	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**
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1	Devenport A.G., “Wind Loads on Structures”, Division of Building Research, Ottawa.				1990

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7	Transmission Line Structures, Santhakumar A.R. & Murthy S.S., Tata McGraw-Hill.	1992