Marwadi University

Syllabus for Master of Technology

Structural Engineering

Structural Health Monitoring & Retrofitting of Structures.

01ST0204 (PEC)

Objective of the Course: Objectives of introducing this subject at first year level in Masters of civil engineering are:

- To understand the structural health monitoring for structures.
- To understand the conditional assessment & techniques for strengthening and retrofitting of structures.

Credit Earned:4

Students learning outcomes:

After successful completion of the course, it is expected that student will be able to:

- Identify suitable Sensors & Instruments required in SHM for in-service performance of structures.
- Assess the health of structures using different techniques of SHM.
- Identify suitable technique for structural condition assessment.
- Decide the appropriate strengthening & retrofitting techniques to regain the structural strength.

Teaching and Examination Scheme

Teaching Scheme (Hours)			Credits	Theory Marks			Tutorial/ Practical Marks		Total Marks
Theory	Tutorial	Practical		ESE (E)	CSE (I)	IA (M)	Viva (V)	Term Work (TW)	
4	0	2	4	50	20	30	25	25	150

Detailed Syllabus

Sr No.	Title of the unit	Number of hours
1	**Introduction of Structural Health Monitoring** Need of Structural Health Monitoring, Definition & Concept of SHM, SHM & Biomimetic Comparison of SHM with NDT, Types & Components of SHM, Procedure of SHM, Objectives & Operational Evaluations of SHM, Advantages of SHM.	**4**

2	**Instrumentations & Sensors for SHM** Basics of Instrumentations & Measurements, Classifications, Input-Output Configurations of Instruments, Static & Dynamic Charecteristics, Functions. Various Types of Electromechanical, Electronics & Digital Instruments for SHM. Data Acquisition Systems-Types, Hardware & It's Components. Basics of Sensors, Transducers & Actuators, Classification of Sensors, Characteristics & Working Principles of Various Types of Sensors like Strain Gauges, LVDT, Accelerometers etc. Concept of Smart Materials & Smart Structures with SHM, Basics of Smart Materials like Piezoelectric, Shape Memory Alloys, ER & MR Fluids etc.	**10**
3	**Methods of SHM** Methodologies and Monitoring Principles, Local & Global Techniques for SHM, Static & Dynamic Field Testing, Short & Long-Term Monitoring, Active & Passive Monitoring. Vibration Based SHM Techniques - Use & Demonstration of Dynamic Properties of Structures for Damage Detection & SHM, Ambient Vibration Test, Acoustic Emission Technique, Electromechanical Impedance Technique, Wave Propagation Based Techniques, Fibre Optics Based Techniques, Remote & Wireless SHM Techniques, IoT Application in SHM, Artificial Intelligence & Machine Learning in SHM.	**10**
4	**Structural Assessment & Retrofitting of Structures** Structural Assessment & Need for retrofitting: Introduction to health assessment of structures, structural damages & failures, Principles of structural assessment, Classification & levels of assessment, Current scenario of infrastructure through case studies. Concept of repair & retrofitting of structures**:** Case studies of structural & foundation failure, performance problems, responsibility & accountability, causes of distress in structural members, design and material deficiencies, factors causing extensive Deterioration. Retrofitting of structures: Fundamental of retrofitting, Flow of retrofitting process, Methods of retrofitting, Materials for retrofitting (conventional and smart materials), selection of retrofitting methods	**16**

Suggested Theory Distribution

The suggested theory distribution as per Bloom's taxonomy is as per follows. This distribution serves as guidelines for teachers and students to achieve effective teaching-learning process

Distribution of Theory for course delivery and evaluation					
Remember	Understand	Apply	Analyze	Evaluate	Create
30%	40%	10%	5%	10%	5%

Instructional Method and Pedagogy:

1. Use of Learning Management system like canvas
2. Demonstration through ppt and videos and lectures
3. Brainstorming and group discussion sessions
4. Collaborative learning

List of Experiments/Tutorials:

1. To determine change in dynamic response of material due to damage: Steel
2. To determine change in dynamic response of material due to damage: Concrete
3. Damage detection using Acoustics/Ultrasonic wave propagation
4. Mapping of reinforcement details of given reinforced concrete element
5. Testing of rehabilitated beam – Flexure
6. Testing of rehabilitated beam – Shear
7. Testing of rehabilitated column

Recommended Study Material:

Reference Book:

- Structural Health Monitoring, Daniel Balageas, Peter Fritzen, Alfredo Guemes, John Wiley & Sons,2006.
- Health Monitoring of Structural Materials and Components Methods with Applications, Douglas E
- Adams, John Wiley and Sons, 2007.Structural Health Monitoring and Intelligent Infrastructure, Vol1, J. P. Ou, H. Li and Z. D. Duan,
- Taylor and Francis Group, London, UK, 2006.
- Structural Health Monitoring with Wafer Active Sensors, Victor Giurglutiu, Academic Press Inc,2007.

Web Resources

- https://research.csiro.au/data61/structural-health-monitoring
- https://beanair.com/conditioning-monitoring-system.html
- https://www.hindawi.com/journals/ace/2010/724962/
- https://www.ndt.net/events/NDTCanada2014/app/content/Slides/40_Tamutus.pdf
- https://cpwd.gov.in/Units/FinalDraftHandbook_Apr2007.pdf.

***