**E.G.S. PILLAY ENGINEERING COLLEGE, NAGAPATTINAM.**

**DEPARTMENT OF CIVIL ENGINEERING**

**COURSE PLAN**

**COURSE CODE : CE 6021 COURSE NAME :** **REPAIR AND REHABILITATION OF STRUCTURES**

**SEMESTER : IV Year & Civil ‘A&B’ Sec. ACADEMIC YEAR: 2016-2017**

**COURSE DURATION: JANUARY – MAY 2017 CLASS ROOM : PG Block 207 & 301**

**FACULTY DETAILS: A.ARJUNAN, AP/Civil Engg.**

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| **PURPOSE** | To impart knowledge about Maintenance and Repair Strategies |
| **PREREQUISITE** | 1. Concrete Technology 2. Construction Material And Equipments |
| **INSTRUCTIONAL OBJECTIVES** | 1. To make the students to gain the knowledge on quality of concrete, durability aspects, causes of deterioration, assessment of distressed structures, repairing of structures and demolition procedures. 2. To make the students to assess the durability of concrete due to various climate conditions 3. To prepared the students to select the appropriate rehabilitation, retrofitting and demolition for structures. |
| **COURSE OUTCOME(COs)** | After completion of this course, students can able to   1. suggest maintenance and repair strategies(k2). 2. examine the durability due to various climate conditions(k4) 3. suggest the suitable materials and techniques for repair(k2) 4. choose various rehabilitation and retrofitting techniques.(k3) 5. select suitable demolition techniques for structures(k3) |

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| Course designed by | | Anna University, Chennai. Regulation 2013 | | | | | | |
| 1 | Category | | GENERAL  (G) | BASIC SCIENCES  (B) | | | ENGINEERING SCIENCES  AND TECHNICAL ART  (E) | **PROFESSIONAL**  **SUBJECTS**  **(P)** |
|  |  | | |  | **x** |
| 2 | Broad area | | REPAIR | | | DIAGNOSE | ANALYSIS | STRENGTHENING |
| **X** | |  | |  |  |
| 3 | Course co-coordinator | | | | | | A.ARJUNAN | |

**Direct assessment details**

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| **Name of assessment** | **Internal Marks** | **Topics** | **Duration** |
| Unit Test | 20 | Unit I | 2 periods |
| Daily Test 1 | Unit II | 1 period |
| Daily Test 2 | Unit III | 1 period |
| Daily Test 3 | Unit IV | 1 period |
| Cycle Test -1 | II & III Units | 3 Hrs |
| Cycle Test -2 | IV & V Units | 3 Hrs |
| Model Exam | Entire Syllabus | 3 Hrs |
| Assignments |  | Entire Syllabus |  |
| Innovative Assignment | Content Beyond Syllabus |  |
|  |  |  |  |
| Total | 20 |  |  |

**DETAILED LESSON PLAN**

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| **UNIT I : MAINTENANCE AND REPAIR STRATEGIES**   |  |  |  | | --- | --- | --- | | **LECTURE** | **TUTORIAL** | **PRACTICAL** | | **9 Hrs.** | **0 Hr** | **0 Hr** |   Maintenance, repair and rehabilitation, Facets of Maintenance, importance of Maintenance various aspects of Inspection, Assessment procedure for evaluating a damaged structure, causes of deterioration | | | | | | | | | | | |
| **Session No** | **topics to be covered** | | **Instruction Delivery** | | | | **Testing Method** | **Instructional objective** | | **Course Outcome** | |
| **Method** | | **Teaching Aids** | **Level** |
| **1** | Maintenance, | | Lecture with discussion | | PPT & Videos | Understand |  | 1. To make the students to gain the knowledge on quality of concrete, durability aspects, causes of deterioration, assessment of distressed structures, repairing of structures and demolition procedures.  .  . | | CO1:Could find to mistake earlier by regular inspection. it deflect find either building (or) bridges. it could be repaired. | |
| **2** | repair and rehabilitation | |
| 3 | Facets of Maintenance | | Tests, Assignments |
| 4 | importance of Maintenance | |
| 5 | various aspects of Inspection | |
| 6 | Assessment procedure for damage | |
| 7 | Assessment procedure for evaluating a damaged structure, | |
| 8 | causes of deterioration | |
| 9 | causes of deterioration | |
| **CUMULATIVE HOURS = LECTURE - 9, TUTORIAL – 0** | | | | | | | | | | | |
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| **UNIT II: SERVICEABILITY AND DURABILITY OF CONCRETE**   |  |  |  | | --- | --- | --- | | **LECTURE** | **TUTORIAL** | **PRACTICAL** | | **09Hrs.** | **0 Hr.** | **0 Hr.** |   Quality assurance for concrete construction concrete properties- strength, permeability, thermal properties and cracking. - Effects due to climate, temperature, chemicals, corrosion – design and construction errors - Effects of cover thickness and cracking | | | | | | | | | | | |
| **Session No** | **Topics to be covered** | **Instruction Delivery** | | | | | **Testing Method** | | **Instructional objective** | | **Course Outcome** |
| **Method** | | **Teaching Aids** | | **Level** |
| **1** | Quality assurance for concrete | Lecture with discussion | | PPT & Videos | | Understand | Tests,  Assignments | | To maintenance the durability of concrete adopting quality measures | | By CO2: Adopting repairing techniques improve service life structures elements |
| **2** | construction concrete properties- |
| **3** | strength, and permeability, |
| **4** | Thermal  properties and cracking |
| **5** | Effects due to climate, |
| **6** | temperature, chemicals |
| **7** | Corrosion |
| **8** | Method of Corrosion |
| 9 | Design  and construction errors  Effects of cover thickness  cracking |
| **CUMULATIVE HOURS = LECTURE - 18, TUTORIAL – 0** | | | | | | | | | | | |

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| **UNIT III: SPECIAL CONCRETES**   |  |  |  | | --- | --- | --- | | **LECTURE** | **TUTORIAL** | **PRACTICAL** | | **09Hrs.** | **0 Hr.** | **0 Hr.** |   Electric Discharge Machining (EDM) – Working principles – Equipments - Process parameters – MRR – Electrode Tool – Power circuits, Tool wear – Dielectric – Flushing – Wire cut EDM – Applications | | | | | | | |
| **Session No** | **Topics to be covered** | **Instruction Delivery** | | | **Testing Method** | **Instructional objective** | **Course Outcome** |
| **Method** | **Teaching Aids** | **Level** |
| **1** | Polymer concrete | Lecture with discussion | PPT & Videos | Understand | Tests,  Assignments | To maintenance the durability of concrete adopting quality measures | CO3: Having detailed knowledge about the structural repairing material and technique will give good exposure to the working personal |
| **2** | Sulphur infiltrated concrete |
| **3** | Fibre reinforced concrete |
| **4** | Vacuum concrete, Self compacting concrete, |
| **5** | Grade separation |
| **6** | , Geopolymer concrete |
| **7** | Reactive powder concrete |
| 8 | Concrete made with industrial wastes |
| 9 |  |  |  |  |  |  |
| **CUMULATIVE HOURS = LECTURE - 27, TUTORIAL – 0** | | | | | | | |

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| **UNIT IV: TECHNIQUES FOR REPAIR AND PROTECTION METHODS**   |  |  |  | | --- | --- | --- | | **LECTURE** | **TUTORIAL** | **PRACTICAL** | | **09 Hrs.** | **0 Hr.** | **0 Hr.** |   Non-destructive Testing Techniques, Epoxy injection, Shoring, Underpinning, Corrosion protection techniques – Corrosion inhibitors, Corrosion resistant steels, Coatings to reinforcement, cathodic protection. | | | | | | | | | | | | |
| **Session No** | **Topics to be covered** | | **Instruction Delivery** | | | | | **Testing Method** | | **Instructional objective** | | **Course Outcome** |
| **Method** | **Teaching Aids** | | **Level** | |
| **1** | Non-destructive Testing Techniques | | Lecture with discussion and case studies | PPT & Videos | | Apply | | Tests,  Assignments | | 3.Detail study about the repair materials technique To make the special cement concrete mortal &special types of infrastructure.to cement essential oriental. | | CO4: Modern technique and equipment being adopted for the demolition large and hazardous structure in safe manner |
| **2** | Epoxy injection | |
| **3** | Shoring, | |
| 4 | Underpinning, | |
| 5 | Corrosion protection techniques – Corrosion inhibitors, | |
| **6** | Corrosion resistant steels, Coatings to reinforcement, | |
| **7** | Corrosion inhibitors, Corrosion resistant steels | |
| 8 | Corrosion inhibitors, Corrosion resistant steels | |
| 9 | Coatings to reinforcement, cathodic protection.  . | |
| **CUMULATIVE HOURS = LECTURE - 36, TUTORIAL – 0** | | | | | | | | | | | | |
| **UNIT V: REPAIR, REHABILITATION AND RETROFITTING OF STRUCTURES**   |  |  |  | | --- | --- | --- | | **LECTURE** | **TUTORIAL** | **PRACTICAL** | | **09Hrs.** | **0 Hr.** | **0 Hr.** |   Strengthening of Structural elements, Repair of structures distressed due to corrosion, fire, Leakage, earthquake – DEMOLITION TECHNIQUES - Engineered demolition methods - Case studies | | | | | | | | | | | | |
| **Session No** | | **Topics to be covered** | **Instruction Delivery** | | | | **Testing Method** | | **Instructional objective** | | **Course Outcome** | | |
| **Method** | | **Teaching Aids** | **Level** |
| **1** | | Strengthening of Structural elements, | Lecture with discussion,  Practical demo and practice in Industrial visit | | PPT & Videos | Apply | Tests,  Assignments | | 3.Detail study about the repair materials technique To make the special cement concrete mortal &special types of infrastructure.to cement essential oriental. | | CO5: Adopting this repair measure old and damage structure elements can be made strength and it will being to normal services. (or) working condition | | |
| **2** | | Repair of structures distressed due to corrosion, |
| **3** | | Repair of structures distressed due to fire, |
| 4 | | Repair of structures distressed due to c Leakage, |
| **5** | | Repair of structures distressed due to c, earthquake |
| **6** | | DEMOLITION TECHNIQUES |
| 7 | | DEMOLITION TECHNIQUES - Engineered demolition methods |
| 8 | | Engineered demolition methods |  | |  |
| 9 | | Case study |
| 10 | | Applications. |
| **CUMULATIVE HOURS = LECTURE - 45, TUTORIAL – 0** | | | | | | | | | | | | | |

**Text / Reference Books**

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| **Sl. No.** | **Title of the Book** | **Author(s)** | **Publisher** |
| **TEXT BOOKS** | | | |
| T1 | Concrete Structures, Materials, Maintenance and Repair” | 1. Denison Campbell, Allen and Harold Roper, | Longman Scientific and Technical UK, 1991. |
| T2 | Repair of Concrete Structures, | Allen R.T. & Edwards S.C, | Blakie and Sons, UK, 1987 |
| **REFERENCES** | | | |
| R1 | "Concrete Technology - Theory and Practice" | Shetty M.S., | S.Chand and Company, 2008 |
| R2 | "Design and Construction Failures" | Dov Kominetzky.M.S | Galgotia Publications Pvt. Ltd., 2001 |
| R3 | "Structural Health Monitoring, Repair and Rehabilitation of Concrete Structures" | Ravishankar.K., Krishnamoorthy.T.S, | Allied Publishers, 2004 |
| R4 | Hand book on Seismic Retrofit of Buildings, | CPWD and Indian Buildings Congress | Narosa Publishers, 2008 |
| R5 | "Concrete Technology", | Gambhir.M.L. | McGraw Hill, 2013 |
| **REFERENCE WEBSITES** | | | |
| 1 | [www.wikipedia.com](http://www.wikipedia.com) | | |
| 2 | www. NPTEL.com | | |
| 3 | [www.castle.com](http://www.castle.com) | | |

**GAP ANALYSIS:**

To fill the gaps between **Course Outcomes 1, 2, 3, 4, 5** and Program Outcomes **PO7,08,09,10** and **PO11** the following content beyond syllabi topics are to be given to the students as an innovative assignments.

1. plan to arranged field visit for mukkombu Dam and Tharangampadi Danish fort

2. plan to conduct the value added courses new technique adopted for construction field

**CONTENT BEYOND SYLLUBI:** Assignments forthe following topics:

1. Marine exposure
2. Repairs to overcome low member strength

3. Chemical disruption **COURSE INCHARGE**

**Programme Name: CIVIL ENGINEERING**

**Programme Educational Objectives (PEOs):**

PEO1: Graduates will actively engage in problem solving using engineering principles to address the evolving needs of the society.

PEO2: Graduates will have successful career in civil engineering practice and research activities.

PEO3: Graduates will serve the society with professional ethics and integrity.

**Programme Outcomes (POs): Graduates will be able to**

(PO1) Apply the knowledge of mathematics, science, engineering fundamentals, and an engineering specialization to the solution of complex engineering problems.

(PO2) Identify, formulate, research literature, and analyze complex engineering problems reaching substantiated conclusions using first principles of mathematics, natural sciences, and engineering sciences.

(PO3) 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) 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.

(PO5) 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) 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) Understand the impact of the professional engineering solutions in societal and environmental contexts, and demonstrate the knowledge of, and need for sustainable development.

(PO8) Apply ethical principles and commit to professional ethics and responsibilities and norms of the engineering practice.

(PO9) Function effectively as an individual, and as a member or leader in diverse teams, and in multidisciplinary settings.

(PO10) 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.

(PO11) 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.

(PO12) Recognize the need for, and have the preparation and ability to engage in independent and lifelong learning in the broadest context of technological change.

**Programme Specific Outcomes (PSOs): Graduates will able to**

PSO1: Graduates will be able to apply appropriate methodology for geotechnical, structural design and analysis, material selection, planning, scheduling estimation and costing, using modern tool in construction field.

PSO2: Graduates will be able to Service to the development of public health and environmental safety of the society with ethical values.

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PSO3: Graduates will be able to Pursue lifelong learning and professional development to face challenging and emerging needs of the society

**Mapping Table: COs of CE6021: REPAIR AND REHABILITATION OF STRUCTURES Vs POs**

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| Course Outcomes (COs) | CO  level | Program Outcomes (POs) | | | | | | | | | | | |
| PO1 | PO2 | PO3 | PO4 | PO5 | PO6 | PO7 | PO8 | PO9 | PO10 | PO11 | PO12 |
| PO level |  | K3 | K4 | K5 | K5 | K6/k5/k4 |  |  |  |  |  |  |  |
| CO1 | K2 | 2 | 1 | - | - | 1 |  |  |  |  |  |  |  |
| CO2 | K2 | 2 | 1 | - | - | 1 |  |  |  |  |  |  |  |
| CO3 | K2 | 2 | 1 | - | - | 1 |  |  |  |  |  |  |  |
| CO4 | K3 | 3 | 2 | 1 | 1 | 1 |  |  |  |  |  |  |  |
| CO5 | K3 | 3 | 2 | 1 | 1 | 1 |  |  |  |  |  |  |  |

**Mapping Table 2: COs of CE6021: REPAIR AND REHABILITATION OF STRUCTURES Vs PSOs**

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| Course Outcomes (COs) | CO level | Program Specific Outcomes (PSOs) | | | |
| PSO1 | PSO2 | PSO3 |  |
| PO level |  | K3 | K4 | K2 |  |
| CO1 | K2 | 2 | - | 1 |  |
| CO2 | K2 | 2 | - | 1 |  |
| CO3 | K2 | 2 | - | 1 |  |
| CO4 | K3 | 3 | - | 1 |  |
| CO5 | K3 | 3 | - | 1 |  |

**Note:Adequate Support by the COs to Pos and PSOs: 3- High 2- Medium 1- Low**