University of Sana'a
Faculty of Engineering

45Course Specification of Reinforced Concrete 3

I. Course Identification and General Information:

1	**Course Title:**	***Reinforced Concrete 3***				
2	**Course Code & Number:**	CE 304				
3	**Credit hours:**	C.H				**Credit Hours**
		Th.	Tu.	Pr.	Tr.	
		2	2			3
4	**Study level/ semester at which this course is offered:**	4th year level / 1st semester				
5	**Pre –requisite (if any):**	1. Reinforced Concrete 1 (CE 202) 2. Reinforced Concrete 2 (CE 209) 3. Structural Analysis 2 CE 208)				
6	**Co –requisite (if any):**	Non				
8	**Program (s) in which the course is offered:**	Civil Engineering				
9	**Language of teaching the course:**	English+ Arabic				
10	**Location of teaching the course:**	Class room				
11	**Prepared By:**	Prof. Dr. Ahmed Hasan Alwathaf				
12	**Date of Approval**					

II. Course Description:

This course provides students with an understanding of the behavior and structural design process of reinforced concrete systems and also the ability to design different structural concrete systems considering the design criteria such as strength, serviceability, and economy. Students will apply their knowledge and skills gained from Reinforced Concrete 1 and 2 to find the interaction between individual elements in the entire structural system. The reinforced concrete systems covered in the course are; two-way flooring system using direct design method, building frames and large span halls frames, arched slabs and girders, and pre-stressed and precast concrete. Strength Design Method will be used based on the Building Code Requirements for Structural Concrete (ACI 318). The mechanics underlying

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the code design equations are explained as well as their application to practical design problems.

	III. Course Intended learning outcomes (CILOs) of the course	**Referenced PILOs**
a.1	Describe the governing relationships of concrete design of structural systems and their components under different types of effects.	**A1**
a.2	Describe design procedures of reinforced concrete elements and systems starting from the first step of proposing the initial layout of the system to the last step of calculating reinforcements and preparing design detailing.	**A3**
a.3	Show the role of the structural professional engineer in safety and serviceability of buildings, and traditional practices of structural engineering.	**A4**
b.1	Demonstrate competence in structural design through applying particular elaborated operations including selection of efficient structural system, calculation of imposed loads, structural analyzing, determination of critical sections, and calculation of appropriate cross sections and reinforcements.	**B1**
b.2	Choose appropriate structural modeling and analysis methods and RC design procedures for determinate and indeterminate systems.	**B2**
b.3	Demonstrate proficiency in the evaluation and integration of information and processes in design work including proposing and analyzing different alternatives, identifying interaction between different elements, evaluating and comparing different structural systems, address broad contextual constraints.	**B3**
b.4	Consider the economic and effect of environment on designing of reinforced concrete structures.	**B4**
c.1	Conduct full design calculations for a real reinforced concrete structure based on the Code of practice provisions in which all the components are proportioned to fulfill structural requirements.	**C2**
c.2	Apply a systematic approach to reach the desired solution to a problem including problem definition, concept, planning, design, and development.	**C3**

d.1	Prepare clear design reports and design detailing for the reinforced concrete designs.	**D1**

(A) Alignment Course Intended Learning Outcomes of Knowledge and Understanding to Teaching Strategies and Assessment Strategies:		
Course Intended Learning Outcomes	**Teaching strategies**	**Assessment Strategies**
a1. Describe the governing relationships of concrete design of structural systems and their components under different types of effects.	Lecture Tutorial- Problem solving Directed self-study	Written exam Written assignment
a2. Describe design procedures of reinforced concrete elements and systems starting from the first step of proposing the initial layout of the system to the last step of calculating reinforcements and preparing design detailing.	Lecture Tutorial- Problem solving Directed self-study Course project	Written exam Written assignment Project evaluation
a3. Show the role of the structural professional engineer in safety and serviceability of buildings, and traditional practices of structural engineering.	Lecture Tutorial- Problem solving Directed self-study Course project	Written exam Written assignment Project evaluation

(B) Alignment Course Intended Learning Outcomes of Intellectual Skills to Teaching Strategies and Assessment Strategies:		
Course Intended Learning Outcomes	**Teaching strategies**	**Assessment Strategies**
b1. Demonstrate competence in structural design through applying particular elaborated operations including selection of efficient structural system, calculation of imposed loads, structural analyzing, determination of critical sections, and calculation of appropriate cross sections and reinforcements.	Lecture Tutorial- Problem solving Directed self-study Course project	Written exam Written assignment Project evaluation

b2. Choose appropriate structural modeling and analysis methods and RC design procedures for determinate and indeterminate systems.	Lecture Tutorial- Problem solving Directed self-study Course project	Written exam Written assignment Project evaluation
b3. Demonstrate proficiency in the evaluation and integration of information and processes in design work including proposing and analyzing different alternatives, identifying interaction between different elements, evaluating and comparing different structural systems, address broad contextual constraints.	Lecture Tutorial- Problem solving Directed self-study Course project	Written exam Written assignment Project evaluation
b4. Consider the economic and effect of environment on designing of reinforced concrete structures.	Lecture Tutorial- Problem solving Directed self-study Course project	Written exam Written assignment Project evaluation

(C) Alignment Course Intended Learning Outcomes of Professional and Practical Skills to Teaching Strategies and Assessment Strategies:

Course Intended Learning Outcomes	Teaching strategies	Assessment Strategies
c1. Conduct full design calculations for a real reinforced concrete structure based on the Code of practice provisions in which all the components are proportioned to fulfill structural requirements.	Lecture Tutorial- Problem solving Directed self-study Course project	Written exam Written assignment Project evaluation
c2. Apply a systematic approach to reach the desired solution to a problem including problem definition, concept, planning, design, and development.	Lecture Tutorial- Problem solving Directed self-study Course project	Written exam Written assignment Project evaluation

(D) Alignment Course Intended Learning Outcomes of Transferable Skills to Teaching Strategies and Assessment Strategies:

Course Intended Learning Outcomes	Teaching strategies	Assessment Strategies

d1. Prepare clear design reports and design detailing for the reinforced concrete designs.	Lecture Tutorial- Problem solving Directed self-study Course project	Written exam Written assignment Project evaluation

IV. Course Content:

A – Theoretical Aspect:

Order	Units/Topics List	Learning Outcomes	Sub Topics List	Number of Weeks	contact hours
1	Introduction to Two-Way Flooring System	a1, a2, a3, b1, b2, b3, b4	Type of two-way flooring systems, criteria of selecting the suitable system	1	2
2	Deflection Control and Shear	a1, a2, a3, b1, b2, b3, b4, c1, c2, d1	Thickness requirement in two-way slab, one-way shear, two-way shear	1	2
3	Design of Two-Way Slabs by Direct Design Method	a1, a2, a3, b1, b2, b3, b4, c1, c2, d1	-Distribution of moments in long. and lateral directions -Requirements of reinforcements, drop panel, column capital, construction, drawing and detailing. -Waffle slab system -Moment and shear transfer, design moments in columns	4	8
4	Structural Design Procedure of a Project	a1, a2, a3, b1, b2, b3, b4, c1, c2, d1	Efficient structural layout, loads and boundaries, structural modeling and analysis, members proportioning, detailing and design report.	1	2

5	Design of Building Frames and Structural System	a1, a2, a3, b1, b2, b3, b4, c1, c2, d1	-Preliminary design of elements, beam-column rigid joint, continuous beams vs building frames, structural analysis for gravity and lateral loads. -Design of shear walls	2	4
6	Design of Large Span Hall Frames and Hinges	a1, a2, a3, b1, b2, b3, b4, c1, c2, d1	Varieties of large span hall frames, analysis and design considerations of portal and cantilever frames, design of hinge support, beam-column junction and reinforcements detailing.	1	2
7	Design of Arches	a1, a2, a3, b1, b2, b3, b4, c1, c2, d1	Design of arched slabs Design of arched girders	2	4
8	Pre-stressed and Pre-cast Concrete	a1, a2, a3, b1, b2, b3, b4	Introduction to Pre-stressed Concrete Introduction to Pre-cast Concrete	2	4
Number of Weeks /and Units Per Semester				**14**	**28**

B - Tutorial Aspect:

Order	Tasks/ Experiments	Number of Weeks	contact hours	Learning Outcomes
1	Design of flat plates	1	2	a1, a2, a3, b1, b2, b3, b4, c1, c2, d1
2	Design of flat slabs with column capital and drop panel	2	4	a1, a2, a3, b1, b2, b3, b4, c1, c2, d1
3	Design of flat slabs with edge beams	2	4	a1, a2, a3, b1, b2, b3, b4, c1, c2, d1
4	Design of waffle slabs	1	2	a1, a2, a3, b1, b2, b3, b4, c1, c2, d1

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5	Moment in columns and shear transfer	1	2	a1, a2, a3, b1, b2, b3, b4, c1, c2, d1
6	Discussion on structural design of course project	1	2	a1, a2, a3, b1, b2, b3, b4, c1, c2, d1
7	Design of shear walls	1	2	a1, a2, a3, b1, b2, b3, b4, c1, c2, d1
8	Design of large span hall frame and hinges	2	4	a1, a2, a3, b1, b2, b3, b4, c1, c2, d1
9	Design of arched slabs	1	2	a1, a2, a3, b1, b2, b3, b4, c1, c2, d1
10	Design of arched girders	1	2	a1, a2, a3, b1, b2, b3, b4, c1, c2, d1
11	Evaluation of course project	1	2	a1, a2, a3, b1, b2, b3, b4, c1, c2, d1
Number of Weeks /and Units Per Semester		**14**	**28**	

V. Teaching strategies of the course:

Lecture
Tutorial- Problem solving
Directed self-study
Course project

VI. Assignments:

No	Assignments	Aligned CILOs(symbols)	Week Due	Mark
1	Assignment 1 (design of flat slab)	a1, a2, a3, b1, b2, b3, b4, c1, c2, d1	4	0.75
2	Assignment 2 (design of waffle slab)	a1, a2, a3, b1, b2, b3, b4, c1, c2, d1	7	0.75
3	Assignment 3 (design of frame)	a1, a2, a3, b1, b2, b3, b4, c1, c2, d1	10	0.75
4	Assignment 4 (design of arches)	a1, a2, a3, b1, b2, b3, b4, c1, c2, d1	14	0.75
5	Course Project	a1, a2, a3, b1, b2, b3, b4, c1, c2, d1	15	0.75

VII. Schedule of Assessment Tasks for Students During the Semester:

No.	Assessment Method	Week Due	Mark	Proportion of Final Assessment	Aligned Course Learning Outcomes
1	Written assignment	4,7,10,14	4.5	3%	a1, a2, a3, b1, b2, b3, b4, c1, c2, d1
2	Quizzes	Two times randomly	3	2%	a1, a2, a3, b1, b2, b3, b4, c1, c2, d1
3	Mid-term exam	8	30	20%	a1, a2, a3, b1, b2, b3, b4, c1, c2, d1
4	Course Project	15	7.5	5%	a1, a2, a3, b1, b2, b3, b4, c1, c2, d1
5	Final-exam	16	105	70%	a1, a2, a3, b1, b2, b3, b4, c1, c2, d1
Total			**150**	**100%**	

VIII. Learning Resources:

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

1- Required Textbook(s) (maximum two).

1. M. Nadim Hassoun & Akthem AL-Manaseer (2012). Structural Concrete-Theory and Design, 4th ed. John Wiley & Sons, Inc., USA.
2. Jack C. McCormac & James K. Nelson (2014), Design of Reinforced Concrete, 9th Ed, John Wiley & Sons, Inc., USA.

2- Essential References.

1. ACI 318-11 (2011). Building Code Requirement for Structural Concrete, American Concrete Institute, ACI, USA.
2. ASCE/SEI 7-10 (2010). Minimum Design Loads for Buildings and Other Structures, American Society of Civil Engineers, ASCE, USA.

3- Electronic Materials and Web Sites *etc*.

- Non

Prepared by	Head of Department	Quality Assurance Unit	Dean of the Faculty	Academic Development Center & Quality Assurance
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IX. Course Policies:	
1	**Class Attendance:** The students should have more than 75 % of attendance according to rules and regulations of the faculty.
2	**Tardy:** The students should respect the timing of attending the lectures. They should attend within 10 minutes from starting of the lecture.
3	**Exam Attendance/Punctuality:** 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.
4	**Assignments & Projects:** The assignment is given to the students after each chapter, the student has to submit all the assignments for checking on time.
5	**Cheating:** If any cheating occurred during the examination, the student is not allowed to continue and he/she has to face the examination committee for enquiries.
6	**Plagiarism:** 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.
7	**Other policies:** -All the teaching materials should be kept out the examination hall. -The mobile phone is not allowed. -There should be a respect between the student and his teacher.

Reviewed By	**Vice Dean for Academic Affairs and Post Graduate Studies** **Dr. Tarek A. Barakat** **Dr. Mohammad Algorafi**
	Deputy Rector for Academic Affairs Dr. Ibrahim AlMutaa **Dr. Ahmed mujahed** **Dr. Munaser Alsubri**

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Course Plan (Syllabus) of Reinforced Concrete 3

I. Information about Faculty Member Responsible for the Course:								
Name of Faculty Member	Prof. Dr. Ahmed Hasan Alwathaf	**Office Hours**						
Location& Telephone No.		**SAT**	**SUN**	**MON**	**TUE**	**WED**	**THU**	
E-mail								

II. Course Identification and General Information:						
1-	**Course Title:**	***Reinforced Concrete 3***				
2-	**Course Number & Code:**	CE 304				
3-	**Credit hours:**	**C.H**				**Credit Hours**
		Th.	Tu.	Pr.	Tr.	
		2	2			3
4-	**Study level/year at which this course is offered:**	4th year level / 1st semester				
5-	**Pre –requisite (if any):**	1. Reinforced Concrete 1 (CE 202) 2. Reinforced Concrete 2 (CE 209) 3. Structural Analysis 2 (CE 208)				
6-	**Co –requisite (if any):**	Non				
7-	**Program (s) in which the course is offered**	Civil Engineering				
8-	**Language of teaching the course:**	English+ Arabic				
9-	**System of Study:**	Regular				
10-	**Mode of delivery:**	Lecture + Tutorial				
11-	**Location of teaching the course:**	Class room				

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III. Course Description:

This course provides students with an understanding of the behavior and structural design process of reinforced concrete systems and also the ability to design different structural concrete systems considering the design criteria such as strength, serviceability, and economy. Students will apply their knowledge and skills gained from Reinforced Concrete 1 and 2 to find the interaction between individual elements in the entire structural system. The reinforced concrete systems covered in the course are; two-way flooring system using direct design method, building frames and large span halls frames, arched slabs and girders, and pre-stressed and precast concrete. Strength Design Method will be used based on the Building Code Requirements for Structural Concrete (ACI 318). The mechanics underlying the code design equations are explained as well as their application to practical design problems.

IV. Intended learning outcomes (ILOs) of the course:

- **Brief summary of the knowledge or skill the course is intended to develop:**

a.1 Describe the governing relationships of concrete design of structural systems and their components under different types of effects.
a.2 Describe design procedures of reinforced concrete elements and systems starting from the first step of proposing the initial layout of the system to the last step of calculating reinforcements and preparing design detailing.
a.3 Show the role of the structural professional engineer in safety and serviceability of buildings, and traditional practices of structural engineering.
b.1 Demonstrate competence in structural design through applying particular elaborated operations including selection of efficient structural system, calculation of imposed loads, structural analyzing, determination of critical sections, and calculation of appropriate cross sections and reinforcements.
b.2 Choose appropriate structural modeling and analysis methods and RC design procedures for determinate and indeterminate systems.
b.3 Demonstrate proficiency in the evaluation and integration of information and processes in design work including proposing and analyzing different alternatives, identifying interaction between different elements, evaluating and comparing different structural systems, address broad contextual constraints.
b.4 Consider the economic and effect of environment on designing of reinforced concrete structures.

c.1 Conduct full design calculations for a real reinforced concrete structure based on the Code of practice provisions in which all the components are proportioned to fulfill structural requirements. **c.2** Apply a systematic approach to reach the desired solution to a problem including problem definition, concept, planning, design, and development. **d.1** Prepare clear design reports and design detailing for the reinforced concrete designs.

V. Course Content:

- Distribution of Semester Weekly Plan Of course Topics/Items and Activities.

A – Theoretical Aspect:

Order	Topics List	Sub Topics List	Week Due	Contact Hours
1	Introduction to Two-Way Flooring System	Type of two-way flooring systems, criteria of selecting the suitable system	1	2
2	Deflection Control and Shear	Thickness requirement in two-way slab, one-way shear, two-way shear	2	2
3	Design of Two-Way Slabs by Direct Design Method	Distribution of moments in long. and lateral directions Requirements of reinforcements, drop panel, column capital, construction, drawing and detailing. Waffle slab system Moment and shear transfer, design moments in columns	3,4,5,6	8
4	Structural Design Procedure of a Project	Efficient structural layout, loads and boundaries, structural modeling and analysis, members proportioning, detailing and design report.	7	2
5	Midterm exam		8	2
6	Design of Building Frames and Structural System	Preliminary design of elements, beam-column rigid joint, continuous beams vs	9,10	4

		building frames, structural analysis for gravity and lateral loads.		
7	Design of Large Span Hall Frames and Hinges	Varieties of large span hall frames, analysis and design considerations of portal and cantilever frames, design of hinge support, beam-column junction and reinforcements detailing	11	2
8	Design of Arches	Design of arched slabs, Design of arched girders	12,13	4
9	Pre-stressed and Pre-cast Concrete	Introduction to Pre-stressed Concrete Introduction to Pre-cast Concrete	14,15	4
10	Final exam		16	2
Number of Weeks /and Units Per Semester			**16**	**32**

B – Tutorial Aspect:

Order	Topics List	Week Due	Contact Hours
1	Design of flat plates	1	2
2	Design of flat slabs with column capital and drop panel	2,3	4
3	Design of flat slabs with edge beams	4,5	4
4	Design of waffle slabs	6	2
5	Moment in columns and shear transfer	7	2
6	Discussion on structural design of course project	8	2
7	Design of shear walls	9	2
8	Design of large span hall frame and hinges	10,11	4
9	Design of arched slabs	12	2
10	Design of arched girders	13	2
11	Evaluation of course project	14	2

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Number of Weeks /and Units Per Semester	14	28

VI. Teaching strategies of the course:

Lecture
Tutorial- Problem solving
Directed self-study
Course project

VII. Assignments:

No	Assignments	Aligned CILOs(symbols)	Week Due	Mark
1	Assignment 1 (design of flat slab)	a1, a2, a3, b1, b2, b3, b4,c1,c2, d1	4	0.5
2	Assignment 2 (design of waffle slab)	a1, a2, a3, b1, b2, b3, b4, c1,c2, d1	7	0.5
3	Assignment 3 (design of frame)	a1, a2, a3, b1, b2, b3, b4, c1,c2, d1	10	0.5
4	Assignment 4 (design of arches)	a1, a2, a3, b1, b2, b3, b4, c1,c2, d1	14	0.5
5	Course Project	a1, a2, a3, b1, b2, b3, b4, c1,c2, d1	15	0.5

VIII. Schedule of Assessment Tasks for Students During the Semester:

Assessment	Type of Assessment Tasks	Week Due	Mark	Proportion of Final Assessment
1	Written assignment	4,7,10,14	4.5	3%
2	Quizzes	Two times randomly	3	2%
3	Mid-term exam	8	30	20%
4	Course Project	15	7.5	5%
5	Final-exam	16	105	70%

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	Total		**150**	**100%**

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1- Required Textbook(s) (maximum two).

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X. Course Policies:	
Unless otherwise stated, the normal course administration policies and rules of the Faculty of ----- apply. For the policy, see: ----------	
1	**Class Attendance:** The students should have more than 75 % of attendance according to rules and regulations of the faculty.
2	**Tardy:** The students should respect the timing of attending the lectures. They should attend within 10 minutes from starting of the lecture.
3	**Exam Attendance/Punctuality:** 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.
4	**Assignments & Projects:** The assignment is given to the students after each chapter, the student has to submit all the assignments for checking on time.
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