GUJARAT TECHNOLOGICAL UNIVERSITY, AHMEDABAD, GUJARAT

COURSE CURRICULUM
COURSE TITLE: MAINTENANCE & REHABILITATION OF STRUCTURES
(COURSE CODE: 3360605)

Diploma Programme in which this course is offered	Semesterinwhich offered
Civil Engineering	Sixth

1. RATIONALE

Maintenance of a building is the work done for keeping an existing building in a condition where it can continue to perform its intended functions. Proper maintenance not only improves functional and aesthetic value but also extends the life of building/structure and ensures safety of the users. Normally constructed building remains in a good shape for only for 40 to 50 years and starts deteriorating if not maintained properly. Inadequate maintenance and lack of repair works may lead to limited life span of buildings. However, with regular inspection and maintenance that enable timely identification of deteriorated elements and appropriate remedial measures, the life of normally constructed buildings/structures may be extended up to 100 years.

Most of the modern buildings constructed in India are now becoming old as they have reached the age beyond 40 years and needs maintenance. Thus there is a great demand and employment potential in this area. This course is therefore introduced in the curriculum so that students can also develop competence in this area. The course deals with the maintenance of buildings, concrete repair chemicals, special materials used for repair and repair of various parts of a building, strengthening of reinforced concrete members by shoring, underpinning, plate bonding, RC jacketing, control on termites and fungus in buildings, etc.

Knowledge and skills gained through this course may also prove helpful in upkeep and preservation of historical monuments. Thus this course is an important course for civil engineers.

2. COMPETENCY

The course content should be taught and implemented with the aim to develop required skills in the students so that students are able to acquire following competencies:

- **Carry out preventive and corrective maintenance to improve aesthetic and functional value of existing civil structures and to extend their life.**

3. COURSE OUTCOME (COs):

The theory should be taught and practical should be carried out in such a manner that students are able to acquire required learning out comes in cognitive, psychomotor and affective domain to demonstrate following course outcomes.

- Assess the health condition of structures.
- Inspect and evaluate damage structures.
- Test the assess the condition of properties of existing concrete structures.

- Implement the techniques for repairing of concrete structures.
- Dismantle and demolish structures which cannot be repaired in an environment friendly, with maximum saving of materials and in a safe way.

4. TEACHINGAND EXAMINATION SCHEME

Teaching Scheme (In Hours)			TotalCredits (L+T+P)	Examination Scheme				
				Theory Marks		PracticalMarks		Total Marks
L	T	P	C	ESE	PA	ESE	PA	
3	0	2	5	70	30	20	30	150

Legends:L- Lecture;**T-** Tutorial/TeacherGuidedStudentActivity;**P -** Practical; **C –**Credit; **ESE**-End Semester Examination; **PA**-Progressive Assessment

5. COURSE CONTENT DETAILS

Unit	Major LearningOutcomes (in Cognitive Domain)	Topics and Sub-topics
Unit-I Maintenance of Buildings	1.1 Explain the requirement of Maintenance in building. 1.2 Explain various types of maintenance in building. 1.3 Assess the quality aspects of existing building.	1.1 Introduction 1.2 Importance of maintenance 1.3 Types of maintenance - daily, weekly, monthly, Annually 1.4 General Maintenance - Painting of Buildings - Home Electricity System
Unit-Ii Repair Strategies	2.1 Explain distress diagnostic techniques 2.2 Carry out inspection and evaluation of damaged structure.	2.1 Causes of distress in structures 2.2 Construction and design failures 2.3 Condition assessment and distress-diagnostic techniques 2.4 Inspection and evaluating damaged structure.
Unit-Iii Durability and Serviceability of Concrete	3.1 Explain concrete properties required for construction work. 3.2 Explain weather effect on structure.	3.1 Quality assurance for concrete construction based on concrete properties like (a) strength (b) Permeability (c) Thermal properties (d) cracking 3.2 Effects due to (a) climate (b) temperature (c) chemicals (d) corrosion 3.3 Design and construction errors 3.4 Effects of cover and cracks

UNIT-IV Materials and Techniques For Repair	4.1 Identify materials for repair in building. 4.2 Explain techniques for Repairs.	4.1 Materials for Repair - Special concretes and mortar - concrete chemicals - construction chemicals - Expansive cement - polymer concrete - sulphur infiltrated concrete - Ferro cement - Fibre reinforced concrete - Rust eliminators and polymers coating for rebars - foamed concrete - dry pack - vacuum concrete - asphalt sheeting 4.2 Techniques for Repairs -Gunniting, grouting and Shotcrete - Epoxy injection

Unit	Major Learning Outcomes (in Cognitive Domain)	Topics and Sub-topics
		- Jacketing - shoring and underpinning - Methods of corrosion protection (a) corrosion inhibitors (b) corrosion resistant steels (c) coating and cathodic protection
UNIT-V Repair, Retrofitting and Rehabilitation	5.1 Explain the Repair work of various component in existing masonry building 5.2 Explain the Repair work of various component in existing concrete structure 5.3 Discuss principles of Retrofitting and Rehabilitation.	5.1 Repair of - stone, brick and block masonry (Cracks, dampness, efflorescence, joint separation, etc.) - Flooring - Roofs (sloping, flat, pitched, etc.) - Concrete members due to (i) Steel Corrosion (ii) Lack of Bond (iii) shear, tension, torsion, compression failure - Rainwater Leakage in Buildings - Leakage in Basement, toilet area 5.4 Control on Termites (White Ants) in Buildings 5.5 Fungus Decay of wood works

		in Buildings 5.6 Estimation of Repair and retrofitting.
UNIT-VI Demolition and Dismantling Techniques	6.1 Explain demolition techniques for structures. 6.2 Enlist safety measures to be followed during demolition. 6.3 Explain care to be taken in dismantling of buildings so that maximum resale value material is generated.	6.1 Define: Demolition 6.2 Demolition techniques (a) Non Engineering Demolition - Manual Demolition (b) Engineering Demolition - Mechanical Method (i) Wrecking Ball Method (ii) Pusher Arm technique (iii) Thermic Lance Technique (iv) Non – Explosive Demolition (v) Concrete Sawing Method (vi) Deliberate Collapse Method (vii) Pressure Jetting - Implosion - Deconstruction Method 6.4 Safety measures during demolition operation 6.5 Dismantling of buildings and reuse of materials/fittings from environmental and financial point of view.

6. SUGGESTED SPECIFICATION TABLE WITH HOURS & MARKS(Theory)

Unit	Unit Title	Teaching Hours	Distribution ofTheory Marks			
			R Level	U Level	A Level	Total Marks
I	Maintenance of Buildings	05	3	2	2	**7**
II	Repair Strategies	04	2	3	2	**7**

III	Durability and Serviceability of Concrete	06	3	4	3	**10**
IV	Materials and Techniques for Repair	10	4	6	8	**18**
V	Repair, Retrofitting and Rehabilitation	10	5	5	8	**18**
VI	Demolition and Dismantling Techniques	07	3	3	4	**10**
Total		**42**	**20**	**23**	**27**	**70**

Legends: R = Remember, **U =** Understand**, A=** Apply and above Level (Bloom's revised 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

7. SUGGESTED LIST OF EXERCISES/PRACTICAL

The practical/exercises should be properly designed and implemented with an attempt to develop different types of skills **(outcomes in psychomotor and affective domain)** so that students are able to acquire the competencies/programme outcomes. Following is the list of practical exercises for guidance.

Note*: Here only outcomes mainly in psychomotor domain are listed as practical/exercises. However, if these practical/exercises are completed appropriately, they would also lead to development of certain outcomes in affective domain which would in turn lead to development of* ***Course Outcomes*** *related to affective domain. Thus over all development of* ***Programme Outcomes (****as given in a common list at the beginning of curriculum document for this programme) would be assured.*

Faculty should refer to that common list and should ensure that students also acquire outcomes in affective domain which are required for overall achievement of Programme Outcomes/Course Outcomes.

S. No.	**Unit No.**	**Practical/Exercise** (outcomes in psychomotor domain)	**Approx. Hours Required**
1	I	Prepare a report on (based on internet search) a.Importance of Maintenance. b. Various routine maintenance works in building	02
2	II	Prepare a report on (based on internet search) a.Causes of distress in structures b.Points to be taken care of during inspection and evaluation of damaged structure	02
3	IV and V	Prepare sketches of equipment/tools for repair works. (Based on internet search and site visits)	06

4	I and II	Study the maintenance of a nearby building/civil structure being carried out (or carried out recently) and prepare a case study on it including financial aspects. (this may includes study of maintenance of cracks)	04
5	VI	Study the Demolition/dismantling work of a nearby building/civil structure being carried out (or carried out recently) and prepare a case study on it (including financial aspects and resale value of materials obtained in dismantling).	04
6	V	Study the guide lines of the Municipal Corporation or R& B department, BIS standards etc regarding declaring buildings/structures unsafe for living/use and based on this identify buildings/structures if any in your locality and prepare a case study on it. OR Study the preservation work of a historical building being carried out by Archaeological department in nearby location and prepare a report on it.	04
7	All	Seminar (Present case studies and reports prepared in above practicals in seminar type situation)	6
Total Hours			**28**

8. SUGGESTED LIST OF STUDENT ACTIVITIES

i. Visit, inspect and evaluate damaged structures and give suggestion about repair techniques.(in a group of 3 to 4)
ii. Prepare estimate for repair the damaged structure visited.
iii. Take photographs of site visit
iv. Each group may prepare a report and give seminar with Power Point Presentation.

9. SPECIAL INSTRUCTIONAL STRATEGIES (If Any)

i. Show videos of latest repairing techniques.
ii. Show videos of Dismantling/Demolition of civil engineering structures.
iii. Arrange expert lectures of engineers involved in demolition/dismantling and/or repair/retrofitting of old structures or/and historical monuments.
iv. Show video film or discuss the case of a civil structure which is shifted from one place to another due to need of construction of roads, dams etc. at original position of that structure.

10. SUGGESTED LEARNING RESOURCES

A. BOOKS :

No.	TITLE	AUTHOR	PUBLISHER
1.	Maintenance & Repair Of Civil Structures	B .L.Gupta	STANDARD PUBLICATIONS-
2.	Maintenance, Repair & Rehabilitation and Minor Works of Buildings	P. C. Varghese	PHI
3.	Concrete Structures, Materials, Maintenance and	Denison Campbell, Allen and Harold	Materials, Maintenance and
4.	Building Repair and Maintenance Management	P. S. Gahlot	CBS Publishers and Distributors Pvt Ltd.
5.	Building Construction	Dr. B. C. punamia	Laxmi Publications, New Delhi
6.	Repair of Concrete structures	R.T.Allen and S.C.Edwards	Blakie and Sons, UK
7.	Handbook on Repairs and Rehabilitation of		CPWD,Delhi
8.	Maintenance of Buildings	A.C. Panchdhari	New Age Internationsl
9.	Concrete Technology-Theory and Practice	M.S.Shetty	S.Chand and Compony,New Delhi
10.	Training Course notes on Damage Assessment and Repairs in Low Cost Housing	Santhakumar , A. R.	RHDC –NBO Anna University (July 1992)
11.	Learning from failures-Deficiencies in design, Construction and Service	Raikar R.	R & D centre (SDCPL) ,Raikar Bhavan, Bombay

B. LIST OF RECOMMENDED I.S. PUBLICATIONS:

i.SP:25 Causes, Prevention and Remedies of Cracks in Building

ii.National Building Code of India 2005

C. List of Major Equipment/Materials

i.Crack Gauge and Crack Monitor

ii.Damp meter

D List of Software/Learning Websites

i. www.bis.org.in/sf/nbc.htm

ii. cpwd.gov.in/Units/handbook.pdf
iii. http://www.civilengineeringnews.tk/2014/07/methods-of-demolition-of-building.html
iv. thecontractor.org

11. COURSE CURRICULUMDEVELOPMENT COMMITTEE

FACULTIES FROM POLYTECHNICS, GUJARAT

- **Prof. S. M. Mistry**, H.O.D. Civil Engg Dept., Dr. S& S.S. Ghandhy College of Engg and Tech, Surat
- **Prof. V. K. Shah**, H.O.D. Civil Engg Dept., Dr. S& S.S. Ghandhy College of Engg and Tech, Surat
- **Prof. H. K. Rana**, Lecturer, Governemnt Polytechnic, Valsad
- **Prof. D K PARMAR** , Lecturer , Applied Mechanics , B & B Institute of Technology, V. V. Nagar.

Coordinator and Faculty Members from NITTTR Bhopal

- **Prof. M. C. Paliwal**, Associate Professor, Department of Civil and Environmental Engineering.
- **Prof. Shashi Kant Gupta,** Professor and Coordinator for State of Gujarat.