster resilience**: impact of climate change on disaster frequency and intensity, adaptation strategies, sustainable and resilient infrastructure, and case studies of major disasters in India.			
Total Lecture hours			**30 hours**
Text Book(s)			
1.	Singh, R. B. (Ed.) Disaster Management: Global Challenges and Local Solutions. Rawat Publications, Jaipur.		
2.	Coppola, D. P. Introduction to International Disaster Management. 4th Edition, Butterworth-Heinemann (Elsevier), 2020.		
3.	Guha-Sapir, D., Hoyois, P., & Below, R. Annual Disaster Statistical Review. Centre for Research on the Epidemiology of Disasters (CRED).		
4.	Goel, S. L. Disaster Administration and Management. Deep & Deep Publications, New Delhi.		
Reference Books			
1.	**Alexander, D.** *Principles of Emergency Planning and Management*. Oxford University Press.		
2.	**Carter, W. N.** *Disaster Management: A Disaster Manager's Handbook*. Asian Development Bank.		
3.	**Shaw, R.** *Community-Based Disaster Risk Reduction*. Emerald Publishing.		
4.	**Government of India.** *National Disaster Management Guidelines* (various hazards), National Disaster Management Authority (NDMA), New Delhi.		
5.	**Government of India.** *National Disaster Management Plan (NDMP)*, National Disaster Management Authority (Latest Edition).		
Mode of Assessment: Continuous Assessment Test, Quizzes, Assignments, Final Assessment Test			
Recommended by Board of Studies			
Approved by Academic Council		Date	