



INSTITUTE OF AERONAUTICAL ENGINEERING

(Autonomous)

Dundigal, Hyderabad - 500 043

CIVIL ENGINEERING

COURSE DESCRIPTION FORM

Course Title	Rehabilitation & Retrofitting of structure			
Course Code	A80151			
Regulation	R13-JNTUH			
Course Structure	Lecturers	Tutorials	Practical's	Credit's
	5	-	-	4
Course Coordinator	Mr. P. Vinay Kumar, Assistant Professor, Civil Engineering			
Team of Instructors	Ms. K. Anusha Hadassa, Assistant Professor, Civil Engineering			

I. COURSE OVERVIEW:

The primary objective of this course is to introduce the concept of Rehabilitation as a precise concept, and study how to overcome the defects in regular construction practices, establish their effectiveness in overcoming the problems faced, study their efficiency and memory needs. The course consists of Retrofitting components in addition to adapting new techniques in construction practices.

Retrofitting reduces the vulnerability of damage of an existing structure during a future earthquake. It aims to strengthen a structure to satisfy the requirements of the current codes for seismic design. In this respect, seismic retrofit is beyond conventional repair or even rehabilitation. The applications include different types of buildings, industrial structures, bridges, urban transport structures, marine structures and earth retaining structures.

The benefits of retrofitting include the reduction in the loss of lives and damage of the essential facilities, and functional continuity of the life line structures. For an existing structure of good condition, the cost of retrofitting tends to be smaller than the replacement cost. Thus, the retrofitting of structures is an essential component of long term disaster mitigation.

II. PREREQUISITE(S):

Level	Credits	Periods/ Week	Prerequisites
UG	4	4	Concrete Technology

III. MARKS DISTRIBUTION:

Sessional Marks	University End Exam marks	Total marks
Midterm Test There shall be two midterm examinations. Each midterm examination consists of descriptive paper, objective paper and assignment. The descriptive paper is for 10 marks of 60 minutes duration and shall contain 4 questions in two parts.	75	100

<p>Part-A consists of two questions each carry 5 marks and student has to answer any one question.</p> <p>Part-B consists of two questions each carry 5 marks and student has to answer any one question.</p> <p>The objective paper is for 10 marks of 20 minutes duration. It consists of 10 multiple choice and 10 fill-in-the blank questions, the student has to answer all the questions and each carries half mark.</p> <p>First midterm examination shall be conducted for the first two and half units of syllabus and second midterm examination shall be conducted for the remaining portion.</p> <p>Five marks are earmarked for assignments. There shall be two assignments in every theory course. Assignments are usually issued at the time of commencement.</p>		
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IV. EVALUATION SCHEME:

S. No.	Component	Duration	Marks
1.	I Mid Examination	80 minutes	20
2.	I Assignment	-	5
3.	II Mid Examination	80 minutes	20
4.	II Assignment	-	5
5.	External Examination	3 hours	75

V. COURSE OBJECTIVES:

At the end of the course, the students will be able to:

- I. Identify the causes of deterioration in structures and suggest suitable remedial measures.
- II. Generalize the types of damages and understand their mechanisms.
- III. Infer the causes and prevention mechanisms of corrosion in steel reinforcement and fire induced damages.
- IV. Learn to inspect and assess the structures using techniques of visual inspection and NDT.
- V. Evaluate a structural damage and recommend suitable repair and strengthening methods.
- VI. Identify the latest health monitoring and building instrumentation methods.

VI. COURSE OUTCOMES:

After completing this course, the student must demonstrate the knowledge and ability to:

1. Recognize the mechanisms of degradation of concrete structures and conduct Preliminary forensic assessment of deteriorated concrete structures.
2. Focusing on repairing, maintaining, rehabilitating, and retrofitting of existing infrastructures to extend their life and maximize economic return.
3. Assess the causes of distress in structures and suggest suitable measures for prevention.
4. Analyze the mechanisms of damage in structures and their types.
5. Categorize the causes and prevention mechanisms of corrosion in steel reinforcement and fire induced damages.
6. Able to Examine to inspect and assess the structures using techniques of visual inspection and NDT.
7. Understand the behavior of a structure when damaged due to fire.
8. Choose an appropriate method for diagnosis of distress caused due to fire.
9. Compare different types of repairs and choose the best appropriate method.
10. Identify the various repairing methods and categorize them depending upon the type of structure.
11. Classify the various Components of a Structural Health Monitoring System.
12. Methodology of health monitoring of structures and smart materials.

VII. HOW PROGRAM OUTCOMES ARE ASSESSED:

Program Outcomes		Level	Proficiency assessed by
PO1	Engineering knowledge: Apply the knowledge of mathematics, science, engineering fundamentals, and an engineering specialization to the solution of complex engineering problems.	H	Assignments/ Exams
PO2	Problem analysis: Identify, formulate, review research literature, and analyze complex engineering problems reaching substantiated conclusions using first principles of mathematics, natural sciences, and engineering sciences.	H	Assignments/ Exams
PO3	Design/development of solutions: Design solutions for complex engineering problems and design system components or processes that meet the specified needs with appropriate consideration for the public health and safety, and the cultural, societal, and environmental considerations.	-	-
PO4	Conduct investigations of complex problems: Use research-based knowledge and research methods including design of experiments, analysis and interpretation of data, and synthesis of the information to provide valid conclusions.	S	Assignments
PO5	Modern tool usage: Create, select, and apply appropriate techniques, resources, and modern engineering and IT tools including prediction and modeling to complex engineering activities with an understanding of the limitations.	-	-
PO6	The engineer and society: Apply reasoning informed by the contextual knowledge to assess societal, health, safety, legal and cultural issues and the consequent responsibilities relevant to the professional engineering practice.	-	-
PO7	Environment and sustainability: Understand the impact of the professional engineering solutions in societal and environmental contexts, and demonstrate the knowledge of, and need for sustainable development.	H	Assignments/ Exams
PO8	Ethics: Apply ethical principles and commit to professional ethics and responsibilities and norms of the engineering practice.	-	-
PO9	Individual and team work: Function effectively as an individual, and as a member or leader in diverse teams, and in multidisciplinary settings.	-	-
PO10	Communication: Communicate effectively on complex engineering activities with the engineering community and with society at large, such as, being able to comprehend and write effective reports and design documentation, make effective presentations, and give and receive clear instructions.	S	Group Discussions/ Presentations
PO11	Project management and finance: Demonstrate knowledge and understanding of the engineering and management principles and apply these to one's own work, as a member and leader in a team, to manage projects and in multidisciplinary environments.	H	Presentations/ Assignments
PO12	Life-long learning: Recognize the need for, and have the preparation and ability to engage in independent and life-long learning in the broadest context of technological change.	-	-

S – Supportive

H-Highly Related

VIII. HOW PROGRAM SPECIFIC OUTCOMES ARE ASSESSED:

Program Specific Outcomes		Level	Proficiency Assessed by
PSO1	ENGINEERING KNOWLEDGE: Graduates shall demonstrate sound knowledge in analysis, design, laboratory investigations and construction aspects of civil engineering infrastructure, along with good foundation in mathematics, basic sciences and technical communication.	H	Assignment, Tutorials Exams
PSO2	BROADNESS AND DIVERSITY: Graduates will have a broad understanding of economical, environmental, societal, health and safety factors involved in infrastructural development, and shall demonstrate ability to function within multidisciplinary teams with competence in modern tool usage.	H	Mini Projects
PSO3	SELF-LEARNING AND SERVICE: Graduates will be motivated for continuous self-learning in engineering practice and/ or pursue research in advanced areas of civil engineering in order to offer engineering services to the society, ethically and responsibly.	-	-

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IX. SYLLABUS:

UNIT-I

Introduction: Deterioration of structures-Distress in structures –Causes and prevention. Mechanism of Damage –Types of Damage.

UNIT – II

Corrosion of Steel Reinforcement – Causes – Mechanism and Prevention. Damage Of Structures due to fire – fire Rating of Structures – Phenomena of Desiccation.

UNIT – III

Inspection and Testing – symptoms and Diagnosis of Distress – Damage assessment –NDT.

UNIT – IV

Repair of structures –Common Types of Repairs-Repair in concrete structures –Repair in underwater structures - Guniting –shot create –underpinning. Strengthening of structures – strengthening Methods – Retrofitting –Jacketing

UNIT – V

Health Monitoring of Structures – Use of Sensors – Building Instrumentation.

TEXT BOOKS:

1. Maintenance and Repair of Civil Structures, B.L. Gupta and Amit Gupta, Standard Publications.
2. Concrete technology by A.R Shantakumar , Oxford University press.

REFERENCES:

1. Defects and Deterioration in Building E F & N Spon, London.
2. Non-Destructive Evaluation of concrete structures by Bungey-Surrey University Press.
3. Concrete Repair and Maintenance illustrated, RS Means Company Inc. W.H. Ranso, (1981)
4. Building Failures: Diagnosis and Avoidance, EF&N spon, London, B.A. Richardson, (1991)

X. COURSE PLAN:

At the end of the course, the students are able to achieve the following course learning outcomes:

Lecture Number	Topics Planned to cover	Learning Objectives	References
1 -2	Introduction to Rehabilitation and Retrofitting of Structures, Differentiating between Rehabilitation and Retrofitting.	Define Rehabilitation and Retrofitting of Structures. Classify Rehabilitation and Retrofitting of Structures	T2:26.3
3 - 4	Deterioration of concrete Structure.	Identifying Deterioration of Structure	T2:22.2
5 - 6	Types of distress in concrete structures in beams, columns.	Classify Distress in concrete structures	T2:22.1
7 - 8	Types of causes of Deterioration and distress in concrete Structure.	Define causes of Deterioration and distress in concrete Structure.	T2:22.1
9 - 10	Types of prevention in R.C.C structures like Slabs, Columns, Beams.	Explain prevention for of Deterioration and distress in concrete Structure.	T1:7.1-.6
11-12	Mechanism of damages of various concrete structures.	Explain Mechanism of damages of concrete structure.	T1:8.1-4
13-14	Types of damages for various R.C.C structures	Classify Types of damages	T1:7.1
15-16	Non-Structures damages in building	Identify the Non-Structures damages	T1: 8.1-.3
17	Structures damages for various aspects in engineering structures.	Identify the Structures damages	T1: 8.1-.3
18-19	Determination of corrosion of steel reinforcement in building structures	Define corrosion of steel reinforcement.	T2: 10.1-.3
20-21	Causes for corrosion of steel reinforcement structures	Explain the causes for corrosion of steel reinforcement structures	T2: 10.4
22-23	Mechanism of corrosion and its prevention	Identify the mechanism of corrosion	T2: 10.4
24-25	Prevention for corrosion of steel reinforcement structures	Discuss the Prevention for corrosion of steel reinforcement structures.	T2: 10.4-.6
26	Damage of structure due to fire like loss of life, damage to property	Define Damage of structure due to fire.	T2: 23.4
27-28	Damage of structure due to fire like loss of business, loss of goodwill, Environment pollution.	Explain Damage of structure due to fire.	T2: 23.4 -.7
29	Designing of fire resistance rating structure, selection of materials, planning of services.	Designing of fire rating structure.	T2: 23.4 -.7
30-31	Designing of fire resistance rating structure, horizontal compartmentation, and vertical compartmentation.	Analysis of fire rating structure.	T2: 23.4 -.7
32-33	Definition Phenomena of Desiccation.	Define Phenomena of Desiccation	T2: 22.4
34	Desiccation and its importance in concrete technology.	Explain Desiccation of fire.	T2: 22.5
35-36	Analysis of inspection, Visual inspections, checking originals, in situ testing, laboratory testing.	Analysis of inspection.	T2: 25.1 - .2

37-38	Monitoring and testing of structures and their symptoms.	Calculating testing and monitoring	T2: 25.2
39-40	Distresses in concrete structures are basic symptoms, common defects, overloading.	Explain diagnosis of distress.	T2: 22.1 - .2
41	Damage assessments for existing structures procedure.	Calculating damage assessment	T2: 26.3
42-43	Assessments of existing structures for corrosion monitoring techniques.	Explaining of damage assessment	T2: 10.4-.6
44-45	Repair of structures with techniques and materials used for repairing of structure.	Explain repair of structure	T2: 22.1-.3
46-47	Common types of repairs in structures, repairs in concrete structures are crack repair techniques, sealing with epoxies, routing and sealing, stitching.	Discuss common types of repairs	T2: 22.4
48-49	Repairs in under water structures with termite method.	Define repairs in under water structures.	T2: 22.6
50-51	Guniting and shot Crete discuss with detailed, And materials used for Guniting and shot Crete for repairs.	Identify guniting and shot Crete.	T2: 26.2
52-53	Underpinning of structures various loading, and application and there methodology	Define underpinning.	T2: 26.2
54	Strengthen of structures and its components for various constructions of structures.	Define strengthen of structures	T2: 26.2
55-57	Strengthen methods of structural members and their different methodologies for beams, columns, slabs.	Explain strengthen methods of structures	T2: 25.2
58-59	Strengthen and stiffening of beams, girders and flexural members.	Identify the strengthen methods of structures	T2: 25.3
60	Construction of jacketing and its types and methodology.	Construction of jacketing.	T2: 29.3
61	Design health monitoring structures types and its methodology.	Explain health monitoring structures	T2: 29.3-.4
62-64	Use of sensor technology in various aspects and there types and advantage of sensors.	Discuss uses of sensors	T2: 29.3-.4
65-67	Analysis of instrumentation for building structures and its methods.	Define building instrumentation for SHM	T2: 29.3-.4
68	Revision		

XI. MAPPING COURSE OBJECTIVES LEADING TO THE ACHIEVEMENT OF PROGRAM OUTCOMES AND PROGRAM SPECIFIC OUTCOMES:

Course Objectives	Program Outcomes												Program Specific Outcomes		
	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3
I	S	H											H		
II	H	S								S			H	S	
III				H			S						H	S	
IV											S		S	H	
V	H	S											S		
VI		S					S							H	

S= Supportive

H = Highly Related

XII. MAPPING COURSE OUTCOMES LEADING TO THE ACHIEVEMENT OF PROGRAM OUTCOMES AND PROGRAM SPECIFIC OUTCOMES:

Course Outcomes	Program Outcomes												Program Specific Outcomes		
	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3
1	H	S											H	S	
2	H			S							H		S	H	
3		H											H	S	
4	H	H								H			H		
5	H	S											S		
6	H						S						H	S	
7	H	S											H	S	
8	H			S									S	H	
9	S	H					S			S			H	S	
10	H	H									S		H		
11	H	S											S		
12	H												H	S	

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Prepared by: Mr. P. Vinay Kumar, Assistant Professor, CE

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