SARVAJANIK UNIVERSITY
Sarvajanik College of Engineering and Technology
Master of Technology
Structural Engineering

M. Tech. Ist year Semester – II

Subject Name: Structural Health Monitoring and Retrofitting of Structures **Subject Code:** MTST14204

Type of course: **PE-IV**
Prerequisite: Concrete technology, Analysis & Design of reinforced concrete structures

Rationale: Looking to the recent structural failures and the increased deterioration of the civil structures, demands the technology that can help to preserve structural integrity thereby assuring the public safety. Structural Health Monitoring (SHM) is one of such technology that helps to assess the in-service performance of the structures located in earthquake zones or remote areas, using a variety of sensors and other devices. The proper diagnosis through SHM helps to suggest the most appropriate retrofitting techniques to localize damages at their first occurrence. Structural condition assessment of a structure is required to evaluate its distress level. Based on distress occurred, appropriate retrofitting methods can be applied.

Teaching and Examination Scheme:

TEACHING SCHEME				Theory Marks			Practical Marks		Total
L	T	P	C	TEE	CA1	CA2	TEP	CA3	150
3	0	2	4	60	25	15	30	20	

CA1: Continuous Assessment (assignments/projects/open book tests/closed book tests **CA2:** Sincerity in attending classes/class tests/ timely submissions of assignments/self-learning attitude/solving advanced problems **TEE:** Term End Examination **TEP:** Term End Practical Exam (Performance and viva on practical skills learned in course) **CA3:** Regular submission of Lab work/Quality of work submitted/Active participation in lab sessions/viva on practical skills learned in course

Content:

Sr. No.	Topics	Teaching Hrs.	Module Weightage
1	**MODULE – I** Need of structural condition assessment, Structural Health: Factors affecting Health of Structures, Regular Maintenance, Facets of Maintenance, importance of Maintenance ,structural condition assessment, Repair Strategies: Construction and design failures, Assessment procedure for Inspection and evaluating a damaged structure, selection of repairing and rehabilitation methods, ;	**10**	**25 %**
2	**MODULE – II** Assessment procedure for Inspection and evaluating a damaged structure Causes of Distress, Destructive testing and non-destructive testing, their applicability.	**10**	**20%**
3	**MODULE –III** Strength and Durability Of Concrete- Quality assurance for concrete – Strength, Durability and Thermal properties, of concrete – Cracks,	**10**	**25%**

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	different types, causes – Effects due to climate, temperature, Sustained elevated temperature, Corrosion – Effects of cover thickness; Special Concretes- Polymer concrete, Sulphur infiltrated concrete, Fibre reinforced concrete, High strength concrete, High performance concrete, Vacuum concrete, Self-compacting concrete, Geopolymer concrete, Reactive powder concrete, Concrete made with industrial wastes		
4	**MODULE – IV** Epoxy injection, Shoring, Underpinning, Corrosion protection techniques – Corrosion inhibitors, Corrosion resistant steels, Coatings to reinforcement, cathodic protection; Repair, Rehabilitation and Retrofitting of Structures- Evaluation of root causes; Underpinning & shoring; some simple systems of rehabilitation of structures; Guniting, shotcreting; Non-Destructive testing systems; Use of external plates, carbon fibre wrapping and carbon composites in repairs. Strengthening of Structural elements, Repair of structures distressed due to corrosion, fire, Leakage, earthquake – Demolition Techniques – Engineered demolition methods –safety measures to be followed during demolition, care to be taken in dismantling of buildings so that maximum resale value material is generated. Case studies.	**14**	**30%**

Suggested Specification table with Marks (Theory/Practical):

% Distribution of Marks					
R Level	**U Level**	**A Level**	**N Level**	**E Level**	**C Level**
10%	**20%**	**35%**	**10%**	**20%**	**05%**

Legends: R: Remembrance, **U:** Understanding; **A:** Application, **N:** Analyze, **E:** Evaluate **C:** Create and above Levels **(Revised Bloom's Taxonomy)**

Note: This specification table shall be treated as a general guideline for students and teachers. The actual distribution of marks in the question paper may vary slightly from above table.

Reference Text Books:

Sr. No.	Title of book /article	Author(s)	Publisher and details like ISBN	Year of publication	Publication Edition
1.	Learning from failures Deficiencies in design, Construction and Service,	Raikar R. R & D centre (SDCPL)	Raikar Bhavan, Bombay		
2.	Concrete Technology by	A.R. Santakumar,	Oxford University press ISBN-13: 978-0-19-945852-3	2018	2nd edition
3.	Testing of Concrete in Structures	J.H. Bungey S.G. Millard	Taylor & Francis ISBN10: 0–415–26301–8	2004	4th edition

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		M.G. Grantham	ISBN13: 978–0–415–26301–6		
4.	Maintenance and Repair of Civil Structures, ,	B.L. Gupta and Amit Gupta	Standard Publications. ISBN-10 : 8180141020 ISBN-13 : 978-8180141027	2009	1st edition
5.	Structural Health Monitoring	Daniel Balageas, Claus-Peter Fritzen, Alfredo Güemes	Wiley-ISTE ISBN-10 : 1905209010 ISBN-13 : 978-1905209019	2006	1st edition
6.	Structural Health Monitoring and Intelligent Infrastructure,	Jinping Ou, Hui Li, Zhongdong Duan	CRC Press ISBN-10 : 0415396522 ISBN-13 : 978-0415396523	2005	1st edition
7.	Structural Health Monitoring (SHM) of Civil Structures	Gangbing Song, Chuji Wang, Bo Wang	Mdpi AG ISBN-10 : 3038427837 ISBN-13 : 978-3038427834	2016	-

Course Outcome:

Sr. No.	CO Statement After learning this subject, students will be able to	Marks % weightage
CO-1	Evaluate the structural condition assessment of building	25
CO-2	Learn the fundamentals Evaluate the structural health by static field tests	25
CO-3	Evaluate the structural health by dynamic field tests	20
CO-4	Suggest the appropriate methods of repair and rehabilitation	20
CO-5	Prepare detailed report for structural condition assessment of concrete building.	10

LIST OF PRACTICALS:

1. Structural Condition Assessment : Visit and Report preparation
2. Prepare estimate for repair the damaged structure visited.
3. Presentation of the contents prepared regarding visit.
4. To evaluate the strength of existing concrete components by NDT – Rebound Hammer test
5. To evaluate the strength of existing concrete components by NDT – Ultrasonic Pulse Velocity Test
6. To evaluate the strength of existing concrete components by Destructive test – Core Test
7. To study the carbonation of damaged concrete specimen
8. To repair the damaged concrete section
9. To demonstrate various sensors for health monitoring.

List of Open Source/learning website:

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1. https://research.csiro.au/data61/structural-health-monitoring
2. https://beanair.com/conditioning-monitoring-system.html
3. https://www.ndt.net/events/NDTCanada2014/app/content/Slides/
4. https://cpwd.gov.in/Units/FinalDraftHandbook_Apr2007.pdf

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