B. Tech. Civil Engineering

A) Syllabi for Generic Elective Courses (GEC)

Generic Elective Courses (GEC) are elective courses open to students of all branches and are multidisciplinary in interest.

B) Syllabi for Departmental Elective Courses (DEC)

Departmental Elective Courses (DEC) are other elective courses (Please check for pre-requisites).

Syllabi

for

Generic Elective Courses (GEC)

B. Tech. Civil Engineering/ GEC1				
Course code: Course Title	**Course Structure.**			**Pre-Requisite**
CE307: Applications of Geo-informatics, Remote Sensing, and GIS in Engineering	L	T	P	Nil
	3	0	2	

Course Objective: To equip the students with the knowledge of geo-informatics and GIS, and empower them for its applications in a multi-disciplinary environment in the field.

S. No	Course Outcomes (CO)
CO1	To understand the basics of Geoinformatics, Remote Sensing, GIS and GPS.
CO2	To acquire skills for Remote Sensing.
CO3	To have knowledge and skills for using digital experimentation.
CO4	To analyse data obtained from various digital resources in the domain.
CO5	Students are able to apply knowledge about geo-informatics to the socio-engineering scenario.

S. No	Contents	Contact Hours
UNIT 1	**Introduction to Geoinformatics**, Remote Sensing, GIS and GPS: Definitions of Geoinformatics, Remote Sensing, GIS and GPS, sources of energy, electromagnetic spectrum, electromagnetic radiation, reflection, transmission and absorption, black body radiation, Stefan-Boltzmann law, Wein's displacement law, emissivity, Kirchoff's law, thermal emission, Planc's formula. Platforms and sensors, active and passive sensors, PAN, Multi and hyperspectral remote sensing data acquisition systems in optical wavelength region, basic principles of data acquisition and measurement in natural scenes, multi and hyperspectral data statistics, digital data file formats. GPS satellite network	8
UNIT 2	**Optical, Thermal and Microwave Remote Sensing**: Brief review of Optical, thermal and microwave remote sensing, their utility, merit and demerits, Interaction of EMR with atmosphere, scattering, refraction, absorption, transmission, atmospheric windows, interaction of EMR with earth surface, spectral characteristics of remote sensing data, optical radiation models, summary of visible to shortwave region models, spectral reflectance curves, radiation calculation, thermal sensors and their characteristics. Thermal infrared region models, radiation components – surface-emitted component, surface-reflectance, atmospheric emitted component, path-emitted component, total at-sensor, emitted radiance, interpretation of thermal images – day and night images, emissivity consideration, thermal inertia considerations. Factors affecting analysis of thermal images, data models for thermal image analysis.	8

UNIT 3	**Basic Photogrammetry and Digital Image Processing:** Photogrammetry, aerial and terrestrial, applications of photogrammetry, types and geometry of aerial photograph, flying height and scale, relief (elevation) displacement. Stereoscopy, measurement and parallax and height determination, photogrammetric mapping. Digital data bank, digital image, digital image processing introduction to, preprocessing, enhancement, classification, visual image interpretation, Introduction to software - MATLAB, ENVI, ERDAS, AutoCAD etc.	9
UNIT 4	**Maps, Datums, Projections Systems and spatial data analysis** - Plane and Geodetic surveying, Classification of surveys, Basic Principles of Surveying, Types of maps, scales and uses, plotting accuracy, map sheet numbering. Datums, coordinates and map projection systems. Data retrieval and querying, measurements in GIS, classification, and accuracy.	9
UNIT 5	**Applications of Geoinformatics**, Remote Sensing, GIS and GPS: Land cover classification survey and Mapping, Digital elevation model (DEM), GPS surveys, Introduction to SAR data processing and SAR interferometry, Applications in Disaster management, geology, forest security and military projects. Appropriate experiments would be taken up.	8
	TOTAL	**42**

References

S. No	Name of Books/Authors/Publishers	Year of Publication Reprint
1	Agarwal, C.S. and Garg, P.K., "Remote Sensing in Natural Resources Monitoring and Management", Wheeler Publishing House(ISBN 6-74-268173-4)	2000
2	Bossler, J.D., "Manual of Geospatial Science and Technology", Taylor and Francis. (ISBN 0-74-68914355-7)	2002
3	Burrough, P.A. and McDonnell, R.A., "Principles of Geographic Information Systems", Oxford University Press. (ISBN 0-07-985256-4)	2000
4	Chandra, A.M. and Ghosh, S.K., "Remote Sensing and Geographical Information Systems", Alpha Science. (ISBN 0-07-8452567-1)	2005
5	Gopi, S., "Global Positioning System: Principles and Applications", Tata McGraw-Hill.(ISBN 0-07-7691528-1)	2005

B. Tech. Civil Engineering/ GEC2				
Course code: Course Title	**Course Structure**			**Pre-Requisite**
CE 306: Infrastructure Resilience and Socio-Economic Dynamics	**L**	**T**	**P**	Nil
	3	1	0	

Course Objective: Fostering students' competence in assessing risks, improving infrastructure resilience, and understanding their impact on society.

S. No	Course Outcomes (CO)
CO1	Introduction to the impacts of disasters and their risks on infrastructure.
CO2	Assessment of risk and strategy towards improving resilience.
CO3	Estimating potential losses from multi-hazards using a software approach and mitigating effects.
CO4	Modelling risk given societal impact.
CO5	Students can assess the impact of hazards on society in terms of economics and living conditions.

S. No	Contents	Contact hours
UNIT 1	**Introduction**: Intersection of disasters, people, policy, infrastructure, and the environment; Private and public infrastructure.	8
UNIT 2	**Risk and resilience**, Infrastructure as a hazard amplifier, Risk and equity, Individual response to risk, Modelling risk.	8
UNIT 3	**The emergency management cycle:** Direct vs. Indirect losses, Structural fragility, Assessment of hazard using software tools and databases such as HAZUS-HM. System-level post-disaster operability, gathering situational awareness for resilience, Building codes for recovery and resilience, Interdependent infrastructure, Hazard memory and education, Resilience for infrastructure preparation for disasters with and without warning.	9
UNIT 4	**Sociological concepts and methods:** man and environment relationships, socio-economic profile of Indian society, and urban transformation, traditions and modernity in the context of urban and rural settlements.	9
UNIT 5	**Economic growth and development** due to infrastructure projects, Quality of life, Human development index, Employment and livelihood, Economic principles of land use planning, Policies and strategies of economic planning, Balanced vs. unbalanced growth.	8
	TOTAL	**42**

References

S. No.	Name of Books/Authors/Publishers	Year of Publication / Reprint
1	Critical Infrastructures Resilience: Policy and Engineering Principles: Auroop Ratan Ganguly, Udit Bhatia, Stephen E. Flynn (ISBN-13: 978-1498758635)	2018
2	Resilient Structures and Infrastructure: Noroozinejad Farsangi, E., Takewaki, I., Yang, T., Astaneh-Asl, A., Gardoni, P. (ISBN 978-981-13-7446-3)	2019
3	Strategic Infrastructure Development for Economic Growth and Social Change: Nilanjan Ray (ISBN-13: 978-1466674707)	2015
4	Developing Disaster-Risk Resilience in Cities: Training Module for Urban Local Bodies, including Contexts of Climate Risk and Children's Resilience: Anil K Gupta, Nivedita Mani, Banku Bihari Sarkar, Swati Singh (ISBN: 978-81-933285-3-8)	2019

B. Tech. Civil Engineering/ GEC3				
Course code: Course Title	**Course Structure.**			**Pre-Requisite**
CE405: Wind Effects on Structures and Wind Energy Systems	**L**	**T**	**P**	**Nil**
	3	**0**	**2**	

Course Objective: To familiarize the students with the atmospheric winds, their effects on structures, and converting them into energy.

S. No	Course Outcomes (CO)
CO1	To understand the atmospheric boundary layer and its characterisation for engineering applications.
CO2	To acquire skills for experimentation using wind tunnel testing.
CO3	To have knowledge and skills for the wind energy conversion system.
CO4	To apply knowledge of the effect of wind for designing structures and demonstrating for wind energy towers.
CO5	Students are able to know the various opportunities in wind energy technology inland and offshore, and apply knowledge to the Indian scenario.

S. No	Contents	Contact Hours
UNIT 1	Introduction, Types of wind – Characteristics of wind – Wind velocity, Method of measurement, atmospheric boundary layer, variation of speed with height, shape factor, aspect ratio, drag effects – Dynamic nature of wind, Pressure and suctions, Spectral studies, Gust factor. Shape factor – Aspect ratio – Drag and lift for common structures exposed to wind.	8
UNIT 2	Wind Tunnel Studies, Types of tunnels, – Prediction of acceleration – Load combination factors – Wind tunnel data analysis – Calculation of Period and damping value for wind design. Design Wind speeds and risk coefficients, Design wind pressure and pressure coefficients.	8
UNIT 3	Wind Energy – Fundamentals and Applications: Introduction, Application and Historical background, Merits and Limitations, Nature and Origin of Wind, Wind Energy Quantum, Variables in Wind Energy Conversion Systems, Wind Power Density, Power in a Wind Stream, Wind Turbine Efficiency, Power of a Wind Turbine, Forces on the Blade of a Propeller. Wind Velocities and Height from Ground, Mean Wind Velocity, Wind Velocity duration curve, Energy	9

	Pattern Factor, Wind Power duration Characteristics.	
UNIT 4	Effect of Wind on Structures: Static effect – Dynamic effect – Interference effects. Rigid and Flexible– Static and dynamic effects on tall buildings, Chimneys, wind energy towers. Design of Structures for wind loading – as per IS codal provisions Industrial Sheds: Types of roofing, steel monopoles, transmission line towers, self-supporting, Guyed, including aero-elasticity.	9
UNIT 5	Wind Turbine- Generator Units: Introduction, Various terms and definitions, Types of Wind Turbine Generator (WTG) Units, Horizontal Axis Propeller type, Wind Turbine Generator. Wind Energy Farm and Energy Conversion System: Wind to Electric Energy Conversion System, Power versus Velocity of WTG, Power Duration Curves, Types of Wind Energy System, Energy Storage Requirements with Wind Energy System, Hybrid wind energy systems, Economics of Wind Energy. Offshore Wind Energy Power: Introduction, offshore wind energy technology, scenario for the future offshore development of wind power, National Offshore Wind Energy Policy of India, developments in India	8
	TOTAL	**42**

REFERENCES

S. No	**Name of Books/Authors/Publishers**	**Year of Publication Reprint**
1	Devenport A.G., "Wind Loads on Structures", - Division of Building Research, Ottawa.	1990
2	Wind Effects on Building Vol. I and II, Lawson T.V., Applied Science Publishers, London.	1980
3	Joshua Earnest and Tore Wizelius, "Wind Power Plants and Project Development", PHI Learning Pvt. Ltd., New Delhi.	2011
4	Wind energy handbook, Burton T, Jenkins N, Sharpe D, Bossanyi E., John Wiley and Sons.	2015
5	Advances in wind energy and conversion technology, Mathew S, Philip GS, Berlin, Springer.	2016
6	Tall Chimneys – Design and Construction, Manohar S.N., Tata McGraw-Hill.	1985
7	Transmission Line Structures, Santhakumar A.R. & Murthy S.S., Tata McGraw-Hill.	1992
8	IS: 875 (3) Code of Practice for Design Loads (Other than Earthquake) for Buildings and Structures - Part 3: Wind Loads, BIS.	2016

B. Tech. Civil Engineering/ GEC4				
Course code: Course Title	**Course Structure. Credit=4**			**Pre-Requisite**
CE 404: Structural Health Monitoring and Sustainable Infrastructures	L	T	P	Nil
	3	1	0	

Course Objective: This course empowers students in various aspects within the art and engineering of infrastructure maintenance, combining sensing through instrumentation and analysing the data to make decisions regarding structural health monitoring to ensure infrastructure serviceability, thus sustainability.

S. No	Course Outcomes (CO)
CO1	Understand the concepts of sustainable development goals (SDGs), the infrastructural life cycle, and impact on sustainability.
CO2	Study of existing condition assessment techniques for buildings and bridges.
CO3	Apply various techniques for response and health of infrastructures, assess the damage in the existing structures and their components using time and modal-based methods.
CO4	including artificial intelligence and machine learning, and their relevance to infrastructural management.
CO5	Students are able to design the layout of the sensors and hardware for acquiring the experimental data from the structure.

S. No	Contents	Contact Hours
UNIT 1	Concept of sustainable development goals and infrastructure. Performance and management of infrastructure, including failures. Lifecycle assessment of economic and environmental. Decarbonisation of the construction process and maintenance of infrastructures.	8
UNIT 2	Review of structural dynamics: equation of motion for SDOF, multi-degree of freedom system; response in free and forced vibration; computation of vibration properties, and modal parameters.	8
UNIT 3	The techniques, e.g. visual inspection, load testing, non-destructive evaluation, structural health monitoring, and finite element modelling highlight their advantages and limitations. Automated data collection and interpretation analyses. Remote monitoring, including drones. Design of monitoring systems for assessing structural performance parameters of interest. Influence of deterioration mechanisms. Typical sensors for response measurement- static (strain, tilt, deflection) and dynamic (vibration response).	9
UNIT 4	Concept of structural health monitoring (SHM): Introduction to damage; passive and active SHM; non-destructive evaluation (NDE); A Statistical Pattern Recognition Paradigm for SHM, Statistical Classification of Features for Civil Engineering Infrastructure, Operational Evaluation Example: Bridge Monitoring. Vibration-based	9

	techniques for SHM: data evaluation and assessment; structural damage assessment – diagnostic levels and methods; modelling of damaged structural elements; modal assurance criterion (MAC); damage localization and quantification. Value of SHM.	
UNIT 5	Emerging technologies such as artificial intelligence (AI), model-driven damage detection, to online/real-time data-driven damage detection. feature extraction, and pattern recognition using supervised/unsupervised ML algorithms. Importance of predictive maintenance in civil infrastructure, Incorporating structural health assessment. prediction, damage assessment, digital twins, surrogate modelling through some case studies.	8
	TOTAL	**42**

REFERENCES		
S. No.	**Name of Books/Authors/Publishers**	**Year of Publication / Reprint**
1	D. Balageas, C.-P. Fritzen, A. Güemes (2006) Structural Health Monitoring, ISTE Ltd. ISBN 9781905209019.	2006
2	C.R. Farrar, K. Worden (2012) Structural Health Monitoring: A Machine Learning Perspective, Wiley. ISBN 9781119994336.	2012
3	H.-P. Chen (2018). Structural Health Monitoring of Large Civil Engineering Structures, Wiley Blackwell. ISBN 9781119166627.	2018
4	C.-K. Soh, Y. Yang, S. Bhalla (2014) Smart Materials in Structural Health Monitoring, Control and Biomechanics, Springer. ISBN 9783642244629.	2014
5	Condition Assessment of Reinforced Concrete Bridges: Current Practice and Research Challenges, Tarek Omar and Moncef L. Nehdi. *Infrastructures* 2018, *3*, 36; doi:10.3390/infrastructures3030036	2018
6	Gebrail Bekdas (2019), "Artificial Intelligence and Machine Learning Applications in Civil, Mechanical and Industrial Engineering," IGI Global Publication.	2019

Syllabi

for

Departmental Elective Courses (DEC)

B.Tech. Civil Engineering				
Course code: Course Title	**Course Structure**			**Pre-Requisite**
CE308: Advanced Design of Structures	L	T	P	CE203: Design of Structures
	3	**0**	**2**	

Course Objective: Design of advanced reinforced concrete structures is one of the primary requisites of any structural engineer. Hence, the course aims to provide a detailed theoretical background of various design philosophies and their applications using national and international design guidelines. Therefore, at the end of the course, the student is expected to analyse and design various special reinforced concrete structures. The students are also able to apply the knowledge to real civil engineering problems and to design new and advanced reinforced concrete structures.

S. No	Course Outcomes (CO)
CO1	Analysis, design and detailing of Deam Beams, Curved beams and Corbels
CO2	Analysis, design and detailing of folded plates and cylindrical shells
CO3	Analysis, design and detailing of water tanks
CO4	Analysis, design and detailing of Chimney and silos
CO5	Analysis, design and detailing of the various types of retaining walls.

S. No	Contents	Contact Hours
UNIT 1	Analysis and Design of curved beams in plan, Deep Beams and Corbels	8
UNIT 2	Analysis, design and detailing of folded plates and cylindrical shells (beam and arch theory).	8
UNIT 3	Analysis, design and detailing of cylindrical water tanks resting on the ground (fixed and hinged boundary conditions at the base).	8
UNIT 4	Analysis, design and detailing of circular silos including foundations. Analysis, design and detailing of cylindrical chimneys including foundations.	8
UNIT 5	Retaining walls: Types of retaining walls, Analysis and design of cantilever-type retaining walls, Analysis and design of counterfort and buttress-type retaining walls, Analysis and design of Abutments.	10
	Total	**42**

References

S. No.	Name of Books/Authors/Publishers	Year of Publication / Reprint
1	Pillai and Menon (2003) “Reinforced Concrete Design” - TMH, New Delhi, India.	2003

2	Karve, S.R. and Shah V L (2014) "Limit State Theory and Design of reinforced Concrete" -VGP, Pune, India.	2014
3	Varghese, P. C. (2015)"Advanced Reinforced Concrete Design"-PHI, Delhi, India.	2015
4	Winter, G. (1986) "Design of Concrete Structures" -McGraw Hill, Tokyo, Japan.	1986
5	Gambhir, M.L.(2008) "Design of Reinforced Concrete Structures" -PHI, Delhi, India.	2008
6	Pranesh, R.N. and Raju, K.(2008), "Reinforced Concrete Design" New Age Publications (P) Ltd.	2008

B. Tech. Civil Engineering					
Course Code: Course Title		**Course Structure.**			**Pre-Requisite**
		L	**T**	**P**	
CE 309: Wind Loads on Structures		**3**	**0**	**2**	**Nil**
Course Objective: To familiarise the students with the atmospheric winds, their effects on structure and experimental technique.					
S. No	**Course Outcomes (CO)**				
CO1	To understand basic wind speed around different terrain and their terminology				
CO2	To acquire skills for wind effects, such as static and dynamic effects.				
CO3	To understand different structural systems and wind loads behaviour around the structure				
CO4	To apply knowledge of the effect of wind for designing high-rise structures.				
CO5	Students are able to know the experimental techniques in wind tunnels and their functioning.				
S. No	**Contents**				**Contact Hours**
UNIT 1	**Introduction**: Terminology – Wind Data – Gust factor and its determination - Wind speed variation with height– Shape factor – Aspect ratio – Drag and lift.				8
UNIT 2	**Effect of Wind on Structures**: Static effect – Dynamic effect – Interference effects (concept only) – Rigid structure – Aeroelastic structure (concept only). Tall buildings – Low-rise buildings – Roof and cladding – Chimneys, towers and bridges.				8
UNIT 3	**Structural System in Tall Buildings**: Different types of structural systems, Shear walls of various types, frames, frame-shear wall interaction, staggered wall–beam system.				9
UNIT 4	**Electrical transmission towers**. Application to Design: Design forces on multi-storey buildings, towers and roof trusses.				9
UNIT 5	**Response of high–rise structures** to lateral loads and design considerations. Introduction to Wind Tunnel: Types of models (Principles only) – Basic considerations – Examples of tests and their use.				8
	TOTAL				**42**
REFERENCES					
S. No	**Name of Books/Authors/Publishers**				**Year of Publication/ Reprint**
1	Devenport A.G., “Wind Loads on Structures”, Division of Building Research, Ottawa.				1990

2	Wind Effects on Building Vol. I and II, Lawson T.V., Applied Science Publishers, London.	1980
3	Joshua Earnest and Tore Wizelius, "Wind Power Plants and Project Development", PHI Learning Pvt. Ltd., New Delhi.	2011
4	Wind energy handbook, Burton T, Jenkins N, Sharpe D, Bossanyi E., John Wiley and Sons.	2015
5	Advances in wind energy and conversion technology, Mathew S, Philip GS, Berlin, Springer.	2016
6	Tall Chimneys – Design and Construction, Manohar S.N., Tata McGraw-Hill.	1985
7	Transmission Line Structures, Santhakumar A.R. & Murthy S.S., Tata McGraw-Hill.	1992

B.Tech. Civil Engineering				
Course code: Course Title	**Course Structure**			**Pre-Requisite**
CE310: Advanced Design of Steel Structures	L	T	P	CE302: Design of Steel Structures
	3	**1**	**0**	

Course Objective: Fostering students' competence in the design of steel bridges, towers, tanks, stacks, and fatigue design of Gantry girders and bridges conforming to the relevant IS Codes.

S. No	Course Outcomes (CO)
CO1	Students can design steel bridges.
CO2	Students can design Gantry girders and bridges for fatigue.
CO3	Students can design various types of structural components with thin sections.
CO4	Students can design towers.
CO5	Students can design tanks and stacks.

S. No	Contents	Contact Hours
UNIT 1	Design of steel bridges	10
UNIT 2	Fatigue design of Gantry girders and bridges	8
UNIT 3	Design in light-gauge steel	8
UNIT 4	Design of transmission line/ communication towers	8
UNIT 5	Design of steel tanks and stacks	8
	Total	**42**

References

S. No.	Name of Books/Authors/Publishers	Year of Publication / Reprint
1	Design of Steel Structures, A.S. Arya and Awadhesh Kumar and published by Nem Chand & Bros, Roorkee.	2014
2	Design of Steel Structures: *Limit States Method,* N. Subramanian and published by Oxford University Press.	2016
3	Limit State Design in Structural Steel, M.R. Shiyekar and published by PHI Learning Pvt. Ltd., New Delhi.	2010
4	Design of Steel Structures. N.R. Chandak and published by S.K. Katariya & Sons, New Delhi.	2017
5	Steel tables and IS: 800-2007, "General construction in steel", BIS, New Delhi.	Latest

B. Tech. Civil Engineering				
Course code: Course Title	**Course Structure.**			**Pre-Requisite**
CE 311: Disaster Management	L	T	P	Nil
	3	0	2	

Course Objective: This course aims to conceptualise various aspects of disaster management. The course focuses on understanding the need for disaster management, various types of disasters, and creating awareness about prevention and risk reduction mitigation measures. Assessment of the hazard, vulnerability, and risk is also undertaken in this course.

S. No	Course Outcomes (CO)
CO1	Apply the concepts of Disaster Management
CO2	Understand the various Categories of Disasters
CO3	Realise the need to study disaster impacts, Climate Change, and urban disaster
CO4	Understand the basics of Disaster Risk Reduction and Mitigation measures
CO5	Conceptualise Disaster Risk Reduction and Mitigation measures towards sustainable recovery

S. No.	Contents	Contact Hours
UNIT 1	**Introduction and types of disasters:** Concepts and definitions: disaster, hazard, vulnerability, risks severity, frequency and details, capacity, impact, prevention, mitigation, natural disasters (floods, draught, cyclones, volcanoes, earthquakes, tsunami, landslides, coastal erosion, soil erosion, forest fires etc.); manmade disasters (industrial pollution, artificial flooding in urban areas, nuclear radiation, chemical spills, transportation accidents, terrorist strikes, etc.);	8
UNIT 2	**Disasters:** Earthquakes and their types, Measurement of an Earthquake, seismic zones of India, major fault systems of the Indian plate, Types of floods, Causes of Flood, categorization of Flood Situations, Hazards due to Cyclone, Structure of a cyclone. Classification of Cyclone, Tsunami Velocity, Size of Tsunami, Causes of Tsunami Basic parts of a landslide, Classification of Landslide, Causes of Landslides, Causes of Volcano formation, Types of Volcanoes, Classification of Volcanoes, causes of coastal erosion, Soil erosion, Formation of a Tornado, Tornado intensity, causes of avalanches, Thunderstorms and associated disasters, Causes of Forest fire in India, Man-made disasters, mountain and coastal areas, ecological fragility. hazard and vulnerability profile of India, Vulnerability atlas of India.	8
UNIT 3	**Disaster Impacts & Risk analysis:** Disaster impacts (environmental, physical, social, ecological, economic, political, etc.); health, psycho-social issues; demographic aspects (gender, age, special needs); hazard locations; global and national disaster trends; climate change and urban disasters. Factors of disaster risk, hazards, and vulnerability assessment. Multi-Hazard Assessment, Short-term and Long-term	10

	Prediction, Disaster Risk analysis, Use of technology and Software in disaster management.	
UNIT 4	**Disaster Risk Reduction (DRR):** Disaster management cycle – its phases; prevention, mitigation, preparedness, relief and recovery; structural and non-structural measures; risk analysis, vulnerability and capacity assessment; early warning systems, Post-disaster environmental response (water, sanitation, food safety, waste management, disease control, security, communications); Roles and responsibilities of government, community, local institutions, NGOs and other stakeholders; Policies and legislation for disaster risk reduction, DRR programmes in India and the activities of National Disaster Management Authority. Community-based disaster management, Adaptation, and mitigation strategies to combat climate-related disasters. Guidelines for Building design in earthquake, cyclone, flood flood-prone areas.	8
UNIT 5	**Disasters, Environment and Development**: Factors affecting vulnerability, such as the impact of developmental projects and environmental modifications (including dams, land use changes, urbanization, etc.), sustainable and environmentally friendly recovery, reconstruction, and development methods. Sustainable Development Goals and Disaster Risk Reduction, Mini project on disaster risk assessment and preparedness for disasters	8
	Total	**42**

References:

S. No.	Name of Books/Authors/Publishers	Year of Publication / Reprint
1	Goyal P.K. and Gupta Anil. Disaster Management. AICTE New Delhi.	2023
2	Goyal P.K. "Cyclone Disaster Mitigation and Management in India: An Overview" Chap. 7, Disaster Risk and Management Under Climate Change, Disaster Resilience and Green Growth, Springer.	2024
3	IS: 15498: "Guidelines for Improving the Cyclonic Resistance of Low-Rise Houses and other Buildings/Structures"-Bureau of Indian Standards, New Delhi.	2004
4	Murty, C.V.R.: IITK-BMTPC Earthquake Tips." Public domain. National Information Centre of Earthquake Engineering.	2005
5	Vulnerability Atlas of India, Ministry of Housing and Urban Affairs, Government of India.	2019
6	"Home Owner's Guide for Earthquake and Cyclone Safety," NDMA, Ministry of Home Affairs, Government of India.	2019
7	Goyal P.K. and Datta T.K. (2013). "Effect of wind directionality on the vulnerability of rural houses due to cyclones" Natural Hazard Review, ASCE, 14(4), pp.258–267.	2013

B. Tech. Civil Engineering				
Course code: Course Title	**Course Structure**			**Pre-Requisite**
CE312: Analysis And Design of Underground Structure	L	T	P	CE 206: Soil Mechanics
	3	1	0	

Course objective:

- To understand the Fundamentals and Analyse geotechnical and Geological aspects,
- To Apply Structural Analysis and Design Principles.
- To Explore Tunnel Design and Construction Techniques.
- To develop Practical Engineering and Research Skills.
- To incorporate Seismic and Safety Considerations.

S. No	Course Outcomes (CO)
CO1	Understand the Fundamentals and Analyse Geotechnical and Geological Aspects
CO2	Perform Structural Analysis and Design
CO3	Apply Tunnelling and Excavation Techniques
CO4	Design for Seismic and Safety Considerations
CO5	Analyse Case Studies and Industry Applications

S. No	Contents	Contact Hours
UNIT 1	Introduction to Underground Structures, Importance and applications (Tunnels, Caverns, Subways, etc.), Historical perspective and case studies, Advantages of underground construction, Geotechnical Considerations, Soil and rock mechanics fundamentals, Geotechnical site investigation, Ground classification systems (RMR, Q-system, GSI), Stress-strain behaviour of soil and rock, Groundwater considerations and drainage.	10
UNIT 2	Loading Conditions and Stress Analysis, Structural Analysis of Underground Openings, Elastic and plastic behaviour of soil and rock. Analytical methods: Elastic solutions, Convergence-Confinement Method, Numerical modelling techniques (FEM, FDM, DEM).	8
UNIT 3	Design Methods for Underground Structures, Empirical methods (Rock Mass Rating, Q-System, NATM), Analytical and numerical approaches, Support system design (Shotcrete, Rock bolts, Steel ribs, TBM linings), Segmental lining and its behaviour. Tunnel Design and Construction Methods, Drill and blast method, Tunnel Boring Machines (TBM), Cut-and-cover method, NATM (New Austrian Tunnelling Method), Sequential Excavation Method (SEM).	8

UNIT 4	Introduction to Seismic Design of Underground Structures, Waterproofing and Drainage Systems, Monitoring and Instrumentation.	8
UNIT 5	Case Studies and Practical Applications, Metro tunnels, road and railway tunnels. Underground caverns and storage facilities, Large-scale hydro projects, and underground power plants.	8
	Total	**42**

REFERENCES		
S. No.	**Name of Books/Authors/Publishers**	**Year of Publication / Reprint**
1	Design of underground structure- by Zhen-Dong Cui, Zhong-Liang Zhang, Li Yuan, Zhi-Xiang Zhan, Wan-Kai Zhang.	2020
2	Rock Mechanics Design in Mining and Tunnelling, by Z.T. Bieniawski, Pub: A.A. Balkema.	1984
3	The Handbook of Tunnel Engineering (Vol. 1 & 2) – Bernhard Maidl, Markus Thewes, Ulrich Maidl.	2014
4	Fire Safety in Tunnels – Alan Beard & Richard Carvel.	2005

B. Tech. Civil Engineering				
Course code: Course Title	**Course Structure**			**Pre-Requisite**
CE313: Rock Engineering	L	T	P	CE: 206 Soil Mechanics
	3	0	2	

Course objective:

- To introduce and explain fundamentals of Rock Mechanics, which is used in the applications of Foundation engineering, tunnel engineering, stability of slopes, anchoring and soil nailing, etc.
- To give fundamental knowledge of Rock, its properties and behaviour under various conditions of internal and external load and stresses.
- To develop understanding about Griffith's theory, Coulomb's theory, Deformation characteristics of rock, bearing capacity and stability.
- To imbibe basic laws and equations used for the analysis of rocks.
- To inculcate the importance of rock mechanics and its applications in Industries.
- To Analyse and design different types of tunnels.
- To determine the suitability of the construction method for particular conditions.

S. No	Course Outcomes (CO)
CO1	Identify & classify rock and use this classification for design.
CO2	Collects the sample and tests it to find its different properties.
CO3	Analyse stresses developed due to the opening in the rock mass and the excavations of tunnels .
CO4	Analyse and design the foundation on rock and slope stability.
CO5	Suitability of the construction method for particular conditions.

S. No	Contents	Contact Hours
UNIT 1	Introduction, Classification and index properties of rock, Stress in rock mechanics and rock engineering, stress component and stress matrix, principal stress, in situ stress, method of stress Determination, Strain, strain tensor.	8
UNIT 2	Rock strength and failure criteria, laboratory testing of rocks, Griffith's theory, Coulomb's theory, in-situ tests on rock mass; deformation characteristics, mechanical, thermal and electrical properties of rock mass.	8

UNIT 3	Rock exploration, site investigation, preliminary, detailed and geophysical investigation, exploratory drilling methods and their utility, Exploration planning, Foundation on rocks, bearing capacity of intact and jointed rocks; general consideration for design of foundation, treatment of rock defects.	8
UNIT 4	Openings in rock mass and stresses around openings; pressure tunnels, development of plastic zone; rock support needed to avoid plastic deformation; lined and unlined tunnels; support pressure and slip of the joint; underground excavation and subsidence	8
UNIT 5	Rock slopes; Types of rock slope failure, rock slope analysis-conventional and numerical method, rock slope stabilisation, rock bolt and anchors, methods of construction; problems associated with tunnels, tunnelling in various subsoil conditions and rocks.	10
	Total	**42**

REFERENCES

S. No.	**Name of Books/Authors/Publishers**	**Year of Publication / Reprint**
1	Design and Construction of Tunnels by Pietro Lunardi, Pub: Springer.	2008
2	Engineering Rock Mechanics: An Introduction to the Principles by Hudson and Harrison, Pub: Pergamon.	2000
3	Rock Mechanics Design in Mining and Tunnelling, by Z.T. Bieniawski, Pub: A.A. Balkema.	1984
4	Engineering in Rocks for Slopes, Foundations and Tunnels by T Ramamurthy (ISBN 0-07-0768249-5).	2014
5	Engineering Rock Mass Classification by Z.T. Bieniawski (ISBN 3-78-070891-8).	1989
6	Introduction to Rock Mechanics by R.E. Goodman (ISBN 0-07-754621-7).	1988

B. Tech. Civil Engineering				
Course code: Course Title	**Course Structure.**			**Pre-Requisite**
CE 314: Theory of Elasticity and Plasticity in Soil	L	T	P	CE 206 Soil mechanics
	3	1	0	

Course Objective:

- To analyse stress and strain in two-dimensional and three-dimensional soil problems.
- To apply constitutive laws, equilibrium equations, and compressibility relations in soil mechanics.
- To evaluate drained and undrained loading conditions and failure mechanisms in soils.
- To study critical state soil mechanics, plastic flow, and anisotropic compression behaviour.
- To apply elasto-plastic and rheological models in soil-structure interaction and stability analysis.

S. No	**Course Outcomes (CO)**
CO1	To perform the analysis of stress and strain for analysis of 2D and 3D problems.
CO2	To apply the constitutive law equilibrium equations and compressibility equations.
CO3	TO do failure analysis of soil.
CO4	To apply critical soil mechanics to engineering structures.
CO5	To perform the analysis of earth retaining structures and slopes.

S. No	**Contents**	**Contact Hours**
UNIT 1	Stresses and strains, elastic equilibrium analysis for plane and three-dimensional cases.	8
UNIT 2	Effective stress, analysis of deformation and strain, state of stress and strain, constitutive relations, equilibrium and compatibility, general theorem	8
UNIT 3	Drained and Undrained loading, state boundary surface, plastic flow, yield and hardening, failure theorem for soils.	8

UNIT 4	Failure and plastic flow at critical state, associative and non-associative flow, residual strength, and anisotropic compression. Ideal elastic behavior: two- and three-dimensional system, theorem of plastic collapse.	8
UNIT 5	Application to soil interaction, elasto-plastic theory of soil, rheological models, nonlinear viscoelasticity, problem, and solution.	10
	TOTAL	**42**

- - - - - - -

REFERENCES

S. No.	**Name of Books/Authors/Publishers**	**Year of Publication / Reprint**
1	ME Harr, 'Fundamentals of Theoretical Soil Mechanics': (ISBN 978-0-070267411).	1966
2	HG Poulus and EH Davis, 'Elastic Solutions for Soil and Rock Mechanics', (ISBN 9780471695653).	1974
3	SP Timoshenko & JN Goodier, 'Theory of Elasticity & Plasticity' (ISBN 978-0-9791865-0-9).	1982
4	AN Schofield & CP Wroth, 'Critical State Soil Mechanics' (ISBN 978-0641940484).	1968
5	DM Wood, 'Geotechnical Modelling' (ISBN-978-0419237303).	2004

B. Tech. Civil Engineering				
Course code: Course Title	**Course Structure. Credit=4**			**Pre-Requisite**
CE 315: Advanced Mechanics of Soil	L	T	P	CE206: Soil Mechanics, CE 205 Fluid Mechanics
	3	1	0	

Course Objective: To understand the microscopic structure and mineralogical composition of clayey soils using advanced analysis techniques. To analyse effective stress, pore pressure, and permeability characteristics in soil. To conduct numerical analysis of seepage, flow nets, and filter design for hydraulic structures. To study consolidation theories, settlement behaviour, and the impact of sand drains. To evaluate shear strength parameters, stress-strain characteristics, and stability analysis of soils.

S. No	Course Outcomes (CO)
CO1	To evaluate the microscopic structure and clay mineralogy of the soil.
CO2	To assess the hydraulic conductivity of all types of soil by lab, field, and indirect methods, thereby using data for seepage discharge.
CO3	To evaluate seepage discharge, seepage pressure, and exit gradient through homogeneous and zoned dams.
CO4	To evaluate the settlement of the foundation due to one and 3D consolidation.
CO5	To evaluate shear parameters under different drainage conditions for the estimation of the bearing capacity of the foundation and stability of slopes.

S. No	Contents	Contact Hours
UNIT 1	Clay mineralogy, clay-water electrolyte system, Orientation of clay particles, soil structure analysis using X-ray diffraction, Scanning electron microscope, Optical microscope, differential thermal analysis, Pore Size distribution analysis method.	6
UNIT 2	Effective stress, pore pressure, hydraulic conductivity, and its directional variation, Direct and indirect methods for permeability analysis, and electroosmosis.	8
UNIT 3	Numerical Analysis of Seepage, Seepage behavior of soil flow net construction by various techniques, seepage in layered soil, filter design, seepage through dam body, safety of hydraulic structures against piping.	8

UNIT 4	Consolidation: one-dimensional and generalized consolidation theories, primary and secondary consolidation, Degree of consolidation under time-dependent loading, determination of Cv by various methods, Viscoelastic model, sand drains, effect of smear, numerical solution, consolidation settlement	8
UNIT 5	Shear behavior of soil, Mohr-Coulomb failure criteria, Curvature of Failure envelope, pore pressure parameters UU, CU & CD tests, stress path, methods for settlement analysis. Total and effective stress path, water content contours, stress history, anisotropy of strength, thixotropy creep, determination of in situ undrained shear strength, stress-strain characteristic of soil, determination of modulus of values.	10
	TOTAL	**40**

REFERENCES

S. No.	**Name of Books/Authors/Publishers**	**Year of Publication / Reprint**
1	GE Barnes, 'Principle and Practice' (ISBN 9-03-088753-7)	2000
2	BM Das, 'Advance Soil Mechanics' (ISBN 0-77-04915-8)	1997
3	TW Lambe and RV Whitman, 'Soil Mechanics' (ISBN 0-71-6059714-1)	1987
4	James K. Mitchell, 'Fundamental of Soil Behavior' (ISBN 7-83-4697512-6)	1993
5	RF Scott, 'Principle of Soil Mechanics' (ISBN 9-54-3564799-8)	1963

B. Tech. Civil Engineering/ Elective Subject				
Course code: Course Title	**Course Structure**			**Pre-Requisite**
CE 316: Advanced Fluid Mechanics	**L**	**T**	**P**	Nil
	3	**0**	**2**	

Course Objective: The course aims to equip students with the concepts of fluid mechanics from both theoretical and applications perspectives. The students will have sufficient mathematical and physical background to formulate real-life problems in fluid mechanics.

S. No	Course Outcomes (CO)
CO1	Understand and formulate momentum, energy, and mass transport models.
CO2	Understand, apply, and Analyse Potential Flows.
CO3	Develop approximate solutions for small and large Reynolds number flows.
CO4	Understand and analyse boundary layer formation and stresses acting at the boundary.
CO5	Describe the construction, working, and performance testing of hydraulic turbines.

S. No.	Contents	Contact Hours
1	Kinematics of Flow: Equation of continuity in Cartesian, polar, and cylindrical coordinates, Standard 2D Flow Patterns: Source, sink, doublet, and their combinations, construction of flows by superposition, D'Alembert's paradox.	8
2	Modelling and dimensional analysis: Introduction, Dimensional Homogeneity Methods of Dimensional analysis, Model Analysis like types of similarity, Types of forces acting on moving fluids, Dimensionless numbers, Classification of models, and Model laws.	9
3	Laminar Flow: Derivation of Navier-Stokes equations – exact solutions for flow between parallel plates, Couette flow, flow near a suddenly accelerated plate, and an oscillating plate.	9
4	Boundary Layers: introduction, types of boundary layer, drag force on a Flat plate due to boundary layer analysis of turbulent boundary layer, separation in boundary layer under adverse pressure gradient, and methods of preventing the separation of boundary layer.	8

5	Fundamentals of compressible flows: Introduction, Thermodynamics Relations. Basic equations of compressible flow, velocity of sound or pressure wave in a fluid, and Mach number.	8
	Total	**42**

References:		
S. No.	**Name of Books/Authors/Publishers**	**Year of Publication / Reprint**
1	White, F.M. Viscous Fluid Flow (second edition), McGraw-Hill.	1991
2	Boundary Layer Theory, H. Schlichting.	2000
3	K Muralidhar and G Biswas, “Advanced Engineering Fluid Mechanics”, 3/e, Narosa Publishing House,2001.	2001
4	White, F.M., "Fluid Mechanics", McGraw-Hill.	2000

B. Tech. Civil Engineering				
Course code: Course Title	**Course Structure. Credit=4**			**Pre-Requisite**
CE 317: Water Power Engineering	L	T	P	Nil
	3	0	2	

Course Objective: The course aims to equip students with the knowledge and skills necessary for designing, analysing, and managing Hydro Power Plants efficiently while considering environmental, economic, and sustainability aspects.

S. No	Course Outcomes (CO)
CO1	Identify Issues related to hydropower development in India and assess the hydropower potential of river basins
CO2	Classify and compare different types of hydropower plants, including storage, run-of-river, and pumped storage systems, and evaluate the efficacy of hydropower plants.
CO3	To analyse and design the Water Conveyance System and Design intake structures such as penstocks, Anchor blocks. Forebay, Intakes
CO4	To analyse and design the Dams and Spillways, such as Rigid dams, Gravity dams, and spillways.
CO5	Describe the construction, working, and performance testing of hydraulic turbines.

S. No.	Contents	Contact Hours
1	**Introduction:** Development of water power, Estimation of Hydropower potential, Comparison of Hydro, thermal and nuclear power, Flow duration curve, firm power, secondary power, Load and Load duration curves, Load factor, etc.	8
2	**Types of Hydropower Plants:** Classification of hydropower plants, Run-of-river plants, Valley dam plants, High head diversion plants, Diversion Canal plants, pumped storage plants, and Tidal power plants.	8
3	**Water Conveyance System:** Power canals, Alignment, Design of power canals, Flumes, Covered conduits and tunnels, Drainage and ventilation in tunnels. Penstocks: - Alignment, types of penstocks, economic diameter of penstocks, and Anchor blocks. Forebay, Intakes, Balancing Reservoir, Surge Shafts/ Inclined Shafts. General Layout of power house and arrangement of hydropower units. Underground Power Stations.	10
4	**Dams:** Selection of site, preliminary investigations, Final investigations, Types of dams: Rigid dams, Gravity dams, Arch and buttress dams, Basic principles of design and details of construction. Earthen dams, Rockfill dams, Design considerations.	8

	Spillways: Types, spillway gates, Design of stilling basins.	
5	**Types of Turbines and their utility:** Hydraulic Turbines, Classification Based on Head, Discharge, Turbines, Differences between Impulse and Reaction Turbines, choice of Type of Turbine-Specific Speed. Component Parts & Working Principles of a Pelton Turbine and Francis Turbine.	8
	Total	**42**

References:		
S. No.	**Name of Books/Authors/Publishers**	**Year of Publication / Reprint**
1	Dandekar, M. M., and Sharma, K. N., "Water Power Engineering", Vikas Publishing House, New Delhi.	2013
2	Deshmukh, M.M., "Water Power Engineering, Dhanpat Rai Publications", New Delhi.	1998
3	Nigam, N. C., "Handbook of Hydropower Engineering", Nem Chand and Sons, Roorkee.	1999
4	Sharma, R. K. and Sharma, T. K., "Water Power Engineering", S. Chand & Company, New Delhi.	2003
5	Varshney, R.S., "Hydropower Structures", Nem Chand and Bros., Roorkee (U.P.).	2014

B. Tech. Civil Engineering				
Course code: Course Title	**Course Structure**			**Pre-Requisite**
CE318: Environmental Aspects of Water Resources	L	T	P	Nil
	3	1	0	

S. No	Course Outcomes (CO)
CO1	Learn key concepts, principles, and definitions related to water quality parameters, wastewater management, the ecological flow of rivers, and water conservation.
CO2	Analyse the impact of wastewater flows having organic and inorganic pollutants, heavy metals, and pathogenic microorganisms, on water quality and aquatic ecosystems.
CO3	Prepare an impact assessment of wastewater disposal on river water quality using models like the Streeter-Phelps equation and oxygen sag curve.
CO4	Assess the environmental and socio-economic impacts of large-scale water infrastructure projects, such as dams and irrigation systems.

S. No	Content	Contact hours
UNIT 1	Overview of Water Quality Parameters, dissolved oxygen as an indicator of stream water quality, and water quality based on designated best use. Major Organic and inorganic pollutants, heavy metals, and pathogenic microorganisms. Effects on aquatic ecosystems, oxygen depletion, and implications for human health.	9
UNIT 2	Sources of water pollution include industrial waste discharge, CETP effluent discharge, agricultural runoff, sewage, and wastewater disposal. Disposal of treated wastewater into natural streams, lakes, and estuaries, self-purification of natural streams, impact of wastewater discharge on river water quality, Streeter-Phelps equation, and its application in river water quality management.	9
UNIT 3	Environmental impact assessment of water projects: Environmental impacts of dams and irrigation projects, ecological impacts on aquatic life and wetlands, socio-economic impacts on local communities. Requirements of maintaining ecological flow in rivers. Environmental management plans and regulatory frameworks for water resource development projects ensure sustainable and responsible water management practices.	7

UNIT 4	Water conservation techniques, Rainwater harvesting, Groundwater recharge, Integrated water resource management. Water pricing, economic aspects of environmental and water resource management.	7
UNIT 5	Case study on the Environmental Impact Assessment (EIA) of water reservoir projects. Case study on the environmental and economic aspects of canal projects.	10
TOTAL		**42**

REFERENCES :

S. No.	**Name of Books/ Authors**	**Year of Publication**
1	Water Resources: Environmental Planning, Management, and Development, Asit K. Biswas.	1997
2	Environmental Hydrology– Andy D. Ward & Stanley W. Trimble.	2016

B. Tech. Civil Engineering				
Course code: Course Title	**Course Structure**			**Pre-Requisite**
CE319: Water Resources Planning and System Engineering	**L**	**T**	**P**	Nil
	3	**0**	**2**	

Course Objective: The objective of the course is to provide students with the knowledge and skills needed to design, plan, and manage water resource systems effectively. The course focuses on understanding the hydrological, economic, and environmental aspects of water resources, integrating principles of sustainability and resilience. Students will learn to apply quantitative and qualitative methods for decision-making, optimise water resource allocation, and address challenges such as climate change, water scarcity, and stakeholder conflicts. Through case studies and practical projects, students will develop the ability to create and implement comprehensive water management strategies.

S. No	**Course Outcomes (CO)**	
CO1	Apply hydrological and systems analysis techniques to water resource planning.	
CO2	Develop and optimise sustainable water management strategies.	
CO3	Analyse economic, environmental, and social impacts of water resource decisions.	
CO4	Utilise decision-making tools for effective water allocation and conflict resolution.	
CO5	Address challenges in water management, including climate change and resource scarcity.	
S. No.	**Contents**	**Contact Hours**
UNIT 1	Introduction: Water resources planning process, multi-objective planning. Evaluation of Water Plans: Basic concepts of engineering economics, welfare economics, and economic comparison of alternatives.	8
UNIT 2	Water Plan Optimisation: Plan formulation, objective functions and constraints, analytical optimisation, numerical optimisation, linear programming, dynamic programming, simulation, planning under uncertainty.	10

UNIT 3	Deterministic River Basin Modelling: Stream flow modelling, estimation of reservoir storage requirements – dead storage, active storage for water supply/irrigation/power generation, flood storage. Optimal allocation.	8
UNIT 4	Conjunctive Use/Groundwater Management Models: LP-based conjunctive use modelling, aquifer response models, link-simulation, embedded, matrix response-based models, soft modelling.	8
UNIT 5	Water Quality Management Models: Basic water quality modelling, objectives of management, control alternatives, optimal plans.	8
	Total	**42**

REFERENCES

S. No.	**Name of Books/Authors/Publishers**	**Year of Publication / Reprint**
1	Hall, W.A. and Dracup, J.A., "Water Resources Systems Engineering", McGraw-Hill Book Company.	1970
2	Loucks, D.P., "Water Resource Systems Planning and Analysis", Prentice Hall.	1981
3	Maass et al., "Design of Water-Resource Systems", Harvard University Press.	1962
4	Vedula S. and Mujumdar, P.P., "Water Resources Systems", Tata McGraw-Hill.	2005

B. Tech Civil Engineering				
Course code: Course Title	**Course Structure**			**Pre-Requisite**
CE320: Transportation Safety and Environment	L	T	P	**NIL**
	3	0	2	

Course Objective: This course aims to develop a comprehensive understanding of road accidents, traffic safety issues and environmental pollution. This course also aims to equip students with the knowledge and skills necessary to carry out road safety audit and environmental impact assessments of highway projects.

S. No.	Course Outcomes (CO)
CO1	To expose students to perform traffic and transportation studies
CO2	To expose students to understand the vulnerability of traffic and the causes of road accidents
CO3	To expose students to learn to study the road safety parameters with the manual of road safety audit
CO4	To expose students to learn the environmental impacts due to traffic and transportation with an understanding of relevant guidelines of the MoEF.

S. No	Contents	Contact Hours
UNIT 1	Road accident situation in India, international comparison of road accidents. Multidisciplinary approach to planning for traffic safety and injury control, causes of road accidents, control measures, roles of vehicle, roadway traffic, driver, and environment, crash and injury causations; accident analysis, pre-crash and post-crash models, conflict points.	10
UNIT 2	Safety auditing: road safety audit, stages of auditing, methods involved; case studies. Mixed traffic flow, traffic calming measures, strategies adopted in various countries, and case studies.	10
UNIT 3	Transportation-related pollution: road transport-related air pollution, sources of air pollution, effects of weather conditions, vehicular emission parameters, urban and non-urban traffic noise sources, noise pollution, noise barriers, pollution standards measurement and analysis of vehicular emission, and imitative measures.	10
UNIT 4	EIA: EIA requirements of highway projects, procedure, MoEF, UK guidelines; EIA practices in India.	10
	Total	**40**

REFERENCES

S. No	Name of Books/ Authors/ Publishers	Year of Publication/ Reprint
1.	Khanna, S.K., Justo, C.E.G. and Veeraragavan A. "Highway Engineering", Nem Chand & Bros., Roorkee,	2014

	U.K	
2.	Kadiyali, L. R., “Traffic Engineering and Transportation Planning”, Khanna Publishers, New Delhi	2018
3.	Principles of Traffic and Highway Engineering, Nicholas J. Garber and Lester A. Hoel, Cengage Learning	2010
4.	Peavy, Howard S., Rowe, Donald R. and Tchobanoglous, George, “ Environmental Engineering”, McGraw-Hill Education (India) Pvt. Ltd., New Delhi	1985
5.	IRC-SP:88 2019 Manual on Road Safety Audit Indian Roads Congress New Delhi	2019

B. Tech. Civil Engineering				
Course code: Course Title	**Course Structure**			**Pre-Requisite**
CE321: Computational Fluid Dynamics	**L**	**T**	**P**	Nil
	3	**0**	**2**	

Course Objectives: To familiarise the students with the concepts of the subject and its related applications in Civil Engineering.

S. No.	Contents	Contact Hours
Unit 1	**Introduction to Computational Fluid Dynamics (CFD):** Introduction to Computational Fluid Dynamics, Applications of Computational Fluid Dynamics, Advantages of Computational Fluid Dynamics. Governing Equations: Principles of Conservation: Continuity Equation, Navier-Stokes Equation, Energy Equation. General Structure of Conservation Equations.	6
Unit 2	**Classification of Partial Differential Equations and Physical Behaviour:** Mathematical classification of Partial Differential Equations: Illustrative examples of elliptic, parabolic and hyperbolic equations, Physical examples of elliptic, parabolic and hyperbolic partial differential equations.	6
Unit 3	**Discretisation** Basics of discretisation. Boundary conditions: Possible types of boundary conditions, Conservativeness, Boundedness, Transportive Ness, boundary layer treatment, variable property, interface and free surface treatment. Well posed problem. Classification and Overview of Numerical Methods: Classification into various types of equations, parabolic, elliptic and hyperbolic; boundary and initial conditions; overview of numerical methods.	6
Unit 4	**Discretisation Methods: Finite Difference Methods,** Finite Difference Technique: Finite difference methods; different means for formulating finite difference equations; Taylor series expansion. Implicit, fully explicit and Crank-Nicolson scheme. **Finite Volume Methods** Finite Volume Technique: Finite volume methods; different types of finite volume grids; approximation of surface and volume integrals; interpolation methods; central, upwind and hybrid formulations and comparison for convection-diffusion problem. **Finite Element Methods:** Finite element methods; Rayleigh-Ritz, Galerkin and Least square methods; interpolation functions; one and two-dimensional elements; applications.	8

Unit 5	**Solution Methods:** Methods of Solution: Solution of finite difference equations; iterative methods; matrix inversion methods; ADI method; operator splitting; fast Fourier transform. Time integration Methods: Single and multilevel methods; predictor-corrector methods; stability analysis; Applications to transient conduction and advection-diffusion problems.	6
Unit 6	**Grid Generation** Numerical Grid Generation: Numerical grid generation; basic ideas; transformation and mapping.	2
Unit 7	**Turbulence Modelling** Turbulence modelling: Reynolds averaged Navier-Stokes (RANS) equations, RANS modelling, DNS and LES.	6
	Total	**40**
Lab Work: The students would be expected to gain hands on experience on simulation of some classical fluid dynamics problems using related software in the laboratory: Viscous flow across flat plate, Flow past a sphere, Study of laminar flow through a pipe, Study of turbulent flow through pipe, Study of sudden expansion in a pipe, Study of steady and unsteady flow past a cylinder.		

References:

S. No.	Name of Books/ Authors	Year of Publication/ Reprint
1	Computational Fluid Dynamics, John D Anderson Jr, McGraw Hill Publications(ISBN 0-07-07592-7).	2000
2	Computational Methods for Fluid Dynamics, John Freziger, Miloven Peric, Springer(ISBN 0-07-94562-6).	1999
3	Computational Fluid Dynamics for Engineers Bengt Andersson, Ronnie Andersson, Love Ka Kansson, Mikael Mrtensen, Rahman Sudiyo, Berend Van Wachem, Cambridge University Press (ISBN 0-07-146498-7).	1996
4	Computational Fluid Dynamics – A Practical Approach, Jiyuan Tu, Guan Heng Yeoh, Chaoqun Liu(ISBN 0-07-0228847-9).	2005

B. Tech Civil Engineering				
Course code: Course Title	**Course Structure**			**Pre-Requisite**
CE322: Tunnel, Ports and Harbour Engineering	L	T	P	**NIL**
	3	1	0	

Course Objective: This course aims to develop a comprehensive understanding aspects of planning, design and construction of tunnels, harbours and docks.

S. No.	Course Outcomes (CO)
CO1	To expose students to equip them with knowledge of different methods and procedures of tunnelling.
CO2	To expose students to understand the elements of planning and design of a harbour.
CO3	To expose students to equip them with knowledge of the construction features of different types of docks.
CO4	To expose students to learn the concept of dredging and various navigational aids at the harbour.

S. No	Contents	Contact Hours
UNIT 1	Tunnelling: tunnel alignment and grade, size and shape of tunnel, methods of tunnelling in soft soil, compressed air and shield tunnelling, shafts in tunnels, safety measures, ventilation, lighting and drainage in tunnels.	10
UNIT 2	Introduction and planning of harbour: Harbour classification, characteristics of good harbour, and principles of harbour planning, site selection criteria and lay out of harbours. Breakwaters: function, types, general design principles, wharves, quays, jetties, piers, pier heads, dolphin, fenders, mooring accessories- function, types and suitability.	10
UNIT 3	Design and construction features, docks and locks; tidal basin, wet docks, design consideration, operation of lock gates and passage, repair docks, graving docks, floating docks, marine railway. Port amenities; ferry, transfer bridge, floating landing stages, transit sheds, ware houses, cold storage, aprons, cargo handling equipment, purpose and general description.	10
UNIT 4	Harbour navigational aids; channel and entrance demarcation, buoys, beacons, light house electronic communication device. Dredgers: types, suitability, disposal of dredged material.	10
	Total	**40**

REFERENCES

S. No	Name of Books/ Authors/ Publishers	Year of Publication/ Reprint
1.	Srinivasan R., "Harbour, Dock and Tunnel Engineering", Charotar Publishing House Anand, Gujarat	2016

2.	Bindra S.P., “A course in Docks and Harbour” Dhanpat Rai Publications, New Delhi	2010
3.	Saxena S.C., “Tunnel Engineering” Dhanpat Rai Publications, New Delhi	2010

B. Tech. Civil Engineering					
Course code: Course Title	**Course Structure**				**Pre-Requisite**
CE 323: Quantity Surveying and Estimation.	**L**	**T**	**P**	**C**	**NIL**
	3	**1**	**0**	**4**	

Course Objective: To understand methods of quantity survey, estimation and specifications of materials, rate analysis as required in construction projects**.**

S. No	Course Outcomes (CO)
CO1	Understand basic terms and the importance of estimation of quantity and cost.
CO2	Understand the technical specifications for various works to be performed for a project.
CO3	Understand methods of evaluating quantities of constituents, derive their cost rates and estimate the cost of the structure.
CO4	Understand how competitive bidding works and how to submit a competitive bid proposal.

S. No	Contents	Contact hours
UNIT 1	Introduction to estimation - Types of estimates- Necessity - Method of measurements – Specifications of construction materials.	10
UNIT 2	General items of work in construction projects – Standard units, Principles of working out quantities for detailed and abstract estimates – Methods of estimating. Detailed estimates of projects.	10
UNIT 3	Rate Analysis – Working out data for various items of work, overhead and contingency charges.	10
UNIT 4	Contracts – Types of contracts – Contract documents – Conditions of contract, Valuation – Standard specifications for different items of construction projects.	10
	Total	**40**

REFERENCES		
S. No.	**Name of Books/Authors/Publishers**	**Year of Publication / Reprint**

1	B.N. Dutta, “Estimating and Costing in Civil Engineering”, UBS Publishers.	2017
2	2. A.K. Upadhyay, “Civil Estimating and Costing”, S.K. Kataria and Sons Publishers.	2013
3	G.S. Birde, “Estimating and Costing”, Dhanpat Rai Publishing Company	2014
4	M. Chakraborty, “Estimating, Costing, Specifications and Valuation in Civil Engineering. Chakraborti Publication.	2006
5	Standard Schedule of Rates and Standard Data Book by the Public Works Department.	2018

B. Tech. Civil Engineering				
Course code: Course Title	**Course Structure**			**Pre-Requisite**
CE 324: Earthquake Technology	L	T	P	Nil
	3	0	2	

Course Objective: The course provides the basic principles of earthquake-resistant design of structures. Students are introduced to the engineering aspects of earthquakes, their characterisation, and effects. The course covers seismic design force computation, design, and detailing as per Indian Standards. An introduction to seismic evaluation and retrofitting is also included.

S. No	Course Outcomes (CO)
CO1	Able to understand the basic principles involved in earthquake engineering
CO2	Analyse the effects of harmonic motion, vibrations and natural frequencies etc.
CO3	Able to apply the concept of various degrees of systems involved in earthquake analysis.
CO4	Understand the liquefaction process and its effects on foundations.
CO5	Able to design and analyse the structure using IS 1893 and IS 13920 code provisions.

S. No.	Contents	Contact Hours
UNIT 1	Introduction of structural dynamics, types of prescribed loads, Coordinates and coordinate transformation, Principles of Dynamics: D-Alembert's principle, Principle of Virtual Work, Hamilton's principle, mathematical and analytical models., Free body diagram and equation of motion. Single degree freedom systems, Simple problems on undamped and damped free vibration, frequency, period, and amplitude, Logarithmic decrement, Types of damping systems.	
UNIT 2	Response of SDOF System to Harmonic excitation, Dynamic excitation, Vibration of undamped two degrees of freedom system, Simple problems, Free vibration of MDOF System, Natural Frequencies & Mode shapes, Rayleigh's method, Stodola method.	
UNIT 3	Modal response of MDOF systems, Mathematical model of MDOF Systems, Seismic coefficient and response spectrum method of analysis as per IS 1893 Code Provision. Simple problems on the response of MDOF systems to earthquake excitation.	
UNIT 4	Strong ground motion measurements, Seismic hazard analysis, Measurement of dynamic soil properties, One dimensional ground response analysis, Liquefaction: Susceptibility and effects, Simple problems.	
UNIT 5	Concept of Earthquake Resistant Design, IS 1893: Part I 2002; Provisions for Seismic Design: Ductile reinforcement detailing as per IS 13920 Code., Provisions of IS 4326: 1993,IS 13827 1993,IS 13828 1993 Appropriate experiments would be taken up.	
	Total	**42**

REFERENCES		
S. No.	**Name of Books/Authors/Publishers**	**Year of Publication / Reprint**
1	Dynamics of Structures A K Chopra. Published by Prentice Hall. ISBN 10: 013156174X, ISBN 13: 9780131561748.	2003
2	Dynamics of structures, Ray W. Clough and Joseph Penzien, McGraw-Hill, New York, 1993. ISBN 0-07-011394-7.	1993
3	Elements of Earthquake Engineering Jai Krishna, Brijesh Chandra South Asian Publishers, ISBN-10: 8170031834 ISBN-13: 978-8170031833.	2000
4	Structural Dynamics: Theory and Computation Mario Paz CBS Publishers & Distributors Pvt. Ltd New Delhi (2004) ISBN 10: 8123909780 ISBN 13 : 9788123909783.	2004
5	Geotechnical Earthquake Engineering, Steven L. Kramer, Pearson Education Inc. Dorling Kindersley (India) Pvt. Ltd. Delhi ISBN 81-317-0718-0.	2007
6	Theory of Vibration with Application, William T. Thomson, Marie Dillon Dahleh, Pearson Education Inc. Dorling Kindersley (India) Pvt. Ltd. Delhi ISBN 81-317-0932-9.	2007
7	IS 1893 Part I : 2002 BIS New Delhi.	2002
8	IS 13920: 1993 BIS, New Delhi.	1993
9	IS 4326: 1993 BIS, New Delhi.	1993
10	IS 13827, IS13828: 1993 BIS, New Delhi.	1993

B. Tech. Civil Engineering				
Course code: Course Title	**Course Structure**			**Pre-Requisite**
CE325: Geodesy and Navigation	**L**	**T**	**P**	**Nil**
	3	**1**	**0**	

Course Objective: To equip students in an understanding of Fundamentals of Geodesy, Geometric geodesy, satellite geodesy, and the application of physical geodesy in mapping, navigation, and geophysical research.

S. No	Course Outcomes (CO)
CO1	Introduction to Fundamentals of Geodesy
CO2	Physical Geodesy: Gravity Field and Potential Theory. Geoid Modeling and Height Systems.
CO3	Geometric Geodesy: Geometric Relationships on the Ellipsoid. Geodetic Measurements and Computations
CO4	Understanding Satellite Geodesy
CO5	To understand GNSS principles, error sources, and navigation applications.
CO6	To equip students to apply signal processing techniques in navigation and geospatial data analysis.

S. No	Contents	Contact hours
UNIT 1	**Fundamentals of Geodesy**: **Introduction to Geodesy:** Definition, branches, history, and importance of geodesy. **Earth's Shape and Gravity:** Understanding the Earth's shape (geoid, ellipsoid), gravity field, and its relationship to geodesy. **Coordinate Systems:** Horizontal and vertical datums, reference surfaces (geoid, ellipsoid), and coordinate systems (e.g., WGS84, GRS80). **Map Projections:** Introduction to map projections, their purpose, methods, and classification. **Geodetic Datums:** Understanding different geodetic datums and their geometric attributes.	8
UNIT 2	**Physical Geodesy : Gravity Field and Potential Theory**: **Gravity and Potential:** Gravitational law, gravity potential, and equipotential surfaces. **Laplace and Poisson Equations:** Understanding and applying these equations in the context of gravity field modeling. **Normal Gravity Field:** Definition and characteristics of the normal gravity field, including the GRS80 and WGS84 systems. **Anomalous Gravity:** Understanding gravity anomalies and their causes. **Geoid Modeling and Height Systems**: **Geoid Modeling:** Stokes' integral, Koch's formula, Vening-Meinesz formula, and Molodensky's approach. **Spherical Harmonics:** Using spherical harmonics to model the Earth's gravity field. **Height Systems:** Physical and geometric heights, height systems around the world, and the geoid as a vertical reference frame.	6

UNIT 3	**Geometric Geodesy: Geometric Relationships on the Ellipsoid**: - **Geodesic Lines:** The shortest distance between two points on an ellipsoid, **Direct and Inverse Problems:** Calculating coordinates from distances and angles, and vice-versa, **Radii of Curvature:** Understanding the curvature of the ellipsoid along meridians and prime verticals, **Azimuths and Angles:** Determining the direction and angle of lines on the ellipsoid. **Geodetic Measurements and Computations -Triangulation and Trilateration:** Surveying methods for establishing horizontal control networks, **Coordinate Transformations:** Converting coordinates between different reference systems and datums, **Map Projections:** Transforming the Earth's surface onto a flat map, **Error Analysis and Adjustments:** Understanding and minimizing errors in geodetic measurements.	8
UNIT 4	**Satellite Geodesy: Satellite Motion: Orbital Mechanics:** Understanding satellite orbits and their dynamics., **Time Systems:** Different time systems used in satellite geodesy (e.g., UTC, GPS time). **Satellite Methods: Very Long Baseline Interferometry (VLBI):** Precise measurements of satellite positions and Earth rotation. **Satellite Laser Ranging (SLR):** Measuring the distance between satellites and Earth., **Lunar Laser Ranging (LLR):** Measuring the distance between the Earth and the Moon, **Doppler Orbitography and Radio-positioning Integrated by Satellite (DORIS):** Satellite positioning using Doppler shift measurements, **Satellite Altimetry:** Measuring the height of the Earth's surface.	8
UNIT 5	**Satellite Navigation** - Fundamentals of GNSS: GPS, GLONASS, Galileo, BeiDou, GPS Signal Structure and Positioning Methods, Differential GPS (DGPS) and Real-Time Kinematic (RTK) Techniques, GPS Data Processing and Accuracy Assessment, Applications of GNSS in Engineering and Mapping, Case Studies: GNSS in Land and Urban Planning.	6
UNIT 6	**Digital Signal Processing** - Basic review of signals, types of classification of signals and systems, Convolution and Correlation of signals, Fourier Analysis in frequency domain – DFT, Filtering techniques in geospatial data analysis - median and Gaussian filtering, Wiener filters for denoising.	6
	TOTAL	**42**

REFERENCES

S. No.	**Name of Books/Authors/Publishers**	**Year of Publication / Reprint**
1	Heiskanen, W. A., & Moritz, H. Physical Geodesy.	(1967).
2	Hofmann-Wellenhof, B., & Moritz, H. Physical Geodesy.	(2006).
3	Elements of Geodesy.	2005
4	Supplementary Resources Online materials (e.g., IAG publications, lecture notes provided by the instructor).	1985
5	Proakis and Manolakis, Digital Signal Processing, PHI Publication.	2007
6	R. Babu, Digital Signal Processing, SciTech Publication.	2011

B. Tech. Civil Engineering/ Elective Subject				
Course code: Course Title	**Course Structure.**			**Pre-Requisite**
CE326: Cyclonic Risk and Management	L	T	P	Nil
	3	0	2	

Course Objective: To impart knowledge of the basics of cyclones, hazard assessment techniques of cyclones, and protection against cyclones.

S. No	Course Outcomes (CO)
CO1	Understand the concept of Cyclones and classification, and its impact
CO2	Understand the wind characteristics and analyse wind effects on structures
CO3	Understand and analyse the quantification of damage and behaviour of structures in past cyclones.
CO4	To analyse and assess the risk using a direct and component-based approach
CO5	Describe the Mitigation measures, planning, and design under cyclonic wind

S. No.	Contents	Contact Hours
1	**Tropical Cyclones:** Introduction, types of high wind, hurricanes, typhoons, cyclones, Concept of Tropical Cyclones, General structure of Cyclones, Quantification of Cyclones, Various scales for measuring wind storms, Climate change and its impact on tropical cyclones, Nature of cyclonic wind, wind storm/cyclone hazard in India, wind speed map of India, Frequency of cyclones in India.	7
2	**Wind Characteristics**: Global atmospheric circulation-pressure gradient force, Coriolis force, frictional force, geostrophic flow, wind profile, effects on structures due to cyclone, Building codes with particular reference to IS875(part-III). Probabilistic description of cyclonic wind speed, Exceedance Probabilities.	8

3	**Quantification of damage**: Classification of Buildings, damaging effects of high wind speeds on housing in the coastal region of India. Classification of damages according to Indian standard procedure (IS 15499:2004), Behavior of structures in past cyclones and wind storms - lessons learnt.	8
4	**Risk Assessment:** Vulnerability and risk assessment in high cyclone-prone areas, Concept of cyclonic micro-zonation, Different techniques used to describe the vulnerability of buildings. Concept of vulnerability of houses to cyclonic wind, fragility curve, damage ratio, Direct and component-based approach, Concept of damage probability matrix.	10
5	**Mitigation measure:** Cyclonic risk mitigation and preparedness. Life–line structures such as cyclone shelters. Retrofitting and strengthening of structures. Rehabilitation. General planning and design considerations under wind storms and cyclones.	7
	Total	40

References:

S. No.	Name of Books/Authors/Publishers	Year of Publication / Reprint
1	Simiu, E.,& Scanlan, R.H.. "Wind effects on structures: An Introduction to Wind Engineering."- John Wiley.	1986
2	Goyal P.K. and Gupta Anil "Disaster Management" AICTE New Delhi	2023
3	IS: 15498: "Guidelines for Improving the Cyclonic Resistance of Low-Rise Houses and other Buildings/Structures"-Bureau of Indian Standards, New Delhi.	2004
4	Bhandari, N.M., Krishna, P. and Krishen, K. "Wind storms, damage and guidelines for mitigative measures." -Department of Civil Engineering, Indian Institute of Technology, Roorkee, p. 11, Document No. IITK-GSDMA-Wind03-V3.0	2011
5	Goyal P.K. "Cyclone Disaster Mitigation and Management in India: An Overview" Chap. 7 , Disaster Risk and Management Under Climate Change, Disaster Resilience and Green Growth, Springer	2024
6	Goyal P.K. and Datta T.K.. Cyclonic Micro-zonation. Natural Hazards, Springer.	2012

B. Tech. Civil Engineering				
Course code: Course Title	**Course Structure**			**Pre-Requisite**
CE327: AI in Civil Engineering	L	T	P	Nil
	3	**0**	**2**	

Course objective: This course provides an overview of several Artificial Intelligence techniques and their applications in a variety of civil engineering problems. It aims to develop an understanding of fundamentals, including reasoning, planning, and learning, and their application in engineering decision-making. Students will explore key AI techniques such as **Artificial Neural Networks, Fuzzy Systems**, **and Genetic Algorithms,** focusing on their applications in civil engineering tasks such as classification, clustering, **optimization, predictive modelling, flood forecasting, water quality assessment, etc.** By the end of the course, students will be able to **apply and evaluate AI-based approaches in civil engineering applications**.

S. No	Course Outcomes (CO)
CO1	Learn the fundamental concepts and principles of Artificial Intelligence (AI) and its applications in civil engineering, including stochastic data and pattern recognition, predictive modelling using ARIMA models, and various AI approaches like ANN, fuzzy logic, and Genetic Algorithms.
CO2	Solve real-world civil engineering problems like rainfall-runoff modelling, flood forecasting, river water quality simulation, etc., by applying theoretical knowledge of ARIMA modelling, ANN, fuzzy logic, and Genetic Algorithms.
CO3	Analyse data from the case studies in civil engineering, including the impact of effluent disposal on river quality management, and derive meaningful insights for decision-making and optimization.
CO4	Develop problem-solving skills using appropriate methodologies and AI tools, including simulation techniques, fuzzy linear programming, and Genetic Algorithms.
CO5	Communicate technical findings effectively through reports or technical documentation, including the results of applying AI techniques to civil engineering problems.

S. No	Content	Content hours
UNIT 1	Introduction to artificial intelligence and its applications in civil engineering. Stochastic data & predictive modelling in civil engineering, introduction to ARIMA modelling (Box-Jenkins approach) for univariate data. Limitations of applications of ARIMA modelling.	9

UNIT 2	Fundamentals of ANN, learning algorithms, feedforward with backpropagation for estimating connection weights, various applications of neural networks in civil engineering, including rainfall-runoff modelling and flood forecasting. Limitations of applications of ANNs.	9
UNIT 3	Estimating the impact of effluent disposal on River Water Quality using simulation, **understanding cause-effect relations** in some case studies of civil engineering. Alternative AI approaches and their applications.	6
UNIT 4	Classical and fuzzy sets, fuzzification and defuzzification, development of membership functions, and various fuzzy logic applications (like ANFIS) in civil engineering. Limitations of the applications of fuzzy concepts.	9
UNIT 5	Concepts and basic principles of genetic algorithms (GA), Coding, Fitness function, GA operations, Reproduction, Cross-over, Mutation, and Application of GA in civil engineering. Limitations of the applications of Genetic Algorithms.	9
	TOTAL	**42**

REFERENCES

S. No	Name of Books/ Authors	Year of Publication
1	Neural Networks, Fuzzy Logic, and Genetic Algorithms Synthesis and Applications; S. Rajasekaran, G.A. Vijayalakshmi Pai, PHI Learning Pvt. Ltd, Delhi.	2003
2	Soft Computing in Water Resources Engineering: Artificial Neural Networks, Fuzzy Logic and Genetic Algorithms; G. Tayfur, Izmir Institute of Technology, Turkey.	2012
3	Artificial Intelligence in Civil Engineering**;** Pijush Samui and D.P. Kothari	2012
4	Artificial Intelligence and Machine Learning Techniques for Civil Engineering; Pijush Samui, Nagesh R. Iyer, and Sandeep Chaudhary	2022

B. Tech. Civil Engineering				
Course code: Course Title	**Course Structure**			**Pre-Requisite**
CE328: Fire Safety of Structures	**L**	**T**	**P**	**Nil**
	3	**1**	**0**	

Course Objective: The objectives of this course are to expose the students to the concepts of functional design of building for thermal aspects and energy efficiency, especially in tropical climates, i.e., in the Indian context. Further, the objective is to make the student capable of performing fenestration design for natural ventilation and daylighting & design of space for external and internal noise control.

S. No	Course Outcomes (CO)
CO1	Comprehensive understanding of fire dynamics, fire resistance, and fire safety systems.
CO2	Able to design, analyse, and optimize building services for modern, efficient, and intelligent buildings.
CO3	Comprehensive understanding of water supply, wastewater, drainage, and electrical systems.
CO4	Enable to plan, execute, and manage maintenance activities effectively to ensure the durability and performance of built structures.
CO5	Comprehensive understanding of maintenance cycles, decision-making models, and repair techniques.

S. No	Contents	Contact Hours
UNIT 1	Fire Protection: Process of combustion in fire, Effect of fire load & ventilation condition on enclosure fire, growth and decay of fire in the enclosure. Concepts of fire resistance and severity, Effect of fire on materials. Fire Rating of Structures. Simple Design of elements for the given fire resistance. Planning, Fire detection & suppression systems, Smoke venting	10
UNIT 2	Lifts & Vertical Transportation: arrangement of lifts and Design for optimum service condition. Building Services as a system, Capacity of storage and sizing, control system, etc. & intelligent building. HVAC System: Design Considerations. Basic psychometrics, Air conditioning process & system. Methods of Air Conditioning.	8
UNIT 3	Water Supply, Hydraulic design, Storage, Distribution, Components of cold & hot water supply system. Waste water & Drainage systems: Fixture units & Design of system and elements of electrical services.	8
UNIT 4	Definition, Role of building maintenance in the construction process, Maintenance generators, Expression of Standards, selection of the level of maintenance, and fixing standards. Planned maintenance: Planning vis-a-vis ad hoc maintenance, schedule & contingency maintenance, levels of planning, planned inspection, etc	8

UNIT 5	Maintenance cycle, maintenance profile, repair & replacement models, statistical methods, decision models, optimal renewal cycle, budgeting etc. Effect of design on maintenance, Diagnosis, appraisal, structural defects & various methods of repair	8
	Total	**42**
REFERENCES		
S. No.	**Name of Books/Authors/Publishers**	**Year of Publication / Reprint**
1	Bureau of Indian Standards, "Handbook of Functional Requirements of Buildings, (SP-41 & SP-32)", BIS 1987 and 1989.	1987, 1989
2	Markus, T.A. & Morris, E.N., "Building Climate And Energy", Pitman Publishing Limited. 1980.	1980
3	SP-35 (1987): Handbook of Water Supply & Drainage- BIS, New Delhi.	1987
4	N.B.C.-2007 BIS, New Delhi.	Latest

B.Tech. (Civil Engineering)				
Course Code: Course Title	**Course Structure**			**Pre-requisite**
CE329 : Concrete Technology	**L**	**T**	**P**	**Nil**
	3	**0**	**2**	

Course Objective: Fostering students' competence for the evaluation of cement, fine aggregate, coarse aggregate, pozzolanic materials, and performance improvers properties and finalization of mix proportions, conventional concrete, high-strength concrete, high-performance concrete, and self-compacting concrete.

S.N.	Course Outcomes (COs)
CO1	Students can test cement for its various properties.
CO2	Students can test fine aggregate for its various properties.
CO3	Students can test Coarse aggregate for its various properties.
CO4	Students can evaluate various properties of pozzolanic materials and viscosity-modifying agents and determine the compatibility of super-plasticizer.
CO5	Students can design various types of concrete mixes.

S. No.	Contents	Contact Hours
Unit 1	Cement: Role of various compound oxides present in cement, various tests for cement properties, and influences of those properties on the final product. Various tests to ensure the suitability of water.	8
Unit 2	Fine Aggregate: Tests for various properties and role of these properties, grading zone, gradation curve, and tailoring for desired gradation.	8
Unit 3	Coarse Aggregate: Tests for various properties and role of these properties, gradation curve, and tailoring for the desired gradation.	8
Unit 4	Evaluation of various properties of pozzolanic materials, role of these properties, compatibility of super-plasticizer, and role of viscosity-modifying agents.	8
Unit 5	Durability, design of mixes for conventional concrete, high-strength concrete, high-performance concrete, and self-compacting concrete.	10
Total		**42**

REFERENCES		
S.N.	**Name of Book/ Author(s)/Publisher**	**Year of Publication / Reprint**
1.	Concrete Technology by A.M. Neville and J.J. Brooks, published by Pearson India Education Services Pvt. Ltd., Noida.	2010
2.	Concrete *Micro-structure, Properties & Materials* by P.K. Mehta & P.J.M. Monteiro and published by ICI, Chennai	1997
3.	Concrete Admixtures Handbook: *Properties, Science and Technology* by V.S. Ramchandran and published by Standard Publishers Distributors, Delhi.	2002
4.	Concrete Technology by M.L. Gambhir and published by McGraw Hill Education (India) Pvt. Ltd., New Delhi.	2014
5.	Concrete Technology Theory and Practice by M.S. Shetty, published by S. Chand & Company Ltd., New Delhi.	1992
6	IS: 456-2000, "Plain and Reinforced Concrete-Code of Practice", BIS, New Delhi. And, IS: 10262-2019, "Concrete Mix Proportioning – Guidelines (2^{nd} Revision)", BIS, New Delhi.	Latest

B. Tech. Civil Engineering/ Elective				
Course code: Course Title	**Course Structure.**			**Pre-Requisite**
CE 330: Geotechnical Processes	**L**	**T**	**P**	**Nil**
	3	**0**	**2**	
Course Objective: Students can solve field-based problems in the geotechnical process to implement the design of civil infrastructure projects.				

S. No	Course Outcomes (CO)
CO1	Understanding of the principles of ground conditions.
CO2	Exposure to prevalent techniques such as prefabricated vertical drains, stabilisation, chemical modifications, and hydraulic modification, including geosynthetics.
CO3	Proficiency in dynamic stabilization techniques suitable for wide applications.
CO4	Proficiency in ground modification by reinforcement techniques in various applications.
CO5	Students can solve field-based problems in the ground improvement-related process and implement them in the design projects.

S. No	Contents	Contact hours
Unit 1	Introduction: importance and history of ground improvement. Mechanical Modifications: properties of compacted soil, compaction control tests, field compaction, and applications. Precompression: technique, procedure, and applicants. Sand Drains: method, procedure, and applications.	8
Unit 2	Prefabricated vertical drains: method of installation and design. Soil Stabilisation: shallow stabilisation with additives- lime, fly ash cement, and other materials. Chemical modifications and Grouting. Hydraulic modification: dewatering systems, filtration, drainage, and seepage control with geosynthetics.	8
Unit 3	Vibroflotation technique, stone columns, sand compaction piles, dynamic compaction technique, ground freezing, and electro-osmosis.	8
Unit 4	Ground modification by soil reinforcement: reinforcement techniques, use of flexible geosynthetic reinforcement in bearing capacity improvement, slope stability, erosion control, retaining walls, and pavement.	8
Unit 5	Difficult soils: collapsible soils, physical parameters, and identification, collapse settlement, improvement techniques; expansive soils, general nature, swell test and swelling pressure tests, classification, improvement of expansive soils.	12
	Total	42

S.N.	Name of Books/ Authors	Year of Publication
1	Das, B.M. (2011). Principles of Foundation Engineering. Cengage Learning. (ISBN 0-07-525486-7.	2007
2	Koerner, R.M. (2012). Designing with Geosynthetics, Vol. 1&2. Xlibris Corporation. (ISBN 0-25—755246-7).	2007

B. Tech. Civil Engineering				
Course code: Course Title	**Course Structure,**			**Pre-Requisite**
CE 332: Transportation Geotechniques	**L**	**T**	**P**	**CE:206 Soil Mechanics; CE305: Transportation Engineering**
	3	**1**	**0**	

Course Objectives:

- To understand the geotechnical aspects of railway engineering, including track substructure, subgrade evaluation, and embankment design.
- To study the behaviour of railway subgrades under cyclic and dynamic loading.
- To analyse the settlement, stability, and drainage requirements in railway track foundations.
- To explore the use of geosynthetics in railway track design for reinforcement and filtration.
- To apply geotechnical engineering principles for the safe design and maintenance of railway embankments, tunnels, and bridges.

S. No.	Course Outcomes (COs)
CO1	To evaluate the geotechnical properties of railway track subgrades and their significance.
CO2	To analyse the dynamic loading effects on railway track foundation stability.
CO3	To design railway embankments considering settlement, drainage, and slope stability.
CO4	To study the role of geosynthetics in railway engineering for track reinforcement.
CO5	To assess track maintenance, rehabilitation, and stabilization techniques in railway geotechniques.

S. No.	Contents	Contact Hours
UNIT 1	Introduction to railway geotechniques, track substructure components (subgrade, ballast, formation), geotechnical properties of railway track materials, testing methods for railway subgrades.	7
UNIT 2	Dynamic behaviour of railway track subgrade, effect of cyclic loading, settlement and stability of railway track foundation, field and laboratory evaluation of track deformation characteristics.	7
UNIT 3	Design and construction of railway embankments, ground improvement techniques for weak subgrades, drainage and filtration requirements in railway track systems.	7
UNIT 4	Use of geosynthetics in railway track stabilization, functions of geotextiles and geogrids in railway foundation, design of reinforced track embankments and ballast layers.	7

UNIT 5	Railway track failures, maintenance and rehabilitation of railway subgrades, case studies on geotechnical challenges in railway infrastructure, emerging trends in railway track geotechniques.	6
TOTAL		**34**

References		
S. No.	**Name of Books/Authors/Publishers**	**Year of Publication / Reprint**
1	Satish Chandra & M.M. Agarwal (*Railway Engineering* (ISBN: 978-0198083535), Publisher: Oxford	2013
2	M. M. Agarwal, *Indian Railway Track 2nd Edition*, Publisher: Prabha & Co.	2018
3	S. C. Saxena & S. P. Arora, *A Textbook of Railway Engineering* (ISBN: 978-8189928834), Publisher: Dhanpat Rai	2010
4	J S Mundrey, *Railway Track Engineering, 4th Edition.* (ISBN: 9780070680128) Publication Date & Copyright: 2009. McGraw-Hill Education (India) Private Limited.	2009

B. Tech. Civil Engineering				
Course code: Course Title	**Course Structure. Credit=4**			**Pre-Requisite**
CE 334: Design of Hydraulic Structures	**L**	**T**	**P**	Nil
	3	**0**	**2**	
Course Objective: The objective of this course is to provide students with the comprehensive knowledge and skills necessary for the design, analysis, and evaluation of hydraulic structures. The course focuses on the principles, methodologies, and practical aspects of designing various hydraulic structures such as dams, spillways, weirs, and culverts, with an emphasis on safety, efficiency, and sustainability.				

S. No	Course Outcomes (CO)
CO1	Understanding of the fundamental principles and concepts involved in the design and functioning of various hydraulic structures, including the forces acting on these structures and the methods to analyse them.
CO2	Ability to design hydraulic structures such as dams, spillways, weirs, and culverts.
CO3	Safety assessments and risk analyses for hydraulic structures, understanding the potential hazards, failure modes, and designing structures to mitigate these risks effectively.
CO4	Proficient in using computational tools and software.
CO5	Enhance their project management skills, including planning, executing, and presenting design projects.

S. No	Contents	Contact Hours
Unit 1	Gravity dams: Design Criteria, forces acting on gravity dams, elementary profile, low and high gravity dams, stability analysis, evaluation of profile by method of zoning, practical profile, foundation treatment, construction joints, galleries in gravity dams.	12
Unit 2	Earth and Rock fill dams: Earth Dams: Types, causes of failure and design criteria, soils suitable for earth dam construction, construction methods, foundation requirements, typical earth dam sections, estimation of seepage through and below the dam, seepage control, stability of slopes by slip circle method of analysis, pore pressures, sudden drawdown, steady seepage and construction pore pressure condition. Rock fill dams: Types, merits and demerits, conditions favourable for their adoption.	7

Unit 3	Spillways: Ogee spillway and its design, details of syphon, shaft, chute, and side channel spillways, emergency spillways.	8
Unit 4	Energy dissipators and gates: Principles of energy dissipation. Energy dissipators based on tail water rating curve and jump height curves, Spillway crest gates - vertical lift and radial gates, their design principles and details. Design of canal regulating structures, Detailed design of Sarda Falls, design of cross drainage works, and syphon aqueduct.	10
Unit 5	Hydropower Plants: Introduction of Hydropower development, assessment of power potential, types of hydropower plants, general features of hydro-electric schemes, selection of turbines, draft tubes, surge tanks, penstocks, power house dimensions, development of micro hydel stations, tidal plants, pumped storage plants, and their details.	5
	Total	**42**

Suggested Books:

S. No.	Name of Books/ Authors	Year of Publication
1	Garg, S.K, "Irrigation Engineering and Hydraulic Structures", Khanna Publishers, New Delhi. (ISBN 0-07-06487-1).	2014
2	Modi , P.N., "Irrigation Water Resources and Water Power Engineering", Standard Book House, Delhi. (ISBN 0-07-078546-7).	1990
3	Asawa, G. L. "Irrigation and Water Resources Engineering", New Age International Publishers. (ISBN 0-07-795568-3).	1993
4	Sharma, R. K. and Sharma, T. K., "Water Power Engineering", S. Chand & Company, New Delhi	2003
5	Varshney, R.S., "Hydropower Structures", Nem Chand and Bros., Roorkee (U.P.),	2014
6	Deshmukh, M.M., "Water Power Engineering, Dhanpat Rai Publications", New Delhi,	1998

B. Tech. Civil Engineering				
Course code: Course Title	**Course Structure**			**Pre-Requisite**
CE336: Groundwater Hydrology	**L**	**T**	**P**	Nil
	3	**1**	**0**	
Course Objectives: The objective of this course is to provide students with a comprehensive understanding of the principles and practices of groundwater hydrology. The course aims to equip students with the skills necessary to analyse, model, and manage groundwater systems, addressing issues related to groundwater flow, contamination, and sustainable use.				

S. No	Course Outcomes (CO)
CO1	Develop a thorough understanding of the physical principles governing groundwater flow, including aquifer properties, Darcy's law, and the groundwater flow equations.
CO2	Proficiency in constructing and utilizing groundwater flow models using tools such as MODFLOW, enabling them to simulate and analyse groundwater flow under various conditions.
CO3	Learn to model contaminant transport in groundwater, understanding the processes of advection, dispersion, and chemical reactions, and develop strategies for groundwater contamination remediation.
CO4	Ability to design and implement sustainable groundwater management practices.
CO5	Enhance their research skills by investigating contemporary issues in groundwater hydrology.

S. No.	Contents	Contact Hours
UNIT 1	Introduction: Definition of groundwater, role of groundwater in the hydrological cycle, groundwater bearing formations, classification of aquifers, flow and storage characteristics of aquifers, Darcy's law, anisotropy, and heterogeneity.	8
UNIT 2	Wells and Well Hydraulics: Different types of wells, construction of wells, steady and unsteady state solutions for confined, unconfined, and leaky aquifers, effect of boundaries, Multiple Well Systems, Partially Penetrating Wells, Well for special Conditions, Characteristics of Well Losses, Specific Capacity.	10
UNIT 3	Surface investigation of groundwater: Geologic methods, Remote sensing, geophysical exploration, Electric resistivity Method, Seismic Refraction Method, Gravity and Magnetic Methods, Water Witching.	8

UNIT 4	Concept of Artificial Recharge of Groundwater, recharge methods, research on water spreading, Wastewater recharge for reuse, Recharge Mounds. Artificial Recharge on Long Island, New York, includes recharge, artificial Recharge for Energy purposes.	8
UNIT 5	Groundwater Flow Modelling: Porous media models, Analog models, Electric Analog Models, and Digital computer models.	8
	Total	**42**

REFERENCES

S. No.	**Name of Books/Authors/Publishers**	**Year of Publication / Reprint**
1	Todd, D.K., "Groundwater Hydrology", John Wiley.	1959
2	Bear, J., "Hydraulics of Groundwater", McGraw-Hill.	1979
3	Bouwer, H., "Groundwater Hydrology", McGraw-Hill.	1978
4	Walton, W.C., "Groundwater Resources Evaluation", McGraw-Hill.	1970

B. Tech Civil Engineering				
Course code: Course Title	**Course Structure**			**Pre-Requisite**
CE338: Advanced Transportation Engineering	L	T	P	**CE305: Transportation Engineering**
	3	1	0	

Course Objective: This course aims to expose the students to advanced topics of transportation engineering: the process of transportation planning, urban transport technology, aspects of transport economics and financing, and guidelines for pavement design and maintenance.

S. No.	**Course Outcomes (CO)**
CO1	To expose students to carry out various planning studies for travel demand estimation.
CO2	To expose students to the features of different modes of urban transportation and urban infrastructure.
CO3	To expose students to various aspects of transportation economics and finance.
CO4	To equip students with the knowledge of pavement design.
CO5	To expose students to identify pavement defects and their rectification methods.

S. No	**Contents**	**Contact Hours**
UNIT 1	Transportation system planning: transportation policy, types of surveys, OD matrix, travel demand forecasting process, trip generation, modal split analysis, trip distribution, trip assignment.	10
UNIT 2	Urban transport technology: mass and rapid transit system, introduction to intelligent transportation system (ITS), public transport policy, intermediate transport modes. Introduction to BRT, Mono rail, sky bus, metro. Grade separated interchanges such as flyovers, under passes, overpasses, concept of integrated inter model transit system.	10
UNIT 3	Transport economics: vehicle operations cost, running cost, pollution cost, value of travel time, road damage cost, congestion cost, accident cost. Highway financing: pay as you go method, credit financing, private financing, BOT, BOOT, dedicated road funds, road pricing, tolls, advantages and limitations.	10
UNIT 4	Criteria of pavement design, comparison of flexible and rigid pavement, study of distress in pavements, Design of flexible and rigid pavement as per guidelines.	10

REFERENCES

S. No	**Name of Books/ Authors/ Publishers**	**Year of**

		Publication/ Reprint
1.	Khanna, S.K., Justo, C.E.G., and Veeraragavan A. "Highway Engineering", Nem Chand & Bros., Roorkee, U.K	2014
2.	Kadiyali, L. R., "Traffic Engineering and Transportation Planning", Khanna Publishers, New Delhi	2018
3.	Sharma, S.K., "Principles, Practice and Design of Highway Engineering including Airport Pavements," S. Chand and Company, New Delhi	2012
4.	Khanna S.K., Arora M.G. and Jain S.S., "Airport Planning and Design", Nem Chand & Bros., Roorkee, U.K	2022

B. Tech Civil Engineering				
Course code: Course Title	**Course Structure**			**Pre-Requisite**
CE340: Solid Waste Management and Air Pollution	L	T	P	NIL
	3	0	2	

Course Objective: This course focuses on the classification and characterisation of solid waste, including waste estimation, collection, transportation, processing, and disposal methods such as engineered landfilling and deep-well injection. It also explores strategies for waste reduction, material reuse, and energy recovery. The course also covers air quality characteristics, national standards, pollutant classification, and the impacts of key pollutants on health, plants, and buildings. It introduces meteorological principles, dispersion mechanisms, and enables the computation of ambient air quality. It also explores the engineered system for air pollution control, including control devices for particulate and gaseous pollutants.

S. No.	**Course Outcomes (CO)**
CO1	To provide an overview of the sources, classification, and characteristics of solid waste and air pollutants.
CO2	To develop solid waste collection and transportation plans based on waste generation patterns and urban planning principles.
CO3	To decide appropriate processing technologies, such as composting, incineration, and landfilling, for a typical solid waste management facility.
CO4	To assess pollution spread in the ambient air based on the pollution inventory and the dispersion model.
CO5	To plan integrated solutions for environmental sustainability based on pollution control technologies and regulatory frameworks for both air pollution and solid waste management.
CO6	To develop a material and energy recovery plan for promoting sustainable reuse and circular economy principles.

S. No	**Contents**	**Contact Hours**
UNIT 1	**Definition, Characteristics, and Perspectives:** Types of solid wastes; municipal, Industrial, and Hazardous waste. Sources of municipal waste, physical and chemical composition. Reduction in raw materials usage, reduction in solid waste quantities, reuse of solid waste materials, material recovery, and energy recovery.	**6**
	Engineered System for Solid Waste Management: functional elements, typical generation rates of solid waste, estimation of solid waste quantity, factors affecting generation rates, On-Site handling, storage, and processing of solid waste.	

UNIT 2	Types of collection systems, determination of vehicles and labor requirements, collection routes, transfer stations and their siting factors, mechanical volume reduction, and thermal volume reduction techniques. Landfilling: design and operation of landfills. Deep-well injection technique of waste disposal	**8**
UNIT 3	**Engineered Systems for Resource and Energy Recovery:** Processing techniques; mechanical size reduction, component separation, magnetic and electromechanical separation, and drying and dewatering. Materials and energy recovery; composting, anaerobic digestion, combustion, incineration, gasification, and pyrolysis.	**7**
UNIT 4	**Air Quality:** Definition, characteristics and perspectives of air quality. Historical air pollution episodes, units of measurement, sources and classification of pollutants, primary and secondary pollutants, particulates, PM_{10}, $PM_{2.5}$ and their significance, health effects of particulates accompanied with other pollutants. Detection, analysis and effects of air pollutants (Hydrocarbons, CO, oxides of Sulphur and nitrogen) on human health, plant and building materials. National ambient air quality standards. Indoor air pollution.	**6**
UNIT 5	**Meteorology and Natural Purification Processes:** atmospheric properties, scales of motion, influence of meteorological phenomenon on air quality, Lapse rates and dispersion, pressure systems and dispersion, wind and dispersion, moisture and dispersion, Gaussian dispersion modeling, determination of stack height.	**7**
UNIT 6	**Engineered Systems for Air Pollution Control:** Atmospheric cleansing processes, and control at source approach. Control devices for particulate contaminants; gravitational settling chambers, centrifugal collectors, wet collectors, fabric filters (baghouse filters), and electrostatic precipitators (ESP). Control devices for gaseous contaminants, and automotive emission control.	**8**
Total		**42**

REFERENCES

S. No	Name of Books/ Authors/ Publishers	Year of Publication
1.	Peavy, Howard S., Rowe, Donald R., and Tchobanoglous, George, "Environmental Engineering," McGraw-Hill Education (India) Pvt. Ltd., New Delhi.	1985
2.	CPHEEO manual on Municipal Solid Waste Management, Ministry of Urban Development, New Delhi.	2016
3.	Rao, C.S., "Environmental Pollution and Control Engineering", New Age International publishers.	2006

B. Tech. Civil Engineering				
Course code: Course Title	**Course Structure. Credit=4**			**Pre-Requisite**
CE 342: Experimental Mechanics	L	T	P	CE104: Mechanics of solids
	3	0	2	

Course Objective: Fostering students' competence in experimental mechanics suitable for research, industrial, defence, and space applications.

S. No	Course Outcomes (CO)
CO1	Introduction to Basic Theory of Elasticity.
CO2	Introduction to Full-field method using Photoelasticity (2D and 3D) for both static and dynamic stress analysis, including Digital Photoelasticity.
CO3	Introduction to the Full-field method using Moire method of stress analysis and the DIC (Digital Image Correlation) method.
CO4	Introduction to Point-wise application of Electrical resistance Strain Gauge, Piezo-Electric, Photo-Electric method, and apply to develop transducers for various research, Industrial, Defence, and Space applications. Application of AI & ML in strain assessment.
CO5	Students are able to design and analyse data for Research, Industrial, Defence, and Space applications.

S. No	Contents	Contact hours
UNIT 1	Introduction to the Theory of Elasticity, Concept of Stress and Strain Tensor, Transformation equations in 2D and 3D stress and Strain analysis. Dynamic Stress Analysis.	8
UNIT 2	Introduction to Nature of Light, Wave Plate, Plane Polariscope, Circular Polariscope. Effect of the stressed photoelastic model on Plane Polariscope, Circular Polariscope. Determination of Isoclinics on a Circular Disc. Determination of Isochromatics on a Circular disc subjected to diametrical compression. Separation of Principal stresses. Determination of Material fringe value using monochromatic light. Casting of the photoelastic sheet using Araldite (CY-230) and Hardener (HY-951). Application on the model beam of photoelastic material subjected to concentrated loads (3- 3-point and 4-point loadings). Application to 2D and 3D stress analysis and use of Digital Photoelasticity.	10
UNIT 3	Introduction to Moiré methods and shape determination. Moiré methods using electronic grating. Moiré methods using Laser Interferometer for in-plane and out-of-plane strain determination. Introduction to Digital Image Correlation (DIC) method and application to Research, Industrial, Defence, and Space problems. Full-field stress analysis Method of brittle coating.	8

UNIT 4	Introduction to Point-wise application of Electrical resistance Strain Gauge, Piezoelectric, Photo-Electric method, and apply to develop transducers for various research, Industrial, Defence, and Space applications.	8
UNIT 5	Point-wise Static and Dynamic Stress analysis using Electrical resistance strain gauges. Application of AI & ML in strain assessment. Application to research, industrial, Defence, and Space problems. Strain measurement using piezo sensors, fiber-optic sensors, etc.	8
	TOTAL	**42**

REFERENCES		
S. No.	**Name of Books/Authors/Publishers**	**Year of Publication / Reprint**
1	Dally and Riley, "Experimental stress analysis," McGraw-Hill.	2021
2	Handbook of Stress Analysis, SEM publication.	2021
3	Engineering Mechanics, Timoshenko, Young, and Rao. TMH books.	2017
4	K. Ramesh: Special Issue OLEN: Developments in Photoelasticity and Diverse Applications.	2025
5	K. Ramesh: New Book: Developments in Photoelasticity - A Renaissance.	2024
6	Instrumentation, Measurement and Analysis by B. C. Nakra and K. K. Chaudhary, Tata McGraw-Hill.	1985
7	Experimental Methods for Engineers by J P Holman and W J Gajda, McGraw-Hill Co.	1978

B. Tech. Civil Engineering				
Course code: Course Title	**Course Structure. Credit=4**			**Pre-Requisite**
CE 344: Building Materials, Masonry, Prestressing, and Construction Management	**L**	**T**	**P**	**CE203: Design of Structures-I**
	3	**0**	**2**	

Course Objective: Fostering students' competence in the use of different building materials, including masonry, prestressed concrete, and management of construction practices.

S. No	Course Outcomes (CO)
CO1	Introduction to the common building materials for civil infrastructure.
CO2	Proficiency for the design of special concrete structures**.**
CO3	Proficiency for the design of prestressed concrete structures.
CO4	Proficiency for the design of masonry and other materials of construction.
CO5	Students are able to implement knowledge of construction practices, planning and management in field works.

S. No	Contents	Contact hours
UNIT 1	**Building Materials**: Stone, Lime, Glass, Plastics, Steel, FRP, Ceramics, Aluminium, Fly Ash, Basic Admixtures, Timber, Bricks and Aggregates: Classification, properties and selection criteria; Cement: Types, Composition, Properties, Uses, Specifications and various Tests; Lime & Cement Mortars and Concrete: Properties and various Tests; Design of Concrete Mixes: Proportioning of aggregates and methods of mix design.	8
UNIT 2	**Design of Special Concrete Structures:** Design of Staircases; Counterfort-type retaining walls. Water tanks: Design requirements for Rectangular and circular tanks resting on the ground. Principles of earthquake-resistant design of structures.	6
UNIT 3	**Prestressed concrete**: Principles of pre-stressed concrete design including materials and methods; Methods and systems of prestressing, anchorages, Analysis and design of sections for flexure based on working stress, loss of prestress.	10
UNIT 4	**Masonry and other materials**: Specific use of materials like Ferro cement, fibre reinforced concrete, and timber construction. Masonry principles and construction detailing, Types of plastering, pointing, flooring, roofing, and common repairs, Functional planning of buildings and Building code provisions, Design of Masonry Structure as per I.S. Codes.	8

UNIT 5	**Construction Practices, Planning and Management**: Construction - Planning, Equipment, Site investigation and Management including Estimation with latest project management tools and network analysis for different Types of works; Analysis of Rates of various types of works; Tendering Process and Contract Management, Quality Control, Productivity, Operation Cost; Land acquisition; Labour safety and welfare. Construction activity schedules and organization, Quality assurance principles. Basic principles of network analysis (CPM and PERT), Economic analysis and methods, Project profitability and financial planning.	10
	TOTAL	**42**

- - - - - - -

REFERENCES

S. No.	Name of Books/Authors/Publishers	Year of Publication / Reprint
1	Prestressed Concrete. N. Krishna Raju, McGraw-Hill Co.	2018
2	Prestressed Concrete Structures, Dayaratnam Pasala, Oxford and I B H Publishing Co	2015
3	Design Of Masonry Structures, A.W. Hendry, B.P. Sinha, and S.R. Davies. Routledge- Informa UK Limited.	2004
4	Review of Design Codes for Masonry Buildings, Document No. :: IITK-GSDMA-EQ10-V1.0, Dr. Durgesh C Rai, IIT Kanpur	2010
5	Punmia B. C., and Khandelwal K. K., "PERT and CPM", Laxmi Publications, New Delhi. (ISBN 0-07-23998904-1)	1999
6	R. L. Peurify, Construction Planning: Equipment and Methods, Tata McGraw-Hill, Inc. (ISBN 0-07-0476158-7	2000
7	Satyanarayanan & Saxena, Construction Planning and Equipment, Standard Publishers Distributors, New Delhi. (ISBN 0-01-257859-8)	1998
8	Advanced Reinforced Concrete Design, Varghese, P. C., Phi Learning.	2016
9	Design of Reinforced Concrete Structures, N. Subramanian, Oxford and IBH Publishing Co.	2013

B. Tech. Civil Engineering				
Course code: Course Title	**Course Structure.**			**Pre-Requisite**
CE406: Pre-stressed Concrete Structures	**L**	**T**	**P**	CE203: Design of Structures-I
	3	1	0	

Course Objective: To equip students for analysing, designing prestressed concrete structures**.**

S. No	Course Outcomes (CO)
CO1	Understand the principles and necessity of prestressing in concrete structures. Analyse different prestressing systems and materials.
CO2	Learn the design methodologies for prestressed concrete beams, slabs, and other structural elements.
CO3	Study losses in prestress and deflection considerations.
CO4	Examine the behaviour of prestressed structures under various loading conditions.
CO5	Gain exposure to real-world applications in bridges, buildings, and special structures.

S. No	Contents	Contact hours
UNIT 1	**Introduction:** Design of simply-supported beams, slabs, and bridges, Concept of prestressing: Need and advantages, Comparison between Reinforced Concrete (RC) and Prestressed Concrete (PC), Historical background and development, Applications of prestressed concrete in infrastructure.	6
UNIT 2	**Materials & Prestressing Systems:** High-strength concrete and high-tensile steel, Pre-tensioning vs. post-tensioning, requirement of minimum grade of concrete. Prestressing systems, Anchorage devices, jacking equipment, and prestressing cables.	6
UNIT 3	**Analysis of Prestressed Concrete Members:** Stress calculations at transfer and service loads, Load balancing method, stress concept method, and strength concept method. Pressure line and thrust line concepts.	8
UNIT 4	**Losses of Prestress:** Types of losses: Elastic shortening, creep, shrinkage, friction, relaxation of steel, anchorage slip, Calculation of short-term and long-term losses, Methods to minimize prestress losses	6
UNIT 5	**Design of Prestressed Concrete Sections:** Flexural design of beams, Limit state design: Serviceability and ultimate strength, IS Code provisions (IS:1343), Shear and torsion in prestressed concrete. Design of simply supported beams, slabs, and bridges. **Deflections and Cracking:** Short-term and long-term deflections, Factors affecting deflections, Control of cracking in prestressed	10

	concrete, Design considerations for deflection control.	
UNIT 6	**Special Topics and Applications:** Prestressed concrete in bridge structures, Prestressed concrete in tall buildings, Segmental construction and precast prestressed elements, Prestressed concrete tanks and pavements, Case studies of failure and durability concerns.	6
	TOTAL	**42**

REFERENCES		
S. No.	**Name of Books/Authors/Publishers**	**Year of Publication / Reprint**
1	Prestressed concrete. Krishna Raju N., Tata McGraw-Hill Company, New Delhi.	2007
2	Prestressed concrete, Mallik S.K. and Gupta A.P., Oxford and IBH.	1987
3	Design of Prestressed Concrete Structures, Lin T .Y and Burns N.H, John Wiley and Sons.	1982
4	Fundamentals of Prestressed Concrete, Sinha N.C and Roy S.K., S. Chand and Co., New Delhi.	1985
5	Prestressed Concrete. R. Rajagopalan	2010
6	IS: 1343 Code of Practice Prestressed Concrete.	2012

B. Tech. Civil Engineering				
Course code: Course Title	**Course Structure.**			**Pre-Requisite**
CE 407: Introduction to Building Information Modelling (BIM)	L	T	P	Nil
	3	0	2	

Course Objective: Fostering students' competence in the use of modern tools of Building Information Modelling, including software usage towards engineering, construction & operation projects of infrastructures.

S. No	Course Outcomes (CO)
CO1	Introduction to the concept of Building Information Modelling.
CO2	To understand the workflow followed in the industry during the creation of a BIM 3D Model using Revit.
CO3	Proficiency for creating BIM models and Asset Information Model (AIM).
CO4	Proficiency in the application of the BIM model.
CO5	Students are able to implement BIM and digital solutions in engineering and construction projects.

S. No	Contents	Contact hours
UNIT 1	**Introduction to BIM Concepts and Design:** Engineering from 2D drawings to BIM Model, Isometric View, concept of 3D-Modeling, Design Authoring – Concepts and workflow, stages of BIM Modelling process as per ISO 19650, Federated model- concepts and demonstrations, workflow of design coordination, Engineering Analysis – Concept and types of analysis, Process and workflow of Design Review in BIM, exposure to software, Revit.	8
UNIT 2	**Visualization and Interference/Clash check:** Views in BIM Model, Modes, Walkthrough, Fly through the model, Layers & Properties, viewpoints, Sectioning and Visualization through Tablet and Mobile, BIM Kiosk & BIM Rooms, Visualization through Augment Reality (AR), Virtual Reality (VR) & Mixed Reality (MR). Clash Check – Types, Clash avoidance/ detection process, Clash Detection Priority Matrix and Report generation.	6
UNIT 3	**Documentation & CDE & Level of Development**. Documentation and CDE (Common Data Environment) -2D drawings generation from BIM Model, Computer Network types, Concept of Cloud Computing, Setting up the workflow and process for CDE- Request for Information and Review Process. Concept of LOD (Level of Development), Progression matrix- Level of Detail and Information, LOD- Wall foundation, Precast Structural Inverted T-Beam, Domestic Water Piping, Plumbing Fixture, Packaged Generator Assembly.	10

UNIT 4	**4D / Field BIM & Its Applications**. Introduction, construction sequence and project schedule, using Gantt Chart and its limitations, Modelling- Project demo and workflow, Synchronization with project schedule. Reviewing project progress, Generation of Reports. Application of Field BIM/ 4D BIM: for coordination- 3D Coordination and Visual Communication, Site utilization planning and Construction analysis, wearables in coordination. 3D Control and planning. Other Applications: for safety, disaster and risk analysis, digital fabrication and scan to BIM, Condition Modelling, Phase Planning, As-built/ Record Models	8
UNIT 5	**5D BIM, AIM & Beyond BIM - Emerging Trends:** Concepts of 5D BIM, UoM, QTO with UoM, QTO for Wall, Plaster & Tile, BIM Maturity LOD, Cost Breakup structures, cost control. AIM: Introduction to Asset Information Model (AIM), COBie structures and Asset Information Deliverables, Space Attributes and Asset Attributes- Examples. Discipline-wise Infrastructure System, Classification code, and Information Exchange, Information Exchange with Facility Management. Beyond BIM: Industrialisation, IoT, Big Data, Data Analytics and applications in BIM: Data Analytics using AI & ML. Smart Infrastructure and connected infrastructure, Digital twins- Concepts and benefits, National Digital Twin policy, in a Smart City, Digital Twin applications in diverse industries.	10
	TOTAL	**42**

REFERENCES

S. No.	Name of Books/Authors/Publishers	Year of Publication / Reprint
1	Building Information Modelling (BIM) in Design, Construction and Operations IV. WIT Transactions on The Built Environment	2021
2	Building Information Modelling: Global & Indian Perspective, Harshul Savla, Chandrahauns Chavan, Pallavi Patil.	2021
3	ISO 19650-1:2018 Organization and digitization of information about buildings and civil engineering works, including building information modelling (BIM) — Information management using building information modelling, Part 1: Concepts and principles.	2018/ 2024
4	Building Information Management. A Standard Framework and Guide to BS 1192.	2007
5	BIM Handbook: A Guide to Building Information Modelling for Owners, Designers, Engineers, Contractors, and Facility Managers, Rafael Sacks, Charles Eastman, Ghang Lee, Paul Teicholz, Wiley Co.	2018
6	Building Information Modelling- BIM, Ngibjörg Birna Kjartansdóttir et al., Erasmus, Construction Managers Library.	2017

B. Tech. Civil Engineering				
Course code: Course Title	**Course Structure**			**Pre-Requisite**
CE408: Retrofitting of Structures	**L**	**T**	**P**	
	3	**1**	**0**	

Course Objective: This subject imparts a broad knowledge in the area of repair and rehabilitation of Structures.

S. No	**Course Outcomes (CO)**
CO1	Evaluate/ assess the existing buildings through field investigations and RVS, and conduct a Preliminary forensic assessment of existing or damaged structures through NDT.
CO2	Understand the different techniques for structural retrofitting at the local and global level.
CO3	Analyse the deficiency in the existing building and recommend the type of strengthening techniques for RCC structures.
CO4	Able to understand the process of adding new components in structures for retrofitting.
CO5	Analyse the energy dissipation involved in the retrofitting of structures.
S. No	**Contents**
UNIT 1	Introduction: Terminology; Basic principles of seismic evaluation and retrofitting. Qualitative Methods of Seismic Evaluation: Rapid visual screening procedure (RVSP) and simplified evaluation of buildings; Visual inspection method and non-destructive testing (NDT) method.
UNIT 2	Quantitative Methods of Seismic Evaluation: Performance based method using nonlinear static push-over analysis (NSP) and non-linear dynamic method of analysis (NDP); Estimation of seismic capacity (strength and ductility).
UNIT 3	Local and Global Methods of Seismic Retrofitting of RC Buildings: System completion; Strengthening of existing components; RC, Steel and FRP Jacketing;
UNIT 4	Addition of new components – frames, shear walls and braced frames; Design of connections for retrofitting of structures.
UNIT 5	Introduction to supplemental energy dissipation and base isolation.

REFERENCES

S. No.	**Name of Books/Authors/Publishers**	**Year of Publication / Reprint**
1	Agarwal, Pankaj, Shrikhande, Manish. (2006), "Earthquake Resistant Design of Structures"- Prentice–Hall India.	2006
2	Duggal, S.K. (2007)., "Earthquake Resistant Design of Structures"- Oxford University Press.	2007

3	Priestley, M. N., Seible, F., & Calvi, G. M. (1996). Seismic design and retrofit of bridges"- John Wiley & Sons.	1996
4	Seismic Evaluation and retrofit of concrete building" – Vol. I & II"- Applied Technology Council, California, ATC 40. (1996)	1996
5	Rapid Visual Screening of Buildings for Potential Seismic Hazards, Federal Emergency Management Agency, Building Seismic Safety Council, Washington, D.C., FEMA 154/155. (2002)	2002
6	FEMA-356. "Commentary for the Seismic Rehabilitation of Buildings," Federal Emergency Management Agency, Washington, DC. (2000)	2000
7	FEMA, P-695. "Quantification of Building Seismic Performance Factors"- Federal Emergency Management Agency. (2009)	2009
8	FEMA-440, A., "Improvement of nonlinear static seismic analysis procedures"- . FEMA-440, Redwood City. (2005)	2005
9	A Primer on Rapid Visual Screening (RVS) Consolidating Earthquake Safety Assessment Efforts in India by National Disaster Management Authority (2020)	2020

B. Tech. Civil Engineering				
Course code: Course Title	**Course Structure. Credit=4**			**Pre-Requisite**
CE 409: Design of Bridges	**L**	**T**	**P**	**CE203: Design of Structures-I**
	3	**1**	**0**	

Course Objective: To equip students with skills to design and manage the bridge stocks.

S. No	Course Outcomes (CO)
CO1	Introduction to the bridge system and components; the collection of data for the design.
CO2	Exposure to loading and other parameters required for the design of bridge structures**.**
CO3	Proficiency in the design of superstructures using various approaches.
CO4	Proficiency in the design of substructures using various approaches.
CO5	Proficiency in the design of various appurtenances, bearings, expansion joints, etc.
CO6	Development of systems to maintain and manage the bridges with exposure to state-of-the-art knowledge in the domain of Bridge Management Systems.

S. No	Contents	Contact hours
UNIT 1	Introduction, components of bridges, classification of bridges, related structures, classical examples of various types of bridges. Selection of site and initial decision process, survey and alignment, geotechnical investigations, collection of bridge design data, hydrological calculations, waterway calculations, scour, depth of foundation, freeboard considerations, vertical clearance.	8
UNIT 2	Standard loadings for bridge design as per different codes of practice, IRC, BS and AASHTO codes, various types of loads considered for design of bridges, impact factor, centrifugal force, wind and seismic considerations, width and roadway considerations, influence lines, load combinations, limit and working stress design considerations, pre-design considerations, roadway vs. railway bridges.	8
UNIT 3	Superstructure of bridge: selection of main bridge parameters, design methodologies, choice of superstructure type, load distribution in various types of superstructures, RCC and PSC superstructures, longitudinal analysis of bridges, transverse analysis of bridge, temperature analysis, effect of differential movements of supports, reinforced earth structures, box girder bridges.	8

UNIT 4	Substructure of bridge: pier, abutment, wing walls, importance of substructure soil interaction, open foundation, pile foundation, well foundation, simply supported and continuous bridges.	8
UNIT 5	Appurtenances, Bearings and deck joints: types of bearings, expansion joints, design of bearings and joints, parapets and railings for highway bridges, definitions, classifications of bridge parapets, related details.	6
UNIT 6	Bridge inspection, maintenance and management strategies, lessons learned from failure of bridges, life extension and lifecycle analysis with case studies.	4
	TOTAL	**42**

REFERENCES

S. No.	**Name of Books/Authors/Publishers**	**Year of Publication / Reprint**
1	M.J. Ryall, Parke G.A.R. and Harding J.E.,' The manual of bridge engineering', Thomas Telford Publishers ASIN 8000Q91ZDY.	1997
2	Raina V.K., 'Concrete bridge practice – analysis, design and economics, Tata McGraw-Hill Publishing Company Ltd. (ISBN 8184043783).	2002
3	Ponnuswamy S., 'Bridge engineering', Tata McGraw-Hill Publishing Company Ltd. ISBN: 9780070656956.	2000
4	Essentials of Bridge Engineering, 6th Edition, by D.J. Victor. CBS Publishers.	2018
5	IRC:5. Standard Specifications and Code of Practice for Road Bridges. Section I- General Features of Design.	2015
6	IRC:6 Standard Specifications and Code of Practice for Road Bridges Section II. Loads and Load Combinations.	2017
7	IRC: 112 Code of Practice for Concrete Road Bridges.	2011

B. Tech. Civil Engineering				
Course code: Course Title	**Course Structure.**			**Pre-Requisite**
CE410: Advanced Geotechnical Engineering	**L**	**T**	**P**	**CE 301 Geotechnical Engineering**
	3	**0**	**2**	

Course Objective: To familiarize the students with modern and advanced concepts of Geotechnical Engineering and its related applications in Civil Engineering.

S. No	Course Outcomes (CO)
CO1	Application of knowledge and practical skills in soil exploration techniques, in-situ testing, reliability-based site characterization, and microstructural soil analysis for geotechnical engineering.
CO2	Knowledge of innovative ground improvement techniques, sustainable geotechnical practices, and eco-friendly materials, waste utilization, and sustainability assessment in foundation design.
CO3	Identify, formulate, and analyse the retaining structure substantiated and concluded using the engineering knowledge
CO4	Advancements in geotechnical engineering, AI, and geosynthetics with embedded sensor technologies.
CO5	Provide an in-depth understanding of advanced foundation engineering, including load transfer mechanisms, foundation behaviour under complex conditions, non-destructive testing techniques, and numerical modelling for accurate performance prediction

S. No	Contents	Contact hours
UNIT 1	**Introduction:** Soil Exploration & Site Characterization; Geophysical methods: seismic refraction, electrical resistivity; Soil microstructure analysis: Scanning Electron Microscopy, X-Ray Diffraction	8
UNIT 2	**Ground Improvement:** Microbially induced calcite precipitation, biopolymers, geosynthetics, and soil stablisation; vacuum preloading, thermal ground modification, electro-osmosis and energy geotechniques; fly ash, industrial by-products for sustainable soil stabilization; harnessing microbially induced calcite precipitates to use in improving the engineering properties of loose sandy soils	8
UNIT 3	**Earth Pressure Theories & Retaining Structures:** Introduction, determination of lateral earth pressure at rest; retaining structures under active and passive earth pressure; deformation necessary for dynamic elastic and plastic conditions, Mononobe-Okabe solution, plastic flow and stress distribution, vibration control of flexible retention systems.	8

UNIT 4	**Sensors in Geotechnical Engineering:** Geotechnical Infrastructure: Adaptive designs for rural and urban areas with locally available geomaterials; sustainable geotechnical construction materials and methodologies; utilization of AI in geotechnical Engineering, including machine learning and image processing; sensors in geostructures; influence of frequency on piezo-dynamics of confined geomaterials.	8
UNIT 5	**Foundations:** Load transfer in foundations: elastic and plastic soil-foundation interaction models; pile foundations under cyclic loading, scouring effects, offshore and marine pile behaviour; Numerical analysis of shallow and deep foundation; heavy axle loads on mining roads; Pile groups subjected to axial and torsional loads in flow-controlled geomaterial.	10
	TOTAL	**42**

List of experiments:

1. To determine shear strength parameters of soil using unconfined compressive shear test.
2. To obtain load-displacement curves for dynamic loads using digital vibration meter
3. To obtain stress-strain plot for soil subjected to dynamic load using piezo-sensors.
4. To determine acceleration-velocity-displacement profile of a geomaterial
5. To determine the dynamic response of foundations using block vibration test
6. Numerical simulation of retaining wall for active and passive earth pressure
7. Numerical simulation of shallow & deep foundations

References

S. No.	**Name of Books/Authors/Publishers**	**Year of Publication / Reprint**
1	Foundation analysis and design by J.E. Bowles, published by McGraw-Hill.	1982
2	Fundamentals of Soil Dynamics by B M Das, Published by Elsevier Science Ltd.	1982
3	Introduction to Geosynthetic Engineering by S.K. Shukla, published by CRC Press.	2016
4	Analysis and Design of Foundations and Retaining Structures Subjected to Seismic Loads by Swami Saran, published by Dreamtech Pres.s	2020

B. Tech. Structural Engineering				
Course code: Course Title	**Course Structure**			**Pre-Requisite**
CE411: Forensic Engineering	**L**	**T**	**P**	**Nil**
	3	**1**	**0**	

Course Objective: The proposed course is expected to enhance and strengthen the knowledge on role and responsibility of a forensic engineer, different cause of deterioration in structures and its prevention, the uses of different NDT equipment's, awareness regarding the structural health monitoring, knowledge in Different modern techniques of retrofitting will be discussed.

S. No	Course Outcomes (CO)
CO1	Enable to conduct thorough investigations, adhere to global standards, and contribute to the advancement of safe and resilient structural systems.
CO2	A comprehensive understanding of the causes and consequences of structural failures, the importance of accountability, and the strategies to prevent and address such failures in engineering practice.
CO3	Equipped with the knowledge and skills to diagnose and assess structural distress effectively, utilizing a range of inspection and testing techniques.
CO4	Equipped with the knowledge and skills to design, assess, and strengthen buildings to ensure their durability, safety, and resilience in the face of environmental and natural hazards.
CO5	Equipped with the knowledge and skills to effectively repair, retrofit, and maintain structural components using modern techniques and materials.

S. No	Contents	Contact Hours
UNIT 1	An Introduction to Forensic Structural, Standards and Codes & Practices in FSE (Understanding various codes, standards, applicable practices and ethics involved in various parts of the globe on Forensic Structural Engineering), The Process of Forensic Investigation: Basic steps in a forensic investigation, Presentation of "Life cycle" and "Pathology Base" Approaches as investigation techniques.	8
UNIT 2	Engineering Failure of Structures: Review of the construction theory – performance problems – responsibility and accountability – case studies (Failure of Bridges, Fire Damaged Structures, Pre-cast segmental construction, Geotechnical Failures, Tunnel Collapse) – learning from failures – causes of distress in structural members – design and material deficiencies – over-loading.	8
UNIT 3	Diagnosis and Assessment of Distress: Visual inspection – non-destructive tests, crack detection techniques – case studies – single and multistorey buildings – Fibre optic method for prediction of structural weakness.	8

UNIT 4	Environmental Problems and Natural Hazards: Effect of corrosive, chemical and marine environment – pollution and carbonation problems – durability of RCC structures – damage due to earthquakes and strengthening of buildings – provisions of BIS 1893 and 4326.	8
UNIT 5	Methods of repair in concrete, steel and timber structural components.- Modern Techniques of Retrofitting: Structural first aid after a disaster – guniting, jacketing – use of chemicals in repair – application of polymers – ferrocement and fiber concretes as rehabilitation materials – strengthening by pre-stressing – case studies.- Maintenance – inspection and planning, budgeting, and management.	10
	Total	**42**

REFERENCES

S. No.	**Name of Books/Authors/Publishers**	**Year of Publication / Reprint**
1	Design and Construction Failures, Dovkaminetzky, Galgotia Publication, New Delhi, 2009.	2009
2	Concrete – Building Pathology, Macdonald S, John Wiley and Sons, 2002.	2002
3	Forensic Structural Engineering Handbook, Robert. T Ratay, Mc Graw Hill, 2009.	2009
4	Understanding Building Failures, James Douglas and Bill Ransom, Taylor and Francis Group, 2007.	2007
5	Concrete Repair and Maintenance, Peter H Emmons, Galgotia Publications, 2010.	2010

B. Tech. Civil Engineering				
Course code: Course Title	**Course Structure**		**Pre-Requisite**	
CE 412: Climate Change and Sustainable Development	**L**	**T**	**P**	Nil
	3	1	0	

Course Objective: To familiarise students with the concept of sustainability in view of climate change

S. No	Course Outcomes (CO)
CO1	Introduction to importance of climate
CO2	Understanding fundamental concepts of climate and its implications to environment
CO3	
CO4	Familiarisation with sustainable development and practices

S. No	Contents	Contact hours
UNIT 1	Climate systems: Overview, climate change and variability and indicators; Earth atmosphere- structure, composition, interactions; biogeochemical cycles; radiative budget; Indian Summer Monsoon- clouds, precipitation, storms; Essential Climate Variables (ECV); National Information System for Climate and Environmental Studies (NICES)	8
UNIT 2	Climate change and modelling: Global warming- Causes, GHGs, RCPs; Policies- IPCC and ither initiatives; climate models- energy balance, radiation, GCM	6
UNIT 3	Climate change impact on Natural resources: Impact assessment on agriculture, and crop systems; drought; impact assessment on biodiversity, forest fires and species migration; carbon sequestration; geomorphological hazards; cryosphere impacts	10
UNIT 4	Sustainable Development and Policies: SDGs and reliance; SDGs with specific targets for Climate action; Target achievements in relation to RCPs; international climate policies- IPCC, Kyoto, UNFCC, Paris agreement	8
UNIT 5	Renewable energy and climate mitigation- solar and wind and hydro energy systems; energy efficiency; green infrastructure; bioenergy and biofuels; carbon capture utilisation and storage (CCUS)	4
UNIT 6	Climate resilient cities and sustainable development- smart cities and low carbon urban development; sustainable transportation; waste management and circular economy; green infrastructure and nature-; urban microclimate studies; based solutions; urban temperature and urban precipitation issues	6
	TOTAL	**42**

REFERENCES		
S. No.	**Name of Books/Authors/Publishers**	**Year of Publication /**

		Reprint
1	Anil Markandya & Kirsten Halsnaes, "Climate Change and Sustainable Development: Prospects for Developing Countries", Earthscan, USA	2013
2	Mishra, R. K., Janaki-Krishna, P. S., & Kumari, L., "Climate Change and Sustainable Development: Global Perspective", Academic Foundation	2017
3	Mitsova, D., & Esnard, A. M., "Geospatial Applications for Climate Adaptation Planning", Routledge, T&F	2019
4	Palme, M., & Salvati, A., "Urban Microclimate Modelling for Comfort and Energy Studies", Springer	2021

B. Tech. Civil Engineering				
Course code: Course Title	**Course Structure. Credit=4**			**Pre-Requisite**
CE 413: Vulnerability and Risk Management	**L**	**T**	**P**	**Nil**
	3	**0**	**2**	

Course Objective: To impart knowledge and skill involving basic concepts and processes required for vulnerability and risk assessment and management to infrastructures due to different hazards.

S. No	Course Outcomes (CO)
CO1	Introduction to the various hazards encountered for civil infrastructure.
CO2	Introduction to randomness associated with hazards and probability.
CO3	Proficiency for modelling random variables for the design of structures.
CO4	Proficiency for the vulnerability assessment including **d**amage statistics and cumulative damage models.
CO5	Students are able to implement knowledge for risk assessment and management in civil infrastructures.

S. No	Contents	Contact hours
UNIT 1	**Introduction:** Overall view of Hazard, Vulnerability, and Risk assessments for Natural Hazards, Risk, terminology, randomness, uncertainty, Sources of Uncertainty, Steps in the Modelling of Uncertainty. Modelling of Uncertainty: Descriptors of Randomness.	8
UNIT 2	**Basics of Probability:** Sample space and events, Interpretation of probability, Probability axioms, Elementary theorems, conditional probability, Bayes' theorem. Random Variables: Definition of random variables - discrete and continuous; Probability definitions - PMF, PDF, CDF; Moments and expectations. **Probability Distributions:** Discrete distributions - binomial distribution, Poisson's distribution; Continuous distributions – uniform distribution, exponential distribution, gamma distribution, Weibull, Normal, and lognormal distributions. Extreme value distributions, Multivariate Distribution-Bivariate Normal distribution, other bivariate distributions, Transformations to Normal distribution	10
UNIT 3	**Determination of Distributions a Parameters from Observed Data:** Determination of Probability Distribution, Estimation of Parameters of a Distribution, Interval estimation of Mean and Variance, Tests of goodness-of-fit	8

	(chi-square test, Kolmogorov-Smirnov test), Modelling random variables like loads, material properties etc.	
UNIT 4	**Vulnerability Assessment:** Damage statistics and cumulative damage models, analytical and hybrid methods, calibration of models. Simulation Methods: Basis of simulations methods, random number generation, concept of Monte Carlo simulation and applications, Case study of Monte Carlo simulation.	8
UNIT 5	**Risk Assessment and Management:** Risk assessment due to various types of structures, Probabilistic and deterministic risk analysis**,** Probabilistic risk assessment application to Civil engineering problems using MATLAB	10
	Total	**42**

REFERENCES

S. No.	**Name of Books/Authors/Publishers**	**Year of Publication / Reprint**
1	Haldar, A., and Mahadevan, S. "Probability, reliability and statistical methods in engineering design." John Wiley and Sons, New York.	1999
2	J R Benjamin and C A Cornell, "Probability, statistics and decisions for civil engineers," John Wiley, New York.	1976
3	A Papoulis, "Probability, random variables and stochastic processes" 3rd Edition, McGraw-Hill, New York.	1991
4	HAZUS-MH, MR1& MR2 Technical Manual, Federal Emergency Management Agency	2020

B. Tech. Civil Engineering				
Course code: Course Title	**Course Structure**			**Pre-Requisite**
CE414: Urban Planning and Flood Management	**L**	**T**	**P**	**Nil**
	3	**0**	**2**	

Course Objective: The course introduces students to the fundamental principles of urban planning and flood management. It covers planning methodologies, flood risk assessment, and sustainable management strategies. Students will gain theoretical and practical knowledge to design and implement effective flood mitigation measures in urban environments.

S. No	Course Outcomes (CO)
CO1	Understand urban hydrology and its impact on flood occurrences.
CO2	Analyze flood risk and design appropriate flood management strategies.
CO3	Evaluate urban planning techniques for mitigating flood risks.
CO4	Apply GIS and remote sensing tools for flood risk mapping.
CO5	Implement sustainable urban drainage systems and flood resilience measures.

S. No.	Contents	Contact Hours
UNIT 1	**Introduction to Urban Planning and Floods**: Urban planning concepts and their relationship with flooding. The causes and types of urban flooding, impact of urbanization on water management. Case studies on major urban flood disasters highlighting key challenges and solutions.	8
UNIT 2	**Flood Hydrology and Risk Assessment**: Hydrologic cycle, flood hydrograph analysis, and rainfall-runoff relationships. Flood frequency analysis techniques and flood risk assessment ethodologies, vulnerability mapping to understand the extent and severity of urban floods.	10

UNIT 3	**Urban Drainage and Flood Management Strategies**: Traditional and modern urban drainage systems. Sustainable urban drainage systems (SUDS), green infrastructure for flood mitigation, and urban flood modeling techniques. Strategies for reducing flood risks through improved drainage planning and management.	8
UNIT 4	**IS and Remote Sensing in Flood Management**: GIS and remote sensing applications in flood management. Flood risk mapping, satellite-based flood monitoring, and case studies showcasing how GIS tools assist in flood preparedness and mitigation planning.	8
UNIT 5	**Policy, Governance, and Climate Change Impacts**: Urban flood management policies, governance frameworks, and the role of different stakeholders in flood mitigation. The impact of climate change on urban flooding and strategies for enhancing urban resilience to extreme weather events, Future trends in flood management.	8
	Total	**42**

REFERENCES

S. No.	**Name of Books/Authors/Publishers**	**Year of Publication / Reprint**
1	Kundzewicz, Z.W., "Flood Risk Science and Management", Cambridge University Press.	2012
2	Ashley, R., Garvin, S., Pasche, E., Vassilopoulos, A., Zevenbergen, C., "Advances in Urban Flood Management", CRC Press.	2007
3	Chow, V.T., "Handbook of Applied Hydrology", McGraw-Hill.	1964
4	Schanze, J., Zeman, E., Marsalek, J., "Flood Risk Management: Hazards, Vulnerability and Mitigation Measures", Springer.	2006

B. Tech. Engineering				
Course code and name	**Course Structure**			**Pre-Requisite**
CE415: Geotechnical Exploration and Excavation Methods	**L**	**T**	**P**	**CE206: Soil Mechanics**
	3	**1**	**0**	

S. No	Course Outcomes (CO)
CO1	Students understand: origin and nature of soils, geotechnical exploration, borings, and their layout
CO2	Students understand: samples and samplers, mechanisms, and work procedures of a variety of in-situ tests
CO3	Students understand: various correlations developed from in-situ tests and their usage. Exploration in rocks, equipment, results and correlations
CO4	Students understand: mechanisms, equipment, procedures, and correlations for geophysical exploration. Preparation of exploration report. Exploration of landfills and objectives of excavation.
CO5	Students understand: various geotechnical excavations, their protection, stability, and construction.

S. No	Contents
UNIT 1	Origin of soils, nature of different types of soils. Objectives and procedures of geotechnical exploration. Methods of exploratory borings, required depth, and spacing of borings.
UNIT 2	Various samplers and collections of samples. Various in-situ tests: standard penetration test, static cone penetration test (both mechanical and piezocone), dynamic cone penetration test, vane shear test, pressuremeter test, and dilatometer test.
UNIT 3	Various correlations and charts to be developed on the basis of in-situ tests. Methods of exploration in rocks, various types of core barrels and coring bits, typical results, and correlations.
UNIT 4	Various geophysical explorations: methods, equipment, procedures, and correlations. Preparation of subsoil exploration report. Exploration of closed landfill sites. Objectives of geotechnical excavation.
UNIT 5	Protection of excavations and surrounding structures, various methods such as sheet pile walls, braced walls, and coffer dams, their procedures for construction, types of construction, and analysis of stability. Ditches and Tunnels: excavation, stability, and loads.

REFERENCES		
S. No.	**Name of Books/Authors/Publishers**	**Year of Publication / Reprint**
1	Bowles, J. E. “Foundation Analysis and Design”, McGraw-Hill International.	1997
2	Das, B. M. “Principles of Foundation Engineering”, Cengage.	2016
3	Murthy V. N. S., “Advanced Foundation Engineering”, CBS Publishers and Distributers.	2012
4	Singh, Alam. “Soil Engineering in Theory and Practice Volume 1”, CBS Publishers and Distributors.	2014
5	Powrie, William “Soil Mechanics Concepts and Applications.”, CRC Press.	2014
6	Punmia B. C. Jain A. K. Jain A. K. “Soil Mechanics and Foundations” Laxmi Publications.	2022

B. Tech. Civil Engineering				
Course code: Course Title	**Course Structure.**			**Pre-Requisite**
CE416: Masonry, Timber, and Bamboo Structures	L	T	P	Nil
	3	0	2	

Course Objective: This course aims to provide students with an understanding of the properties, behaviour, and design principles of masonry, timber, and bamboo structures, focusing on their resistance to earthquake, wind, and cyclone forces. Students will learn to design and evaluate these structures under various loads, understand failure mechanisms, and apply relevant codes (IS 1905, IS 4326, IS 15912). The course also covers emerging trends in sustainable construction and heritage preservation.

S. No	Course Outcomes (CO)
CO1	Understand the engineering properties of masonry, timber, and bamboo materials.
CO2	Analyse the structural behaviour of masonry, timber, and bamboo under various loads.
CO3	Apply earthquake, wind, and cyclone-resistant design principles to these structures.
CO4	Design masonry, timber, and bamboo structures considering axial, flexural, and shear loads.
CO5	Explore emerging trends in construction, preservation of heritage structures, and sustainable innovations.

S. No	Contents	Contact Hours
UNIT 1	**Engineering Properties of Materials**: Engineering properties of masonry, timber, and bamboo; Types of masonry: Brick, stone, concrete blocks, reinforced masonry; Types of timber: Solid wood, engineered wood, laminated wood products; Types of bamboo used in construction; Durability, fire resistance, pest resistance, and preservative treatments.	8
UNIT 2	**Structural Behaviour Under Various Loads**: Principles of earthquake, wind, and cyclone-resistant design; Structural behaviour of masonry, timber, and bamboo under gravity, seismic, wind, and extreme weather conditions; Failure mechanisms and response to axial, flexural, shear, and torsional loads; Strengthening techniques; Stability criteria; Relevant codes (IS 4326 for masonry, IS 15912 for bamboo, and timber codes).	8
UNIT 3	**Design of Masonry Structures**; Structural Limit state design of masonry walls, arches, bridge substructures, and retaining walls for Gravity, seismic, wind, and cyclone loads; Relevant codes: IS 1905, Eurocode 6, ACI 530, IS 4326 (for seismic design).	10
UNIT 4	**Design of Timber and Bamboo Structures**: Structural limit state design of timber and bamboo beams, columns, and trusses for axial, flexural, shear, and torsional loads; Design of joints and fasteners: Bolted, nailed, glued, and dowel connections; Relevant codes IS 15912 (for bamboo), ISO 22156 (for bamboo), and timber codes.	8

UNIT 5	**Emerging Trends and Preservation of Archaeological Structures**: Seismic retrofitting techniques, Prefabrication and modular construction in masonry, timber, and bamboo; Smart materials and composites; Sustainable innovations in heritage preservation; Case studies of successful preservation and adaptive reuse of historical buildings; Challenges in maintaining structural integrity of ancient masonry and timber structures; Techniques for seismic retrofitting of heritage structures.	8
	TOTAL	**42**

References

S. No	Name of Books/Authors/Publishers	Year of Publication Reprint
1	M. D. Bondy, Design of Masonry Structures, McGraw-Hill, ISBN: 978-0070666667, 1st Edition.	2012
2	E. S. Hearn, Masonry Design and Construction, Routledge, ISBN: 978-0367338931, 1st Reprint.	2017
3	James R. McDonald, Structural Masonry: Design and Construction, Wiley, ISBN: 978-1118291567	2015
4	R. L. Taylor, Masonry Design and Construction, Longman Scientific and Technical, ISBN: 978-0582247369, 2nd Reprint.	1996
5	IS 1905: 2002, Code of Practice for Structural Use of Masonry, Bureau of Indian Standards (BIS).	2002
6	IS 4326: 2013, Code of Practice for Earthquake Resistant Design and Construction of Buildings, Bureau of Indian Standards (BIS).	2013
7	Eurocode 6: 2005, Design of Masonry Structures, European Committee for Standardization, ISBN: 978-1841193664.	2005
8	ACI 530: 2019, Building Code Requirements for Masonry Structures, American Concrete Institute (ACI), ISBN: 978-1942837657.	2019
9	A. S. Arya, Masonry and Timber Structures, Name Chand and Brothers, ISBN: 978-8185780092	2011, -
10	M. A. Green, Timber Design: Principles and Practice, Wiley-Blackwell, ISBN: 978-0470626366	2013, 1st Edition
11	B. J. Givoni, Design of Timber Structures, Elsevier, ISBN: 978-0444872076	1985, -
12	C. E. W. Lutterodt, Timber Engineering: A Design Guide, CRC Press, ISBN: 978-0367338092	2019, -
13	K. J. Williams, Structural Timber Design, John Wiley & Sons, ISBN: 978-0470663506	2010, 2nd Reprint
14	Johan V. L. Rook, Bamboo: Seismic and Wind Resistant Design for Sustainable Buildings, ISBN: 978-1138922325	2017, 2nd Reprint
15	Hannah C. Webb, Designing for Earthquakes and Cyclones with Bamboo, ISBN: 978-1138925692	2016, -

16	P. R. Bhandari and S. K. Gupta, Seismic Performance of Bamboo Structures: Challenges and Solutions, ISBN: 978-8184246250	2014, -
17	David Brown, Building with Bamboo for Extreme Weather: Cyclone and Earthquake Resilience, ISBN: 978-1138746709	2018, -
18	C. E. S. Thompson, Bamboo Structures and Earthquake Engineering, ISBN: 978-3319071174	2014, 1st Reprint
19	Ravi K. R. Sundar, Seismic Design of Bamboo Buildings: A Guide for Engineers and Architects, ISBN: 978-1138748611	2020, -
20	IS 15912: 2012, Code of Practice for Bamboo for Structural Use, Bureau of Indian Standards (BIS)	2012, 1st Reprint
21	ISO 22156: 2004, Bamboo Structures – Structural Design of Bamboo for Building and Construction, ISBN: 978-9284200962	2004, 1st Reprint
22	R. S. Dhawan & R. S. Sharma, Design of Bamboo Structures: Seismic and Cyclone Safety, ISBN: 978-8189766790	2013, -
23	B. G. L. Suresh, Bamboo in Construction: Seismic and Cyclone-Resistant Design, ISBN: 978-8126909391	2015, -
24	Duggal, V., Earthquake Resistant Design of Structures, Oxford Higher Education, ISBN: 978-0198069704	2007, 1st Edition

B. Tech. Civil Engineering				
Course code: Course Title	**Course Structure**			**Pre-Requisite**
CE 417: Computer Methods in Geotechnical Engineering	**L**	**T**	**P**	**CE206: Soil Mechanics**
	3	**0**	**2**	
Course objective: To understand the role of computer-based methods in geotechnical engineering. Apply numerical methods in solving soil and rock mechanics problems. To use the geotechnical software for modelling and solving real-world problems. To apply AI and Machine learning for geotechnical data analysis and prediction.				

S. No	Course Outcomes (CO)
CO1	Understand Computational Methods
CO2	Apply Numerical Techniques
CO3	Use Geotechnical Software
CO4	Apply AI and Machine Learning
CO5	Solve Real-World Geotechnical Problems

S. No	Contents	Contact Hours
UNIT 1	Introduction to Computational Methods in Geotechnical Engineering: Importance of computational methods in geotechnical engineering. Overview of numerical modelling techniques (FEM, FDM, DEM) Review of fundamental soil mechanics concepts. Introduction to geotechnical problem-solving using computers.	8
UNIT 2	Numerical Methods for Geotechnical Problems. Finite Difference Method (FDM) and its application in geotechnical engineering. Finite Element Method (FEM) concepts and basics of meshing. Introduction to Discrete Element Method (DEM) for granular materials. Application of numerical methods for: Slope stability analysis, Seepage, and groundwater flow Consolidation and settlement.	8
UNIT 3	Geotechnical Engineering Software Applications, Overview and application of PLAXIS (FEM-based geotechnical modelling). GeoStudio (Seepage, stability, and stress analysis). FLAC (Finite difference modelling for soil and rock mechanics). ABAQUS (Advanced finite element analysis for soil-structure interaction). Hands-on practice: Modelling soil behaviour, boundary conditions, and interpretation of results	8

UNIT 4	Data Analysis and Machine Learning in Geotechnical Engineering Introduction to data-driven approaches in geotechnical engineering Use of MATLAB/Python for geotechnical data processing Machine learning applications in soil classification and prediction AI-based predictive modelling for geotechnical failures	8
UNIT 5	Case Studies and Practical Applications. Real-world case studies on geotechnical failures and their computational analysis. Project-based learning: Students work on real geotechnical problems using software tools. Report preparation and technical presentation of findings.	10
	Total	**42**

REFERENCES		
S. No.	**Name of Books/Authors/Publishers**	**Year of Publication / Reprint**
1	Numerical Methods in Geotechnical Engineering: Michael A. Hicks, Ronald B.J. Brinkgreve, Alexander Rohe Publisher: CRC Press (Routledge)	2014
2	Finite Element Analysis in Geotechnical Engineering: Application: David M. Potts, Lidija Zdravković. Publisher: Thomas Telford Ltd	2001
3	Finite Element Analysis in Geotechnical Engineering: Theory: David M. Potts, Lidija Zdravković. Publisher: Thomas Telford Ltd.	1999
4	PLAXIS: A Practical Guide for Geotechnical Engineers: Helmut Schweiger Publisher: CRC Press.	2019

B. Tech. Civil Engineering				
Course code: Course Title	**Course Structure**			**Pre-Requisite**
CE418: Water Resource Management	**L**	**T**	**P**	**Nil**
	3	**1**	**0**	

Course Objective: To familiarize the students with the concepts of soil and water conservation, flood estimation and forecasting, engineering economics, and water resources management. Application of this knowledge in the management of water resources is demonstrated through solved examples.

S. No	Course Outcomes (CO)
CO1	The students will be able to apply appropriate rainwater harvesting techniques and estimate reservoir capacity requirements. They will be able to analyze for optimal capacity of reservoirs and spillways as per hydrological considerations.
CO2	The students will be able to estimate the effects of silting on the life of reservoirs and design soil conservation structures in their watershed as preventive measures.
CO3	The students will be able to estimate and forecast floods with the application of hydrological concepts like frequency analyses and unit hydrograph techniques.
CO4	The students will be able to select an optimal scale of water resources projects with the use of economic analysis and optimization techniques. They will also be able to plan for the sequencing and scheduling of the project components.
CO5	The students will understand the utility of computer programs in the design of water resources systems.

S. No	Contents	Contact Hours
UNIT 1	**Water conservation**: Rain water harvesting techniques, water shed development, ground water recharging, check dams, reservoirs and aquifers, control of infiltration, seepage and evaporation.	8

UNIT 2	**Soil Conservation:** Introduction to soil erosion, mechanisms and its causes and control, sheet erosion, rill erosion, gully erosion, control of erosion by bunding, terracing, contour trenching, gully stabilizing, check dams.	8
UNIT 3	**Floods and Flood Routing:** Stream flows and their measurement, stage-discharge curves. **U**nit hydrograph, instantaneous unit hydrograph and synthetic unit hydrograph theories; and their applications. Flood estimation; flood frequency, risk and reliability analysis. Reservoir and channel routing. Flood forecasting and flood management.	8
UNIT 4	**Principles of Engineering Economics:** discounting techniques, un-certainty, planning horizon. Selection of optimal alternatives. Application of linear, nonlinear and dynamic programming in water resources. Optimal sequencing and scheduling of resources.	8
UNIT 5	**Planning of Water Resources Projects:** factors affecting irrigation and power development, cost – benefit analysis for irrigation, water power and floods control projects. Computer applications in the designs of water resources systems**.**	10
	Total	**42**

REFERENCES

S. No.	**Name of Books/Authors/Publishers**	**Year of Publication / Reprint**
1	Hall, W.A. and Dracup, J.A., "Water Resources Systems Engineering", McGraw-Hill Book Company.	1970
2	Loucks, D.P., "Water Resource Systems Planning and Analysis", Prentice Hall.	1981
3	Maass et al., "Design of Water-Resource Systems", Harvard University Press. 1962	1961
4	Vedula S. and Mujumdar, P.P., "Water Resources Systems", Tata McGraw-Hill.	2005
5	Das, Ghanshyam, “Hydrology and Soil Conservation Engineering: Including Watershed Management”, PHI Learning Private Limited	2009

B. Tech. Civil Engineering				
Course code: Course Title	**Course Structure.**			**Pre-Requisite**
CE 419: Environmental Geo-Techniques	**L**	**T**	**P**	**CE206: Soil mechanics CE208: Environmental Engineering**
	3	**1**	**0**	

Course Objective: To understand the fundamental principles of environmental geotechnics and its role in sustainable engineering practices. To study the behavior of soils and rocks in response to environmental factors such as contamination, seepage, and waste disposal. To explore various waste containment systems, landfill engineering, and remediation techniques for contaminated sites. To apply geotechnical engineering principles to the assessment and mitigation of environmental hazards. To introduce advanced techniques such as geosynthetics, bioremediation, and soil stabilization for environmental protection.

S. No	Course Outcomes (CO)
CO1	Understand the fundamental concepts of environmental geotechnics and its importance.
CO2	Analyse soil contamination mechanisms and apply suitable remediation techniques.
CO3	Design waste containment systems considering geotechnical principles.
CO4	Evaluate groundwater contamination and implement appropriate control measures.
CO5	Apply sustainable geotechnical solutions for environmental protection and infrastructure development.

S. No	Contents	Contact hours
UNIT 1	Introduction to Environmental Geotechnics: Scope and importance of environmental geotechnics, Soil-water-contaminant interaction, Sources of contamination in soil and groundwater, Physicochemical and biological behaviour of contaminated soils, Impact of environmental factors on soil properties	8
UNIT 2	Soil Contamination and Remediation Techniques: Mechanisms of soil contamination – Adsorption, Diffusion, Leaching, Contaminant transport in soils – Advection, Dispersion, and Biodegradation, Remediation techniques: In-situ methods – Bioremediation, Soil Vapor Extraction, Electrokinetic Remediation, Ex-situ methods – Soil Washing, Stabilization/Solidification, Thermal Desorption, Case studies of contaminated site remediation	8
UNIT 3	Waste Management and Landfills: Types and classification of waste – Municipal, Industrial, Hazardous, Landfill design and construction, Geotechnical	8

	considerations in landfill engineering, Role of geosynthetics in waste containment – Liners, Covers, Drainage, Leachate generation and management	
UNIT 4	Groundwater Pollution and Control Measures: Sources and types of groundwater pollution, Hydrogeological factors affecting contaminant migration, Groundwater monitoring and sampling techniques, Contaminant transport modelling in groundwater, Groundwater remediation techniques – Pump-and-Treat, Permeable Reactive Barriers, Natural Attenuation	8
UNIT 5	Sustainable Practices and Case Studies: Sustainable geotechnical practices in environmental engineering, Use of recycled materials in geotechnical applications, Climate change impacts on geotechnical structures, Case studies of environmental geotechnics applications in infrastructure projects, Future trends in environmental geotechnics	8
	Total	**40**

REFERENCES

S. No.	**Name of Books/Authors/Publishers**	**Year of Publication / Reprint**
1	Sharma, H. D., & Reddy, K. R. “Geoenvironmental Engineering: Site Remediation, Waste Containment, and Emerging Waste Management Technologies". John Wiley & Sons.	2004
2	Rowe, R. K. "Geotechnical and Geoenvironmental Engineering Handbook". Springer.	2011
3	Reddi, L. N., & Inyang, H. I. "Geoenvironmental Engineering: Principles and Applications". CRC Press.	2000
4	Daniel, D. E. "Geotechnical Practice for Waste Disposal". Springer.	1993
5	Das, B. M. "Principles of Geotechnical Engineering". Cengage Learning.	2017
6	Hari D. Sharma, Sangeeta P. Lewis. “Waste Containment Systems, Waste Stabilization, and Landfills: Design and Evaluation”. John Wiley & Sons.	1994

B. Tech. Civil Engineering				
Course code: Course Title	**Course Structure.**			**Pre-Requisite**
CE421: Geosynthetics	**L**	**T**	**P**	**CE206: Soil Mechanics**
	3	**1**	**0**	

Course Objective:
To introduce students to the classification, properties, and applications of geosynthetics in geotechnical engineering. To understand the functions of geosynthetics such as reinforcement, separation, filtration, drainage, and containment. To study the mechanical and hydraulic properties of geosynthetics and their interaction with soil. To analyse the design methodologies for geosynthetic applications in slopes, retaining walls, pavements, embankments, and landfills. To explore recent advancements and case studies related to geosynthetics in geotechnical engineering projects.

Course Outcomes (COs)	
S. No.	**Course Outcomes (COs)**
CO1	To understand the types, properties, and functions of geosynthetics in civil engineering
CO2	To analyse the mechanical and hydraulic properties of geosynthetics and their interaction
CO3	To design geosynthetic-reinforced slopes, retaining walls, pavements, and embankments.
CO4	To study the role of geosynthetics in filtration, drainage, and containment systems.
CO5	To explore case studies, recent advancements, and sustainability aspects of geosynthetics.

Course Content		
S. No.	**Contents**	**Contact Hours**
UNIT 1	Basic description of geosynthetics, overview of (geotextiles, geogrids, geomembranes, geo-composites).	8
UNIT 2	Geotextile properties and test methods, geotextile function and mechanisms, design for (separation, reinforcement, stabilization, filtration, drainage, multiple functions), construction methods and techniques using geotextile.	8
UNIT 3	Geogrid properties and test methods, designing for reinforcement, designing for	8

	stabilisation, construction methods using geogrids	
UNIT 4	Geomembrane properties and test methods, survivability requirements, liquid containment, covers for reservoirs, water conveyance, solid material, caps and closures, dam and embankments, miscellaneous aspects of geomembrane	8
UNIT 5	Geo-composites in (separation, reinforcements, geo-webs and geocells, filtration, sheet drains, strip (wick) drains, moisture barrier)	8
Total		**40**

References		
S. No.	**Name of Books/Authors/Publishers**	**Year of Publication / Reprint**
1	R. M. Koerner, *Designing with Geosynthetics* (ISBN: 978-0137261758), Publisher: Pearson	2005
2	R. D. Holtz, B. R. Christopher, & R. R. Berg, *Geosynthetic Engineering* (ISBN: 978-0071481985) Publisher: McGraw-Hill	2008
3	J. N. Mandal, *Geosynthetics: Innovative Solutions for Sustainable Development* (ISBN: 978-8123918552) Publisher: CBS Publishers & Distributors	2011
4	C. V. S. K. Rao, *Ground Improvement Techniques* (ISBN: 978-8122424795) Publisher: I.K. International Publishing House	2010

B. Tech. Civil Engineering/ Elective Subject				
Course code: Course Title	**Course Structure.**			**Pre-Requisite**
CE423: Advanced Open Channel Flow	**L**	**T**	**P**	Nil
	3	**0**	**2**	

Course Objective: The objective of this course is to provide students with an in-depth understanding of advanced concepts and analytical techniques in open channel hydraulics. The course aims to equip students with the skills necessary to analyze, design, and manage complex open channel flow systems through a combination of theoretical knowledge and practical application.

S. No	Course Outcomes (CO)
CO1	Understand and distinguish between types of flows in a channel, Specific energy, and critical flow computations.
CO2	Design and Optimization of Open Channel, including channel transitions.
CO3	Understanding and analysis of Uniform and Non-Uniform flow.
CO4	Application of various Hydraulic structures in Open channels.
CO5	Varying and Unsteady flow analysis and problem solving.

S. No.	Contents	Contact Hours
Unit 1	Kinds of open channel flow, channel geometry, types and regimes of flow, Velocity distribution in open channel, wide open channel, specific energy, critical flow, and its computation.	8
Unit 2	Energy in a non-prismatic channel, momentum in open channel flow, and specific force. Qualification of uniform flow, velocity measurement, Manning's and Chezy's formula, determination of roughness coefficients.	9
Unit 3	Determination of normal depth and velocity, most economical sections, and non-erodible channels. Flow in a channel section with composite roughness, and flow in a close conduit with open channel flow.	9

Unit 4	**Varied Flow:** Dynamic equations of gradually varied flow, assumptions and characteristics of flow profiles, classification of flow profile, draw down and back water curves profile determination, graphical integration, direct step and standard step method, numerical methods, flow through transitions Varied Flow: Dynamic equation of spatially varied flow. Analysis of spatially varied flow profile, computation of spatially varied flow using numerical integration.	8
Unit 5	**Unsteady Flows**: St. Venant's equations and their solution using the method of characteristics and finite difference schemes; dam break problem, hydraulic flood routing. Channel Transitions: Sub-critical and supercritical.	8
	Total	**42**

References:

S. No.	Name of Books/Authors/Publishers	Year of Publication / Reprint
1	Chow, V.T., "Open Channel Hydraulics", McGraw-Hill.	1991
2	Choudhary, M.H., "Open-Channel Flows", Prentice-Hall.	2000
3	Ranga Raju, K.G., "Flow Through Open Channels, Tata McGraw Hill.	2003
4	K. Subramaniyam, "Flow in Open Channel," McGraw Hill	2019

B. Tech. Civil Engineering				
Course code: Course Title	**Course Structure**			**Pre-Requisite**
CE425: Flood and Drought Estimation and Management	**L**	**T**	**P**	**Nil**
	3	**1**	**0**	

Course Objective: The objective of this course is to provide an in-depth exploration of the principles and practices of flood and drought management. The course typically focuses on ensuring that students gain a comprehensive understanding of the principles, strategies, and techniques related to managing and mitigating the impacts of floods and droughts.

S. No	Course Outcomes (CO)
CO1	Gains an understanding of the causes of floods and their impacts on society.
CO2	Understands various aspects of droughts and their impact on society.
CO3	Able to estimate magnitude and behaviour of floods for forecasting, relevant warning, and flood fighting.
CO4	Proficiency in economic analysis of flood control works and their management. Enhanced ability to develop integrated flood management plans that combine structural and non-structural measures.
CO5	Gains an understanding of Water Conservation and water management practices.

S. No.	Contents	Contact Hours
UNIT 1	Floods: Definition and types of floods; Causes of floods (natural and man-made factors); Impacts of Floods: Social, Environmental, Economic, and Political Basic causes of flood: Flood-prone areas in India and their problems, case history of some important river basins of India.	8

UNIT 2	Droughts: Definition and types of droughts; Causes of Drought (natural and human-induced factors); Impacts of droughts: Social, Environmental, and Economic.	8
UNIT 3	Estimation of flood magnitudes using rainfall runoff relationships, hydrological modelling, and flood routing techniques. Flood forecasting, flood warning and flood fighting. Morphological study of river behaviour.	8
UNIT 4	Economic aspects of flood control schemes, cost-benefit analysis. Flood Management: Floodplain zoning; Land use planning. Infrastructure development; Early warning systems. Community preparedness; Insurance and risk deduction.	10
UNIT 5	Drought Management: Water Conservation; Drought monitoring and early warning system; Diversification of water sources; Drought-resilient agriculture; Water management policies; Community engagement; Research and innovation.	8
	Total	**42**

REFERENCES

S. No.	Name of Books/Authors/Publishers	Year of Publication / Reprint
1	Drought and Water Crises Science, Technology, and Management Issues By Donald A. Wilhite, 1st Edition Published, 22 March 2005, CRC Press.	2005
2	Chow V.T., Maidment D.R., Mays L.W., "Applied Hydrology", McGraw-Hill Publications, New York, 1995.	1995
3	Vijay P. Singh, "Elementary Hydrology", Prentice Hall of India, New Delhi, 1994.	1994
4	Rangapathy V., Karmegam M., and Sakthivadivel R., Monograph in Flood Routing Methods as Applied to Indian Rivers, Anna University Publications.	2005
5	Yevjevich V., Drought Research Needs, Water Resources Publications, Colorado State University, USA, 1977	1977
6	Drought and Water Crises: Integrating Science, Management, and Policy, Second Edition (2017) By Donald Wilhite.	2017

B. Tech. Civil Engineering				
Course code: Course Title	**Course Structure**			**Pre-Requisite**
CE427: Advanced Hydrology	**L**	**T**	P	Nil
	3	**1**	0	

Course Objective: The objective of this course is to provide an in-depth understanding of the complex processes governing the distribution, movement, and quality of water on Earth. By integrating theoretical concepts with practical applications, students will develop the skills necessary to analyze and solve advanced hydrological problems. The course will cover topics such as surface and groundwater hydrology, hydrological modelling, climate change impacts on hydrological cycles, and water resource management. Upon completion, students will be equipped to conduct independent research, apply advanced hydrological techniques, and contribute effectively to water resource planning and management.

S. No	Course Outcomes (CO)
CO1	Understand and Analyze Hydrological Processes.
CO2	Apply Hydrological Models.
CO3	Evaluate Climate Change Impacts.
CO4	Conduct Independent Research.
CO5	Implement Water Resource Management Strategies.

S. No.	Contents	Contact Hours
UNIT 1	**Introduction:** Hydrologic system and hydrologic budget, fundamental laws of hydrology; atmospheric water vapour. Hydrologic Inputs: Precipitation and its forms, snowfall and rainfall; measurement techniques and space-time characteristics.	8
UNIT 2	**Hydrologic Abstractions**: Infiltration, depression storage, evapotranspiration; measurement techniques, space-time characteristics and their modelling.	8

UNIT 3	**Stream flow**: Measurement techniques, space-time characteristics, rating curves.	8
UNIT 4	**System Approach:** Unit Hydrograph IUH, GIUH. Mathematical Modelling: Linear and Nonlinear models, physically based models.	8
UNIT 5	**Hydrological routing,** Flood forecasting. Advanced Method of Frequency Analysis: Outliers, Time series analysis. Impact of climate change and Land use/Land cover on basin response.	10
	Total	**42**

REFERENCES

S. No.	Name of Books/Authors/Publishers	Year of Publication / Reprint
1	Chow, V.T., Maidment, D.R. and Mays, W.L., "Applied Hydrology", McGraw-Hill.	1988
2	Ojha, C.S.P., Berndtsson, R. and Bhunya, P., "Engineering Hydrology", Oxford University Press.	2008
3	Wanielista, M., Kersten, R. and Eaglin, R., "Hydrology", John Wiley.	1997
4	Subramanya, K., "Engineering Hydrology", Tata McGraw-Hill Education Private Limited.	2008
5	Kumar, D. Nagesh, "Water Resources Systems Planning and Management".	2014

B. Tech. Civil Engineering				
Course code: Course Title	**Course Structure**			**Pre-Requisite**
CE429: Urban Water Resource Management	L	T	P	Nil
	3	1	0	

Course Objective: The objective of this course is to provide an in-depth understanding of various aspects of urban water resource management. It includes: Collection of water from different sources of fresh water to meet the requirement, and Distribution of quality water to end users. Water conservation, groundwater recharge, and managing the drainage network for safe disposal of excess rainwater and sewerage.

S. No	Course Outcomes (CO)
CO1	Understanding of water availability and its quality with respect to BIS specifications.
CO2	Ability to analyse water distribution network and drainage network.
CO3	Understanding of concepts and theoretical perspectives related to Integrated Water Resource Management and application of tools for practicing it.
CO4	Ability to make groundwater and surface water resources as renewable sources.
CO5	Understanding of flood management through an efficient drainage network.

S. No.	Contents	Contact Hours
UNIT 1	Water requirement, water availability, water budget, water balance, Zero liquid discharge concept, and implementation. Urban lakes and reservoirs: quality and quantity assessment, treatment of rough water to meet BIS standards.	8
UNIT 2	Analysis of water distribution network and stormwater network, floodplain delineation, integrated flood management practice, Impact Development, rehabilitation, and restoration of urban water bodies	8
UNIT 3	Integrated Water Resource Management: History of water management, Integrated water resource management: concepts and theoretical perspectives, Principles and tools for practicing IWRM, Issues and challenges in IWRM, Corporate social responsibility in water resource management.	8

UNIT 4	Concept and framework of watershed approach, Soil and water conservation, Water harvesting-importance and techniques. A case study of water harvesting.	8
UNIT 5	Freshwater Ecosystem Management: Artificial recharges of groundwater, River basin management, Management of lakes, Management of wetlands, Case study: Dal Lake, Ganga Action Plan	10
	Total	**42**

REFERENCES

S. No.	**Name of Books/Authors/Publishers**	**Year of Publication / Reprint**
1	Rossmiller, R.L., "Storm water design for sustainable development", Mc.Graw-Hill Education, 2013(First Edition)	2013
2	D. Borchardt, J.J. Bogardi and R.B. Iibish (Editors). 2016. Integrated Water Resources Management: Concept, Research and Implementation. Springer.	2016
3	R. Avis and M. Avis. 2019. Rainwater harvesting: A guide to human-scale system design. New Society Publishers.	2019

B. Tech. Civil Engineering				
Course code: Course Title	**Course Structure**			**Pre-Requisite**
CE431: Traffic Engineering	L	T	P	**CE 305: Transportation Engineering**
	3	0	2	

Course Objective: This course aims to expose the students to traffic surveys, traffic characteristics, and traffic flow theory, concept of capacity, level of service, traffic control devices, highway lighting and parking studies.

S. No.	Course Outcomes (CO)
CO1	To expose students to carry out various traffic studies for traffic flow parameters
CO2	To expose students to the concept of traffic capacity and level of service
CO3	To expose students to types of signals and design methods
CO4	To equip students with the knowledge of pavement marking and signs for traffic control
CO5	To expose students to aspects of highway lighting and parking facilities

S. No	Contents	Contact Hours
UNIT 1	Traffic engineering studies and analysis: Objectives of traffic engineering study, Components of road traffic and their effect on road traffic, Spot speeds, speed and delay study, traffic volume survey, O-D survey.	12
UNIT 2	Theory of Traffic Flow: Basic diagram of traffic flow, Vehicular stream equations and diagrams, shock waves in traffic, freeway capacity and level of service, probabilistic aspects of traffic flow.	10
UNIT 3	Traffic Control: Traffic control through time sharing and space sharing concepts, traffic signs, traffic signals, warrants for traffic signal, road markings, islands, types of traffic signal systems, signal coordination, application of ITS.	10
UNIT 4	Highway lighting: need, principle of visibility, Design factors, Design of highway lighting system; Parking studies: need, types of parking, parking surveys.	10
	Total	**42**

REFERENCES		
S. No	**Name of Books/ Authors/ Publishers**	**Year of Publication/ Reprint**

1.	Khanna, S. K., Justo, C.E.G. and Veeraragavan A. “Highway Engineering”, Nem Chand & Bros., Roorkee, U.K	2014
2.	Kadiyali, L. R., “Traffic Engineering and Transportation Planning”, Khanna Publishers, New Delhi	2018
3.	Pignatyaro L., “Traffic Engineering-Theory and Practice”, John Wiley	2011
4.	McShane W.R. and Roess R.P., “Traffic Engineering” Prentice Hall	1987

B. Tech Civil Engineering				
Course code: Course Title	**Course Structure**			**Pre-Requisite**
CE433: Advanced Surveying and Geoinformatics	L	T	P	CE207: Surveying and Geoinformatics
	3	0	2	

Course Objective: It introduces the advanced concepts of Surveying and Geoinformatics

S. No	Course Outcomes (CO)
CO1	Understand and apply the advanced concepts of Surveying
CO2	Understand and apply advanced concepts of GNSS and GPS in Surveying and navigation
CO3	Understand and apply advanced concepts of Remote sensing in Surveying and Mapping
CO4	Understand and apply advanced concepts of Remote sensing in Surveying and Mapping
CO5	Develop an understanding of emerging technologies and applications in Geoinformatics

S. No	Contents	Contact Hours
UNIT 1	**Advanced Surveying Techniques -**Principles and Methods of Precise Surveying, Electronic Distance Measurement (EDM) and Total Station, Digital Theodolites and Auto Levels, Laser Scanning and LiDAR Surveying, Hydrographic and Underground Surveying, Error Analysis and Adjustment Techniques	8
UNIT 2	**Global Navigation Satellite Systems (GNSS) and GPS -** Fundamentals of GNSS: GPS, GLONASS, Galileo, BeiDou, GPS Signal Structure and Positioning Methods, Differential GPS (DGPS) and Real-Time Kinematic (RTK) Techniques, GPS Data Processing and Accuracy Assessment, Applications of GNSS in Engineering and Mapping, Case Studies: GNSS in Land and Urban Planning	8
UNIT 3	**Remote Sensing for Surveying and Mapping -** Fundamentals of Remote Sensing and Electromagnetic Spectrum, Types of Remote Sensors: Optical, Microwave, Thermal, Satellite Image Interpretation and Classification Techniques, DEM and DSM Generation from Remote Sensing Data, Applications in Topographic Mapping and Land Use Analysis, UAV (Drone) Surveying: Data Acquisition and Processing	8
UNIT 4	**Geographic Information System (GIS) and Spatial Analysis -**GIS Data Models: Raster and Vector, Coordinate Systems and Map Projections, Spatial Data Analysis: Overlay, Buffering, Interpolation, GIS-based 3D Modelling and Terrain Analysis, Web GIS and Cloud-based GIS Applications, Case Study: GIS in Disaster Management and Urban Planning	8
UNIT 5	**Emerging Technologies and Applications in Geoinformatics -** Artificial Intelligence and Machine Learning in Geospatial Analysis, Internet of Things (IoT) and Smart Cities Mapping, 3D Laser Scanning and BIM (Building Information Modelling), Geospatial Big Data and Cloud Computing, Blockchain for Land Records and Cadastral Mapping, Future Trends in Surveying and Geoinformatics	10
	Total	**42**

REFERENCES		
S. No.	**Name of Books/Authors/Publishers**	**Year of Publication / Reprint**
1	Advanced Surveying Techniques - Title: *Advanced Surveying: Total Station, GIS and Remote Sensing* Authors: Satheesh Gopi Publisher: Pearson Education India Edition: Reprint Edition Year of Publication: 2007 ISBN: 9788131700679	2007
2	Global Navigation Satellite Systems (GNSS) and GPS -Title: *GPS and GNSS for Land Surveyors* , Author: Jan Van Sickle , Publisher: CRC Press, Edition: 5th Edition , ISBN: 9781032521022	2023
3	Remote Sensing for Surveying and Mapping -Title: *Remote Sensing and Image Interpretation*, Authors: Thomas M. Lillesand, Ralph W. Kiefer, Jonathan W. Chipman, Publisher: Wiley, Edition: 7th Edition, ISBN: 9781118343289	2015
4	Geographic Information System (GIS) and Spatial Analysis -Title: *GIS, Spatial Analysis, and Modeling*, Editors: David J. Maguire, Michael F. Goodchild, Michael Batty, Publisher: Esri Press, Edition: 1st Edition, ISBN: 9781589481305	2005
5	Emerging Technologies and Applications in Geoinformatics -Title: *Emerging Trends in Open Source Geographic Information Systems*, Editor: G. Mustafa Mohiuddin, Publisher: Engineering Science Reference, Edition: 1st Edition, ISBN: 9781522550396	2018

B.Tech. Civil Engineering				
Course code: Course Title	**Course Structure**			**Pre-Requisite**
CE435: Construction Project Management	L	T	P	Nil
	3	1	0	

Course Objective: Understand the concepts and principles of modern-day Construction.

S. No	Course Outcomes (CO)
CO1	Understand the Network Techniques, Construction Planning, and Management.
CO2	Find the time cost optimization of the projects.
CO3	Understand the site layout, inspection, supervision, and quality control.
CO4	Implement safety in construction.
CO5	Implement the labour laws and Acts

S. No	Contents	Contact hours
UNIT 1	Construction Planning and Network Techniques: Pre-tender planning; contract planning; planning and scheduling construction jobs by bar charts; Planning and scheduling construction jobs by critical path network techniques; allocation of resources; techniques of development and analysis of PERT/CPM networks for building project, bridge project and industrial shed constructions; updating of network; examples and case studies; Computer software for network analysis.	8
UNIT 2	Time-cost Optimization: Direct cost, indirect cost, total cost; purpose, stages, and methods of cost control techniques of time cost optimization; examples and case studies.	8
UNIT 3	Labour Laws and Acts, Project Management: Feasibility study; project reports; progress reports; monitoring and controlling project activities.	8
UNIT 4	Site Layout: Principles governing site layout; factors affecting site layout; preparation of site layout. Supervision, Inspection and Quality Control: Supervisor's responsibilities; keeping records; control of field activities, handling disputes and work stoppages; storage and protection of construction materials and equipment; testing and quality control. Purpose of inspection: Inspection of various components of construction, reports and records; and statistical quality control	9
UNIT 5	Safety in Construction: Safety: importance of safety, accident-prone situations at a construction site, i.e, safety measures for excavation, drilling/blasting, scaffolding/formwork, hoisting & erection, demolition, and hot bituminous work. Fire Safety: Safety record of the construction industry, safety campaign	9

	Total	**42**

REFERENCES		
S. No	**Name of Books/ Authors/ Publishers**	**Year of Publication/ Reprint**
1	Chitkara, K.K. Construction Project Management – Planning, Scheduling and Controlling, Tata McGraw-Hill.	**2015**
2	Seetharaman, S. Construction Engineering and Management, Umesh Publications.	2006
3	Choudhary, S. Project Management. Tata McGraw-Hill	**2004**
4	Srivastava, V.K. Construction Planning and Management, Galgotia Publications.	**2014**
5	Punmia, B.C.; Khandelwal, K.K. (2002). Project Planning & Control with PERT& amp; CPM, Laxmi Publications.	**2002**
6	Kumar, Neeraj Jha. Construction Project Management – Theory and Practice –Pearson.	**2015**
7	Gahlot, P.S. & Dhir B.M. Construction Planning and Management, New Age International.	**2007**

B. Tech Civil Engineering				
Course code: Course Title	**Course Structure**			**Pre-Requisite**
CE437: Construction and Design Aspects in Transportation Engineering	L	T	P	**CE 305: Transportation Engineering**
	3	1	0	

Course Objective: The course aims to equip students with the knowledge and skills necessary for designing, analysing, and managing transportation infrastructure.

S. No.	Course Outcomes (CO)
CO1	To expose students to carry out traffic and transportation studies at a traffic intersection
CO2	To expose students to the concept of traffic capacity and level of service at intersections
CO3	To expose students to the design aspects of at-grade traffic intersections with and without pedestrian flow
CO4	To expose students to the knowledge of planning and design aspects of grade-separated intersections with pedestrian facilities
CO5	To expose students to the planning and design of various terminal facilities

S. No	Contents	Contact Hours
UNIT 1	Types of intersections, Principles of intersection design: basic considerations, maneuver elements, separation of conflict points, design elements, design speed, intersection curves, super elevation of curves at intersection, intersection sight distance.	12
UNIT 2	At grade intersections: types, design considerations, capacity and LOS, design of rotary and signalized intersections, vehicle actuated signals, signal co-ordination, area traffic control system (ATCS), Pedestrian facility planning at grade intersections.	10
UNIT 3	Grade separated inter sections: types, design principles, Planning and design considerations for foot over bridge and subway for pedestrian crossing at grade separated intersections.	10
UNIT 4	Terminal facilities: types, bus terminus, design principles, design elements, design and case studies of inter modal transfer facilities	10
	Total	**42**

REFERENCES

S. No	Name of Books/ Authors/ Publishers	Year of Publication/ Reprint
1.	Khanna, S. K., Justo, C.E.G. and Veeraragavan A. "Highway Engineering", Nem Chand & Bros., Roorkee, U.K	2014
2.	Kadiyali, L. R., "Traffic Engineering and Transportation Planning", Khanna Publishers, New Delhi	2018
3.	Kumar, R.S., "Introduction to Traffic Engineering" United Press Hyderabad	2018
4.	Sharma, S.K., "Principles, Practice and Design of Highway Engineering including Airport Pavements" S. Chand and Company, New Delhi	2012

B. Tech Civil Engineering				
Course code: Course Title	**Course Structure**			**Pre-Requisite**
CE 439: Traffic and Transportation Planning	L	T	P	**NIL**
	3	1	0	

Course Objective: This course aims to expose the students to advance topics of transportation engineering: transportation planning surveys, urban transport modes and travel demand forecasting process.

S. No.	Course Outcomes (CO)
CO1	To expose students to carry out origin destination surveys for travel demand estimation
CO2	To expose students to the features of different modes of urban transportation and urban infrastructure
CO3	To expose students to various issues of transportation planning
CO4	To equip students with the knowledge of various methods of analysing traffic data for trip generation, trip distribution, modal split, and assignment

S. No	Contents	Contact Hours
UNIT 1	Introduction: Urban travel characteristics, transportation planning process, demarcation of traffic zones, and collection of data.	10
UNIT 2	Trip generation analysis: Identification of study area, types and sources of data, roadside interview, home interview surveys, expansion factors, trip generation models, zonal models, category analysis, household models, trip attractions of work centers.	10
UNIT 3	Trip Distribution analysis: Trip distribution models, Growth factor models, Gravity models, opportunity models.	10
UNIT 4	Mode Split analysis: Mode choice behaviour, mode split curves, probabilistic models	6
UNIT 5	Traffic Assignment: Elements of transportation network, minimum path trees, all-or-nothing assignment. Appropriate experiments would be taken up.	6
	Total	**42**

REFERENCES

S. No	Name of Books/ Authors/ Publishers	Year of Publication/ Reprint
1.	Khanna, S. K., Justo, C.E.G. and Veeraragavan A. "Highway Engineering", Nem Chand & Bros., Roorkee, U.K.	2014
2.	Kadiyali, L. R., "Traffic Engineering and Transportation Planning", Khanna Publishers, New Delhi.	2018

3.	Pignatyaro L., “Traffic Engineering-Theory and Practice”, John Wiley.	2011
4.	McShane W.R. and Roess R.P., “Traffic Engineering”. Prentice Hall.	1987

B.TECH. CIVIL ENGINEERING				
Course Code: Course Title	**COURSE STRUCTURE**			**PRE-REQUISITE**
CE 441: Finite Element Method	L	T	P	Nil
	3	0	2	
Course Objective: This course covers continuum mechanics, stress-strain relations, FEM formulations for beams, plates, and plane stress/strain problems, along with variational methods, numerical integration, and convergence criteria. Students will analyse structural components and apply commercial FEM software to real-world problems.				

S. No.	**Course Outcomes (COs)**
CO 1	Understand the fundamental concepts of continuum mechanics, strain-displacement relations, and structural theories.
CO 2	Develop finite element formulations for beams, plane stress/strain problems, and plate bending using variational principles.
CO 3	Apply numerical techniques, including shape functions and integration methods, to improve FEM accuracy and convergence.
CO 4	Analyse structural components such as trusses, plates, and shells using FEM and evaluate eigenvalue problems.
CO 5	Utilize commercial FEM software to model and solve structural mechanics problems, validating results through simulations.

S. No.	**Contents**	**Contact Hours**
Unit 1	Introduction to continuum mechanics, stress and strain state variables, strain-displacement relations for different structural problems, Euler-Bernoulli and Timoshenko beam theories, plane stress and plane strain problems, Kirchhoff's and Mindlin's plate theories, formulation of 3D elasticity, shell problems, and the principle of total minimum potential energy.	**8**
Unit 2	Rayleigh-Ritz method, variational formulation of continuous systems, discretization approach for analysing continuous systems, mesh generation techniques, Galerkin and other weighted residual methods, generalized and natural coordinate models of displacement field, convergence criteria, numerical errors, and finite element model refinements.	**8**
Unit 3	Finite element formulation of Euler-Bernoulli beam problems, plane stress and plane strain using generalized coordinate displacement models, shape functions for Lagrangian, serendipity, and iso-parametric elements, r-s-t and area coordinates, tetrahedron and hexahedron elements, Cartesian mapping, Jacobian, numerical integration methods,	**8**
Unit 4	Stiffness matrix for truss elements using natural coordinates, finite element formulation of Timoshenko beam problems, plane stress and plane strain analysis using quadrilateral and triangular elements, load vector determination, plate bending analysis with rectangular and triangular elements, and introduction to eigenvalue problems.	**8**
Unit 5	Axisymmetric elasticity problems, shear locking, under-integration, singularity elements, patch tests, and FEM software applications using	**10**

	ANSYS and other tools. Introduction to FEM for dynamic analysis, formulation of mass and damping matrices, mode shapes and natural frequencies, time integration methods for dynamic problems, and response spectrum analysis.	
Unit: Lab	Introduction to FEM software (ANSYS, ADINA, ABAQUS, MATLAB), meshing, boundary conditions, solver settings, and analysis of beam, plane stress/strain, plate bending, and axisymmetric problems. Validation through numerical integration and model refinements.	
	Total	**42**

References:

Sr. No.	Name of Books/Authors/Publishers	Year of Publication / Reprint
1	Bathe, K. J., *Finite Element Procedures*, Prentice Hall, ISBN: 978-0979004902	1996
2	Reddy, J. N., *An Introduction to the Finite Element Method*, McGraw-Hill, ISBN: 978-0072466850	2005
3	Zienkiewicz, O. C., & Taylor, R. L., *The Finite Element Method: Volume 1, The Basis*, Butterworth-Heinemann, ISBN: 978-0750650557	2000
4	Cook, R. D., *Concepts and Applications of Finite Element Analysis*, Wiley, ISBN: 978-0471356059	2001
5	Hughes, T. J. R., *The Finite Element Method: Linear Static and Dynamic Finite Element Analysis*, Dover Publications, ISBN: 978-0486411811	2000
6	Logan, D. L., *A First Course in the Finite Element Method*, Cengage Learning, ISBN: 978-0495668251	2011
7	Chandrupatla, T. R., & Belegundu, A. D., *Introduction to Finite Elements in Engineering*, Pearson, ISBN: 978-0132162746	2011
8	Liu, G. R., & Quek, S. S., *The Finite Element Method: A Practical Course*, Butterworth-Heinemann, ISBN: 978-0080983561	2013

B. Tech. Civil Engineering				
Course code: Course Title	**Course Structure**			**Pre-Requisite**
CE443: Sustainable Building Technologies	**L**	**T**	**P**	**Nil**
	3	**0**	**2**	
Course Objective: It is to equip students with knowledge of sustainable building design, energy efficiency, and resource conservation. It covers eco-friendly materials, climate-responsive design, performance validation, and emerging green technologies, preparing them for advancements in sustainable construction.				

S. No	Course Outcomes (CO)
CO1	Understand sustainability principles, green building policies, climate-responsive design, and GIS applications in urban planning.
CO2	Evaluate eco-friendly materials, embodied energy, operational energy, and perform energy modeling for sustainable building design.
CO3	Design sustainable foundations, optimize building components, integrate MEP systems, and apply BIM for performance tracking.
CO4	Conduct energy audits, implement water and waste management strategies, develop carbon-neutral solutions, and understand certification frameworks.
CO5	Explore advanced sustainable technologies, including AI-driven automation, bio-based materials, climate-responsive design, and blockchain integration.

S. No.	Contents	Contact Hours
Unit 1	Principles of Sustainability & Urban Planning: Sustainability principles, carbon footprint, circular economy, ecological balance. Sustainable Development Goals (SDGs) & Green Building Policies – Global (HQE, LEED, BREEAM) & Indian (ECBC, IGBC, GRIHA) perspectives. Climate & Passive Design Principles – Solar orientation, thermal comfort, wind analysis. Urban Sustainability & Smart Cities – GIS applications in sustainable urban planning. **ISO Standards:** 15392, 14050, 37120 , 21929. **Software:** Climate Consultant, ArcGIS, Autodesk Insight(Revit)	9
Unit 2	Sustainable Materials & Energy Analysis: Material selection strategies and energy analysis techniques. Eco-Friendly Materials – Timber, bamboo, rammed earth, fly ash bricks, cement, sand, aggregates, recycled materials. Material Selection Based on Embodied Energy & Carbon Footprint – Life cycle analysis (LCA). Operational vs. Embodied Energy Calculations – Energy payback period analysis. Energy Modelling & Simulation Techniques – Solar exposure, daylighting, HVAC efficiency. **ISO Standards:** 14040, 14044, 52016-1. **Software:** One Click LCA, Athena Impact Estimator, PVsyst, DesignBuilder.	9
Unit 3	Sustainable Structural Components, Foundation Design for Sustainable	8

	Sites – Geothermal heat exchange, soil sustainability, rainwater harvesting. Walls, Roofs & Floors – Insulation, green roofs, modular construction, thermal mass considerations. MEP (Mechanical, Electrical, Plumbing) Integration in Sustainable Buildings – Smart grids, water-efficient plumbing, HVAC system optimization. Building Information Modelling (BIM) for Sustainability – Digital twins, performance tracking, efficiency enhancement. **ISO Standards:** 29481, 15686-5, 52010-1. **Software:** Revit, Tekla, ETABS, ANSYS, Digital Twin Software.	
Unit 4	Performance Validation & Certification: Energy Audits & Performance Benchmarking – Energy rating standards and efficiency checks. Water Management & Waste Reduction – Stormwater modelling, greywater recycling. Carbon Neutral Strategies & LCA in Buildings – Net-zero energy buildings, carbon sequestration techniques. Certification Frameworks & Documentation – LEED, BREEAM, HQE, EDGE, IGBC, ECBC. **ISO Standards:** 50001, 46001, 21930. **Software:** Tally (BIM LCA Plugin), LEED Online, EDGE App, HOMER Pro.	8
Unit 5	Future Trends in Sustainable Building: Smart & Adaptive Buildings – IoT-based energy optimization, AI-driven building automation. Bio-Based & 3D-Printed Materials – Sustainable innovations (e.g., mycelium, algae bricks). Climate-Responsive & Net Positive Energy Buildings – AI-driven predictive performance. Future of Sustainable Construction – Robotics, blockchain for material traceability, carbon capture. **ISO Standards:** 16739, 23386, 17772-1. **Software:** AI-Driven BIM Tools, Siemens *Mindsphere, EnergyPlus*.	8
	Total	**42**

References:

S. No.	Author, Title, Publisher, ISBN No.	Year of Publication & Reprint
1	Kibert, C. J., Sustainable Construction: Green Building Design and Delivery, John Wiley & Sons, ISBN: 9781119055310	2016 (Reprint: 2019)
2	Gorse, C., Johnston, D., & Pritchard, M., A Dictionary of Construction, Surveying and Civil Engineering, Oxford University Press, ISBN: 9780199534463	2017
3	Mendler, S. F., Odell, W., & Lazarus, M., The HOK Guidebook to Sustainable Design, John Wiley & Sons, ISBN: 9780471696131	2006
4	DeKay, M., & Brown, G. Z., Sun, Wind, and Light: Architectural Design Strategies, John Wiley & Sons, ISBN: 9781118332887	2013
5	Rosenlund, H., Climatic Design: Solutions for Buildings That Can Do More With Less Technology, Arvinius + Orfeus Publishing, ISBN: 9789187543311	2010
6	K.S. Jagdish, Sustainable Building Technologies, Published by BMTPC MHUA Govt. of India, I.K. International Publishing House, Pvt. Ltd, New Delhi, ISBN:9789386768209	2019
7	ISO 15392:2019, Sustainability in Buildings and Civil Engineering Works – General Principles	2019
8	ISO 14050:2020, Environmental Management – Vocabulary	2020

9	ISO 37120:2018, Sustainable Cities and Communities – Indicators for City Services and Quality of Life	2018
10	ISO 14040:2006, Life Cycle Assessment – Principles and Framework	2006
11	ISO 52016-1:2017, Energy Performance of Buildings – Calculation of Energy Needs for Heating and Cooling	2017
12	ISO 29481:2016, Building Information Modeling (BIM) – Framework for Information Delivery Manual	2016
13	ISO 15686-5:2017, Service Life Planning for Buildings – Performance Evaluation	2017
14	ISO 52010-1:2017, Energy Performance of Buildings – Climatic Data for Calculations	2017
15	ISO 50001:2018, Energy Management System (EMS) – Requirements with Guidance for Use	2018
16	ISO 46001:2019, Water Efficiency Management Systems – Requirements with Guidance for Use	2019
17	ISO 21930:2017, Sustainability in Building Construction – Environmental Declaration of Building Products	2017
18	ISO 16739:2018, Industry Foundation Classes (IFC) for BIM & Digital Twin Integration	2018
19	ISO 23386:2020, Digital Building Information – Terminology & Classification	2020
20	ISO 17772-1:2017, Energy Performance of Buildings – Indoor Environmental Quality	2017
21	LEED v4.1, Building Design and Construction Reference Guide, U.S. Green Building Council	2018
22	ECBC 2017, Energy Conservation Building Code, Bureau of Energy Efficiency, Government of India	2017
23	ISO 21929-1 Sustainability in Building Construction – Sustainability Indicators — Part 1: Framework for the development of indicators and a core set of indicators for buildings	2022

B. Tech. Civil Engineering				
Course code: Course Title	**Course Structure.**			**Pre-Requisite**
CE445: Integrated Intelligent Transportation System	L	T	P	Nil
	3	1	0	

Course Objective: To introduce the principles, architecture, and technologies of Intelligent Transportation Systems (ITS) and their role in enhancing traffic efficiency, safety, and sustainability. The course emphasizes real-time data, communication systems, and AI/ML applications for smart mobility solutions.

S. No	Course Outcomes (CO)
CO1	To understand the fundamentals and need for Intelligent Transportation System.
CO2	To explore technologies and applications in modern traffic and transportation systems.
CO3	To learn system architecture, data acquisition techniques, and communication protocols.
CO4	To understand transport demand management and public transport in ITS.
CO5	To understand the role of AI, ML, and IoT in Intelligent Transportation Systems and evaluate the effectiveness of ITS solutions in solving real-world transportation problems.

S. No	Contents	Contact hours
UNIT 1	Introduction to ITS: Definition, Scope, and need for ITS, Taxonomy, Historical Background, Urbanization and Motorization Trends, Characteristics of the Transport System, Transport Problems and Key Issues, Component and architecture, Global Implementation, Challenges in Deployment, Need for ITS in Urban Traffic Regulation, Technologies for Vulnerable Road Users	8
UNIT 2	Various Detection, Identification and Collection Method for ITS: Introduction, Sensing and Detection Technologies (Roadway, Environmental, Probe-based, magnetic, ultrasonic and infrared sensors), Bluetooth, Inductive loop detectors, Radar, LiDAR, Cameras, RFID Communication Technologies: Dedicated Short-Range Communication (DSRC), 5G, V2V, V2I, and VANETs, Data acquisition and traffic Monitoring: Mobile Reports, Real-time Using Cellular Network and GPS Probe, Smart Card- Based Data Collection	8
UNIT 3	Traffic Management System Component and ITS Applications: Introduction, Objective of Traffic Management, Traffic Management Measures, ITS for Traffic Management, Development of Traffic Management System, Traffic Management Centre Advanced Traffic Management Systems (ATMS), Advanced Traveller Information Systems (ATIS), Advanced Vehicle Control Systems (AVCS), Commercial Vehicle Operations (CVO), Advance Public Transportation Systems, Emergency Management Systems, Incident Management, Urban Road Safety, ITS for Intermodal Freight Transport	8

UNIT 4	Transport Demand Management and ITS for Public Transport: Introduction, Application of TDM, Use of GPS system, Automatic Passenger Count (APC), Automatic vehicle location (AVL) and Automatic Vehicle Identification (AVI) system, Traffic signal Priority, Real Time Passenger Information (RTPI), Fare Collection, Lane Control Technologies, Surveillance/CCTV/Security System, ITS operation Public Transport, Transport Integrated Management System, Electronic Toll Collection System	8
UNIT 5	Real world Problems; Use of ML and AI in ITS: Real-world case studies: India and global perspectives, Smart cities and ITS integration, Internet of Things (IoT) in ITS, Privacy and Security Concerns, Future Trends: Cooperative ITS (C-ITS), Edge Computing, Digital Twins, Role of AI and ML in Traffic Prediction, Vehicle classification and Detection, and Route Optimization, Deep learning Models for Traffic Video analytics, Intelligent Traffic Signal Control, Autonomous and Connected Vehicles, Use of big data and cloud computing in Transportation	10
	TOTAL	**42**

REFERENCES

S. No.	**Names of Books/Authors/Publishers**	**Year of Publication / Reprint**
1.	Intelligent Transport Systems: Technologies and Applications. Authors: Asier Perallos, Unai Hernandez-Jayo, Enrique Onieva, Ignacio Julio García Zuazola. Publisher: *Wiley*.	2015
2.	IRC SP:110-2017, Application of Intelligent Transport Systems for Urban Roads.	2017
3.	*Intelligent Transportation system: Editors:* Sarkar, P. K., & Jain, A. K. Publisher PHI Learning Pvt. Ltd.	2018
4.	Intelligent Transportation Systems: Concepts and Cases. Sundaravalli Narayanaswami. McGraw Hill Education India.	2022
5.	Introduction to intelligent transportation system and advanced technology. (pp. 3-6). Editors: Upadhyay, R. K., Sharma, S. K., & Kumar, V. Publisher: Springer Nature Singapore	2024