

## 10- Course Specification of Structural Rehabilitation

<b>I. Course Identification and General Information:</b>					
1.	<b>Course Title:</b>	<b>Structural Rehabilitation</b>			
2.	<b>Course Code &amp; Number:</b>	CE 519			
3.	<b>Credit hours:</b>	C.H			<b>Credit Hours</b>
		<b>Lecture.</b>	<b>Laboratory</b>	<b>Seminars.</b>	
		3	-	-	3
4.	<b>Study semester at which this course is offered:</b>	2 <sup>nd</sup> semester,			
5.	<b>Pre –requisite (if any):</b>	Building Materials			
6.	<b>Co –requisite (if any):</b>	Non			
7.	<b>Program (s) in which the course is offered:</b>	Civil Engineering Program			
8.	<b>Language of teaching the course:</b>	English/Arabic			
9.	<b>Course type</b>	Elective Course			
10.	<b>Location of teaching the course:</b>	Civil Engineering Department			
11.	<b>Prepared By:</b>	Prof. Dr. Mahmoud Mohamed Ali Kuleib, Prof. Dr. Abdulmalek Al-Jolahy and Dr. Sulieman Al-Safi			
12.	<b>Date of Approval</b>				

<b>II. Course Description:</b>
<p>This course covers:</p> <p>Deterioration of R.C. structures – Causes - Effects of various cracks in R.C. buildings - Damage assessment &amp; evaluation of structures - Importance of maintenance of R. C. structures - Repair materials - Methods of crack repair - Repair of various corrosion damaged of structural elements (slab, beam, columns and foundation) – Beam and Column jacketing- Deterioration of traditional structures – Traditional repair materials- Long term health monitoring, and structural health monitoring.</p>

<b>III. Course Intended learning outcomes (CILOs) of the course</b>		<b>Reference PILOs</b>
a.2	Recognize the concepts of the rehabilitation and strengthening of structures.	A2
a.3	Explain the concepts of the different methods and techniques of rehabilitation and strengthening in regard with different structures.	A3
b.1	Select the proper repair process for the various structural damages.	B1
b3	Carry out the proper repair process for the various damages in regard with	B3

	different structural elements (slab, beam, column, wall and foundation).	
c.1	Participate in a group undertaking rehabilitation techniques of an integrated research project in regard with real structural deterioration problems.	C1
d.1	Present the project report including a comprehensive description, evaluation, and the recommended treatment for the studied problem/s.	D1
d.2	Carry out rehabilitation and strengthening treatments committed to environment, safety, and economy obligations.	D2

<b>(A) Alignment Course Intended Learning Outcomes of Knowledge and Understanding to Teaching Strategies and Assessment Strategies:</b>		
<b>Course Intended Learning Outcomes</b>	<b>Teaching strategies</b>	<b>Assessment Strategies</b>
a2. Recognize the concepts of the rehabilitation and strengthening of structures.	<ul style="list-style-type: none"> <li>• Lectures.</li> <li>• Presentations.</li> <li>• Discussions.</li> </ul>	<ul style="list-style-type: none"> <li>• Written exam</li> <li>• Assignment</li> <li>• Student presentation</li> </ul>
a3. Explain the concepts of the different methods and techniques of rehabilitation and strengthening in regard with different structures.		

<b>(B) Alignment Course Intended Learning Outcomes of Intellectual Skills to Teaching Strategies and Assessment Strategies:</b>		
<b>Course Intended Learning Outcomes</b>	<b>Teaching strategies</b>	<b>Assessment Strategies</b>
b.1 Select the proper repair process for the various structural damages.	<ul style="list-style-type: none"> <li>• Lecture</li> <li>• self-study</li> <li>• presentation</li> <li>• Analysis and Problem Solving.</li> </ul>	<ul style="list-style-type: none"> <li>• Written exam</li> <li>• Written assignment</li> <li>• Presentations/ Presenting researches</li> </ul>
b.3 Carry out the proper repair process for the various damages in regard with different structural elements (slab, beam, column, wall and foundation).		

<b>(C) Alignment Course Intended Learning Outcomes of Professional and Practical Skills to Teaching Strategies and Assessment Strategies:</b>		
<b>Course Intended Learning Outcomes</b>	<b>Teaching strategies</b>	<b>Assessment Strategies</b>
c1. Participate in a group undertaking rehabilitation techniques of an integrated research project in regard with real structural deterioration problems.	<ul style="list-style-type: none"> <li>• Lecture</li> <li>• self-study</li> <li>• presentation</li> <li>• Analysis and Problem Solving.</li> </ul>	<ul style="list-style-type: none"> <li>• Written exam</li> <li>• Written assignment</li> <li>• Presentations/ Presenting researches</li> </ul>

<b>(D) Alignment Course Intended Learning Outcomes of Transferable Skills to Teaching Strategies and Assessment Strategies:</b>		
<b>Course Intended Learning Outcomes</b>	<b>Teaching strategies</b>	<b>Assessment Strategies</b>
d.1 Present the project report including a comprehensive description, evaluation, and the recommended treatment for the studied problem/s.	<ul style="list-style-type: none"> <li>• Presentation</li> <li>• Independent study</li> <li>• Presenting reports</li> <li>• Presenting researches</li> </ul>	<ul style="list-style-type: none"> <li>• Presentation</li> <li>• Written report.</li> </ul>
d.2 Carry out rehabilitation and strengthening treatments committed to environment, safety, and economy obligations.		

<b>IV. Course Content:</b>					
<b>A – Lecture Aspect:</b>					
<b>Order</b>	<b>Units/Topics List</b>	<b>Learning Outcomes</b>	<b>Sub Topics List</b>	<b>Number of Weeks</b>	<b>contact hours</b>
1	Introduction/Background	a2, a3	<ul style="list-style-type: none"> <li>- Overview of concrete, steel, masonry and wood structures/buildings.</li> <li>- Strength, serviceability and durability requirements</li> <li>- Concept of/differences between maintenance, repair and rehabilitation.</li> </ul>	1	3

			- Related codes of practice and guidelines.		
2	Deterioration of concrete and traditional structures	a2, b1	Causes of Deterioration: <ul style="list-style-type: none"> <li>- Design and construction aspects/errors,</li> <li>- Accidental loading,</li> <li>- Settlement &amp; movement</li> <li>- Environmental effects,</li> <li>- Chemical effects,</li> <li>- Biological effects</li> <li>- Corrosion effects</li> <li>- Cover thickness &amp; cracking effects.</li> </ul>	1	3
3	Causes-effects of various cracks in R.C. buildings.	a3,b3,c1	<ul style="list-style-type: none"> <li>- Classification of cracks,</li> <li>- Causes of cracking in structures,</li> <li>- Effects of cracks in R.C. buildings,</li> <li>- Effects of cracks in masonry elements.</li> </ul>	1	3
4	Study damage assessment and evaluation of the structures	a3,b1,b3,c1	<ul style="list-style-type: none"> <li>- Damage survey and mapping/ Documentation,</li> <li>- Field and lab tests,</li> <li>- Structural modeling,</li> <li>- Results analysis &amp; evaluation,</li> <li>- Planing &amp; design of rehabilitation /strengthening works,</li> </ul>	2	6
5	Repair materials.	a3,b1,b3,c1	<ul style="list-style-type: none"> <li>- Types, properties and uses of repairing materials for R.C. structures (special concrete and mortars, concrete chemicals, special elements for accelerated strengthgain, expensive cement, .....),</li> <li>- Types, properties and uses of repairing materials for traditional structures (masonry units, gypsum, lime and lime based materials.</li> </ul>	2	6
6	Special mortars and protective coatings for concrete and steel structures	a3,b1,b3,c1 ,d1,d2	<ul style="list-style-type: none"> <li>- Special mortars and protective coatings (including those referred to as traditional mortars and plastering materials) for concrete and traditional structures.</li> <li>- Protective coating and sealing compound (protection against chemical attacks, fire protection, corrosion protection, water penetration, ...etc.)</li> <li>- Lime based mortar (Qutra) &amp;</li> </ul>	1	3

			Lime based plaster (Qadad).		
7	Study of various methods of repairing cracks.	a2, a3,b1,d1	<ul style="list-style-type: none"> <li>- Mortar repair</li> <li>- Dry pack grouting/filling repair</li> <li>- Flexible sealing/Epoxy injection</li> <li>- Chemical grouting</li> <li>- Examples (case studies)</li> <li>- Repairing cracks in masonry/traditional structures.</li> </ul>	1	3
8	Study methods of repairing various corrosion damaged of structural elements.	a2,a3,b1,d1	<ul style="list-style-type: none"> <li>- Corrosion mechanism</li> <li>- Corrosion inhibitors,</li> <li>- Cathode protection</li> <li>- Corrosion resistant steel</li> <li>- Coating for steel (derusting, phosphating, cement coating, sealing, galvanized reinforcement)</li> <li>- Concrete removal &amp; preparation for repair</li> </ul>	1	3
9	Study methods of strengthening of beam, slabs, columns and footings.	a3,b1,b3,c1, d1	<ul style="list-style-type: none"> <li>- Thick reinforced concrete jacketing,</li> <li>- Thin fiber reinforced concrete jacketing,</li> <li>- Additional of steel plates &amp; elements</li> <li>- Carbon or glass fiber wrapping,</li> <li>- Soil improvement through injections, jet-grouting, adding piles &amp; micropiles</li> <li>- Examples (case studies).</li> </ul>	3	9
10	Long term health monitoring and structural health monitoring.	a3,b1,b3,c1, d1,d2	<ul style="list-style-type: none"> <li>- Structural health monitoring – an overview</li> <li>- Structural health monitoring technique and methods.</li> </ul>	3	9
<b>Number of Weeks /and Units Per Semester</b>				<b>16</b>	<b>48</b>

### B - Laboratory Aspect:

Order	Tasks/ Experiments	Number of Weeks	contact hours	Learning Outcomes
1	Mixes for different types of traditional materials.	2	6	b.3 and c.1
2				
<b>Number of Weeks /and Units Per Semester</b>		<b>2</b>	<b>6</b>	

## V. Schedule of Assessment Tasks for Students During the Semester:

No.	Assessment Method	Week Due	Mark	Proportion of Final Assessment	Aligned Course Learning Outcomes
1	Assignment	2,6, 8	15	10	a2, a3, b1, b3, c1, and d2
2	Report	11,14	7.5	5	a2,a3,b1, and d1
3	Projects	In lab.	22.5	15	a2, a3, b1,b3, c1, d1, and d2
5	Midterm Exam	8	30	20	a3, b1, b3, and c1
6	Final-exam	16	75	50	a3,b1,b3,c1and c2
<b>Total</b>			<b>150%</b>	<b>100%</b>	

## VI. Assignments:

No	Assignments	Aligned CILOs(symbols)	Week Due	Mark
1	Assignment 1	a2,b1	2	5
2	Assignment 2	a3,b1,b3,c1	6	5
3	Assignment 3	a3,b1,b3,c1,d2	8	5
	<b>Number of Weeks /and Units Per Semester</b>			

## VII. Report:

No	Assignments	Aligned CILOs(symbols)	Week Due	Mark
1	Rehabilitation Materials	a2,a3,b1,c1,d1	11	3.5
2	A project Report on: Rehabilitation techniques for structural deterioration problems.	a2,a3,b1,c1,d1and d2	14	4

## VIII. Learning Resources and Facilities:

- Written in the following order: (Author - Year of publication – Title – Edition – Place of publication – Publisher).

### 1- Required Textbook(s).

12. R. Dodge Woodson, 2009, “Concrete Structures Protection, Repair and Rehabilitation”, U.S.A., Elsevier.

### 2- Essential References.

1. ACI 562, 2013, “Code Requirements for Evaluation, Repair, and Rehabilitation of Concrete Buildings”, U.S.A., American Concrete Institute.
2. Guide for the Structural Rehabilitation of Heritage Buildings, 2010, CIB Publication 335, Lisbon, ISBN: 978-90-6363-066-9.

### 3- Electronic Materials and Web Sites *etc.*

YouTube Videos

Educational and research Facilities and Equipment Required

### Technology Resources

(AV, data show, Smart Board, software, etc.)

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### Other Resources

(Specify, e.g. if specific laboratory equipment is required, list requirements or attach a list)

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## IX. Course Policies:

64.	<b>Class Attendance:</b> The students should have more than 75 % of attendance according to rules and regulations of the faculty.
65.	<b>Tardy:</b> The students should respect the timing of attending the lectures. They should attend within 10 minutes from starting of the lecture.
66.	<b>Exam Attendance/Punctuality:</b> The student should attend the exam on time. The punctuality should be implemented according to rules and regulations of the faculty for midterm exam and final exam.
67.	<b>Assignments &amp; Projects:</b> The assignment is given to the students after each chapter, the student has to submit all the assignments for checking on time.
68.	<b>Cheating:</b> If any cheating occurred during the examination, the student is not allowed to continue and he/she has to face the examination committee for enquires.
69.	<b>Plagiarism:</b> The student will be terminated from the Faculty, if one student attends the exam on another behalf according to the policy, rules and regulations of the university.
70.	<b>Other policies:</b> <ul style="list-style-type: none"><li>• All the teaching materials should be kept out the examination hall.</li><li>• the mobile phone is not allowed.</li><li>• There should be a respect between the student and his teacher.</li></ul>

Reviewed By	<b><u>Vice Dean for Academic Affairs and Post Graduate Studies</u></b> <b><u>Dr. Tarek A. Barakat</u></b> <b><u>Dr. Ahmed Alwadhaf</u></b> <b><u>Dr. Mohammad Algorafi</u></b>
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