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)