

Course Code	Course Title					Core / Elective	
PE 821 CE	Retrofitting and Rehabilitation of Structures					Elective	
Prerequisites	Contact Hours per Week				CIE	SEE	Credits
	L	T	D	P			
Concrete Technology	3	-	-	-	30	70	3
Course Objectives <ul style="list-style-type: none"> ➤ Understand the basic concepts of building maintenance. ➤ Understand the causes, mechanisms and prevention of deterioration of structures. ➤ Understand the methods of condition assessment of structures. ➤ Learning the materials, methodology and techniques of repair. ➤ Learning the methods and strategies of retrofitting of structures. Course Outcomes After completing this course, the student will be able to <ol style="list-style-type: none"> 1. Distinguish between various definitions related to building repair and maintenance. 2. Differentiate the types of defects, damage and explain the various deterioration mechanisms in structures. 3. Classify and explain the various non-destructive tests and condition assessment procedures. 4. Describe various repair materials and techniques. 5. Explain the various retrofitting and rehabilitation procedures. 							

UNIT – I

Introduction to Building Maintenance: Definitions of repair, renovation, remodelling, restoration, retrofitting and rehabilitation. Need for maintenance, types of maintenance, routine maintenance works in buildings.

Types of Defects and Damages in Structures: During pre-construction stage, construction stage and post construction stage. Cracks – Types, Causes and Characteristics

UNIT – II

Mechanisms of Deterioration of Structures & Their Prevention: Concrete Structures: Defects in fresh concrete - Early frost damage, plastic shrinkage, plastic settlement (subsidence), subgrade settlement, formwork movements. Deterioration in hardened concrete: (a) Physical causes - aggregate shrinkage, drying shrinkage, crazing (b) Chemical causes: acid attack, sulphate attack, chloride attack, carbonation, alkali aggregate reaction, corrosion of reinforcement, (c) Thermal causes: Freeze-thaw, temperature variations, differential thermal expansions, humidity influences, (d) Structural causes: improper design loads, accidental overloads, creep

Steel Structures: Causes and types of deterioration, mechanism of corrosion, prevention of deterioration, influence of design details, design and fabrication errors, stresses due to erection.

UNIT – III

Condition Assessment and Non-destructive Testing & Evaluation: Definition, objectives and stages of condition assessment, Destructive and partially destructive tests. Non-destructive tests (NDTs). Classification of NDT procedures, Visual Inspection, Ultrasonic Testing methods (Impact echo, Pulse velocity, Pulse echo), Rebound hammer (IS 13311), Windsor probe test, Half-cell potential measurement, Electrical resistivity measurement, Carbonation depth measurements, Petrographic Analysis, Electromagnetic methods for Rebar detection, Ground Penetrating radar, Infrared thermography, Radiography, Radio isotope gauges, Remote viewing, Hammer sounding, Chain drag techniques.

UNIT – IV

Repair Materials and Techniques: Repair Methodology, Repair materials (cement-based, polymer-based, resin based, microcrete, composites, etc.), compatibility considerations, Repair techniques: Using mortars, dry pack, epoxy bonded pack, pre-placed aggregate concrete, gunite, shotcrete, grouting, polymer impregnation, resin injection, routing & sealing, stitching, surface patching, overlays & surface coatings, autogenous healing, gravity filling, drilling and plugging

UNIT – V

Retrofitting & Rehabilitation Procedures: Strengthening of Existing Structures – Overview, general procedures, Techniques: section enlargement, composite construction, post-tensioning, stress reduction, strengthening by reinforcement, methods of strengthening in beams, slabs, columns (plate bonding, RC jacketing, FRP methods, concrete overlays, etc.) strengthening of substructure (shoring, underpinning)

Suggested Readings:

1. Varghese P. C. (2015), *Maintenance, Repair & Rehabilitation & Minor Works of Buildings*, PHI Learning Pvt. Ltd, Delhi.
2. Modi P.I. and Patel C.N. (2016), *Repair and Rehabilitation of Concrete Structures*, PHI Learning Pvt. Ltd, Delhi.
3. Peter H. Emmons, (2001), *Concrete Repair and Maintenance Illustrated*, Galgotia Publications, New Delhi.
4. Johnson.S.M., (1980), *Deterioration, Maintenance and Repair of Structures*, Krieger Publishing, Melbourne, Florida.
5. Guha. P.K., (1998), *Maintenance and Repairs of Buildings*, New Central Book Agency Ltd., Kolkata.
6. SP: 25-1984, (1999), *Handbook on Causes and Prevention of Cracks in Buildings*, BIS, New Delhi.
7. Guide Book on *Non-destructive Testing of Concrete Structures*, Training course series No. 17, International Atomic Energy Agency, Vienna, 2002.
8. Hand book on "*Repair and Rehabilitation of RCC Buildings*", Published by Director General, CPWD, Govt. of India, 2002.