1- Course Specification of Advanced Structural Analysis

I. Course Identification and General Information:

1.	**Course Title:**	Advanced Structural Analysis			
2.	**Course Code & Number:**	CE580			
3.	**Credit hours:**	C.H			**Credit Hours**
		Lecture.	**Laboratory**	**Seminars.**	
		3	-	-	3
4.	**Study semester at which this course is offered:**	1st semester			
5.	**Pre –requisite (if any):**	Structural analysis 1 and 2 (BSc)			
6.	**Co –requisite (if any):**	Non			
7.	**Program (s) in which the course is offered:**	Master of Science in structural engineering program			
8.	**Language of teaching the course:**	English + Arabic			
9.	**Course type**	Required			
10.	**Location of teaching the course:**	Class room			
11.	**Prepared By:**	Prof. Dr. Ahmed Hasan Alwathaf			
12.	**Date of Approval**				

II. Course Description:

The course exposes students to advanced methods of structural analysis using matrix structural analysis for most structures. The course also presents significant concepts necessary for finite element method in structural analysis. It provides student with theory and application of matrix flexibility and stiffness methods for beams, trusses, and rigid frames. Also, the course presents special topics such as nonlinear and plastic analysis.

III. Course Intended learning outcomes (CILOs) of the course		Referenced PILOs
a1	Demonstrate in depth understanding of knowledge of matrix methods and engineering physic to the structural analysis.	A1. Demonstrate in depth understanding of knowledge of applied mathematics and engineering science to the field of structural engineering.
a2	Connect knowledge of matrix analysis of structures with its implementation in software packages.	A2. Recognize and Explain the contemporary engineering technologies and issues in the specialization field of structural engineering.
		A3. Explain in-depth the principles of sustainable design and development of structural engineering.
		A4. Acquire advanced knowledge of research principles and methods applicable to the field of work or academic in structural engineering and related fields.
b1	Select principles in structural modelling that evaluate accurately structural response.	B1. Assess, select and apply appropriate principles, methodologies, techniques, tools and packages in the analysis, specification, development and evaluation of structural engineering systems.
b2	simulate structural members, supports, loads and analyze complex structural framed systems.	B2. Identify, formulate, analyze research and solve complex structural engineering problems.
b3	Apply matrix methods for analysis and find linear and nonlinear response of complex structural framed systems.	B3. Apply acquired knowledge of analysis and design for complex structural engineering systems and implementation process.
		C1. Develop research to solve structural engineering problems.
		C2. Use advanced methodology and skills to solve structural engineering problems.
c1	Combine matrix methods to solve problems encountering structural engineers such as; support settlement, interior hinges, elastic supports, members release, and elastic connections	C3. Design structural system, component, or process to meet desired needs within realistic constraints.
d1	Present information and ideas clearly and fluently in both written and spoken forms.	D1. Prepare a complete thesis and term-courses works/ tasks, write their documents and defend on them.
		D2. Demonstrate ethical principles, awareness of professional and ethical responsibility as well as knowledge of the standards utilized in related

III. Course Intended learning outcomes (CILOs) of the course		Referenced PILOs
		fields.
d2	Conduct independently research that advances and extends knowledge in analysis of structural systems.	D3. Conduct independently and communicate research that advances and extends knowledge and scholarship in related fields.
		D4. Own intellectual independence, with initiative and creativity in new situations and/or for further learning, plan and execute original research with full responsibility and accountability for personal outputs.

(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. Demonstrate in depth understanding of knowledge of matrix methods and engineering physic to the structural analysis.	Lecture self-study presentation	Written exam Assignment Student presentation
a2. Connect knowledge of matrix analysis of structures with its implementation in software packages.		

(B) Alignment Course Intended Learning Outcomes of Intellectual Skills to Teaching Strategies and Assessment Strategies:		
Course Intended Learning Outcomes	**Teaching strategies**	**Assessment Strategies**
b1. Select principles in structural modelling that evaluate accurately structural response.	Lecture, self-study, presentation, Analysis and Problem Solving.	Written exam, Written assignment, Presentations/ Presenting, researches
b2. simulate structural members, supports, loads and analyze complex structural framed systems.		
b3. Apply matrix methods for analysis and find linear and nonlinear response of complex structural framed systems.		

(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. Combine matrix methods to solve problems encountering structural engineers such as; support settlement, interior hinges, elastic supports, members release, and elastic connections	Lecture, self-study, presentation, Analysis and Problem Solving.	Written exam Written assignment Presentations/ Presenting researches

(D) Alignment Course Intended Learning Outcomes of Transferable Skills to Teaching Strategies and Assessment Strategies:		
Course Intended Learning Outcomes	**Teaching strategies**	**Assessment Strategies**
d1. Present information and ideas clearly and fluently in both written and spoken forms.	Presentation, independent study, Presenting reports, Presenting researches	present the paper, presentation, written report.
d2. Conduct independently research that advances and extends knowledge in analysis of structural systems.		

IV. Course Content:

A – Lecture Aspect:

Order	Units/Topics List	Learning Outcomes	Sub Topics List	Number of Weeks	contact hours
1	Introduction To Matrix Analysis Of Structures	a1, a2, b1 b2, b3	• Importance of matrix analysis, Classical Versus Matrix Methods, • Classification of Framed Structures, • Terms Definition, • Kinematic and Static Indeterminacy, • Fundamental Relationships for Structural Analysis, • Flexibility and Stiffness Methods,	1	3

IV. Course Content:

A – Lecture Aspect:

Order	Units/Topics List	Learning Outcomes	Sub Topics List	Number of Weeks	contact hours
			• Principle of Virtual Work for Deformable Bodies,		
2	Structural Modeling	a1, a2, b1 b2, b3, c1, d2	• Line Diagrams • Modeling Process (members, nodes, supports, loads, material and geometrical properties) • Load Path • Thermal Effects • Matrix Algebra	1	3
3	Matrix Flexibility Method	a1, a2, b1 b2, b3, c1	• Structure flexibility matrix • Element flexibility matrix • Formation of the structure-flexibility matrix from element-flexibility matrices • Analysis of indeterminate structures • Loads between nodal points	3	9
4	Matrix Stiffness Method (part I)	a1, a2, b1 b2, b3, c1	• Stiffness matrix • Element stiffness matrix • Formation of the structure-stiffness matrix from element-stiffness matrices	2	6
	Midterm Exam			1(8)	3
5	Matrix Stiffness Method (part II)	a1, a2, b1 b2, b3, c1	Direct stiffness method: • trusses, • beams, and • frames	2	6
6	Additional Topics in Matrix Methods	a1, a2, b1 b2, b3, c1, d2	• Support movement (settlement), • Interior hinge, • Elastic support, • Releases in Members, • Elastic Connections.	2	6
7	Plastic Analysis	a1, a2, b1 b2, b3, c1, d2	• Plastic moment, plastic hinge • Plastic behavior of beams • Plastic behavior of frames	1	3
8	Non-Linear Analysis of Structures	a1, a2, b1 b2, b3, c1, d2	• Material nonlinearity, • Geometric nonlinearity, • Iterative methods for nonlinear analysis solution.	1	3
9	Presentation of course-projects	a1, a2, b1 b2, b3, c1, d1, d2	Seminar in Structural Engineering Topics	1	3
	Final Exam			1	3
Number of Weeks /and Units Per Semester				**16**	**48**

B - Laboratory Aspect:

Order	Tasks/ Experiments	Number of Weeks	contact hours	Learning Outcomes
1	**(NA)**			
2				

Number of Weeks /and Units Per Semester			

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	Assignments	5,8,11,13,14,15	15	10%	a1, a2, b1 b2, b3, c1, d1
2	Midterm exam	8	22.5	15%	a1, a2, b1 b2, b3, c1, d1
3	Quizzes	Two times randomly	15	10%	a1, a2, b1 b2, b3, c1, d1
4	Course project	15	22.5	15 %	a1, a2, b1 b2, b3, c1, d1, d2
5	Final exam	16	75	50%	a1, a2, b1 b2, b3, c1, d1
Total			**150%**	**100%**	

VI. Assignments:

No	Assignments	Aligned CILOs(symbols)	Week Due	Mark
1	Matrix Flexibility Method	a1, a2, b1 b2, b3, c1, d1	**5**	**3**
2	Matrix Stiffness Method (part I)	a1, a2, b1 b2, b3, c1, d1	**8**	**3**
3	Matrix Stiffness Method (part II)	a1, a2, b1 b2, b3, c1, d1	**11**	**3**
4	Additional Topics in Matrix Methods	a1, a2, b1 b2, b3, c1, d1	**13**	**2**
5	Plastic Analysis	a1, a2, b1 b2, b3, c1, d1	**14**	**2**
6	Non-Linear Analysis of Structures	a1, a2, b1 b2, b3, c1, d1	**15**	**2**
Total				**15**

VII. Report:

No	Assignments	Aligned CILOs(symbols)	Week Due	Mark
1	**Report (and presentation) in Structural Engineering Topics**	a1, a2, b1 b2, b3, c1, d1, d2	**15**	**22.5**
Total				**22.5**

VIII. Learning Resources and Facilities:

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

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

1. CHAJES (1998), Structural Analysis, Prentice-Hall
2. F. ARBABI (1991), Structural Analysis and Behavior, McGraw Hill, Inc.

2- Essential References.

1. A. KASSIMALI (2012) MATRIX ANALYSIS OF STRUCTURES, Cengage Learning, 2nd ed.
2. A. GHALI, A.M. NEVILLE, T.G. BROWN (2009) Structural Analysis a unified classical and matrix approach, Spon Press, 6th ed.

3- Electronic Materials and Web Sites *etc*.

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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)
-

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 enquires.
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.

Course plan of Advanced Structural Analysis

I. Course Identification and General Information:					
.1	**Course Title:**	Advanced Structural Analysis			
.2	**Course Code & Number:**	CE580			
.3	**Credit hours:**	C.H			**Credit Hours**
		Lecture.	**Laboratory**	**Seminars.**	
		3	-	-	3
.4	**Study semester at which this course is offered:**	1st semester			
.5	**Pre –requisite (if any):**	Structural analysis 1 and 2 (BSc)			
.6	**Co –requisite (if any):**	Non			
.7	**Program (s) in which the course is offered:**	Master of Science in structural engineering program			
.8	**Language of teaching the course:**	English + Arabic			
.9	**Course type**	Required			
.10	**Location of teaching the course:**	Class room			
.11	**Prepared By:**	Prof. Dr. Ahmed Hasan Alwathaf			
.12	**Date of Approval**				

II. Course Description:

The course exposes students to advanced methods of structural analysis using matrix structural analysis for most structures. The course also presents significant concepts necessary for finite element method in structural analysis. It provides student with theory and application of matrix flexibility and stiffness methods for beams, trusses, and rigid frames. Also, the course presents special topics such as nonlinear and plastic analysis.

III. Course Intended learning outcomes (CILOs) of the course		Referenced PILOs
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a2	Connect knowledge of matrix analysis of structures with its implementation in software packages.	A2. Recognize and Explain the contemporary engineering technologies and issues in the specialization field of structural engineering.
		A3. Explain in-depth the principles of sustainable design and development of structural engineering.
		A4. Acquire advanced knowledge of research principles and methods applicable to the field of work or academic in structural engineering and related fields.
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b3	Apply matrix methods for analysis and find linear and nonlinear response of complex structural framed systems.	B3. Apply acquired knowledge of analysis and design for complex structural engineering systems and implementation process.
		C1. Develop research to solve structural engineering problems.
		C2. Use advanced methodology and skills to solve structural engineering problems.
c1	Combine matrix methods to solve problems encountering structural engineers such as; support settlement, interior hinges, elastic supports, members release, and elastic connections	C3. Design structural system, component, or process to meet desired needs within realistic constraints.
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III. Course Intended learning outcomes (CILOs) of the course		Referenced PILOs
		fields.
d2	Conduct independently research that advances and extends knowledge in analysis of structural systems.	D3. Conduct independently and communicate research that advances and extends knowledge and scholarship in related fields.
		D4. Own intellectual independence, with initiative and creativity in new situations and/or for further learning, plan and execute original research with full responsibility and accountability for personal outputs.

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Course Intended Learning Outcomes	**Teaching strategies**	**Assessment Strategies**
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(B) Alignment Course Intended Learning Outcomes of Intellectual Skills to Teaching Strategies and Assessment Strategies:		
Course Intended Learning Outcomes	**Teaching strategies**	**Assessment Strategies**
b1. Select principles in structural modelling that evaluate accurately structural response.	Lecture, self-study, presentation, Analysis and Problem Solving.	Written exam, Written assignment, Presentations/ Presenting, researches
b2. simulate structural members, supports, loads and analyze complex structural framed systems.		
b3. Apply matrix methods for analysis and find linear and nonlinear response of complex structural framed systems.		

(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. Combine matrix methods to solve problems encountering structural engineers such as; support settlement, interior hinges, elastic supports, members release, and elastic connections	Lecture, self-study, presentation, Analysis and Problem Solving.	Written exam Written assignment Presentations/ Presenting researches

(D) Alignment Course Intended Learning Outcomes of Transferable Skills to Teaching Strategies and Assessment Strategies:		
Course Intended Learning Outcomes	**Teaching strategies**	**Assessment Strategies**
d1. Present information and ideas clearly and fluently in both written and spoken forms.	Presentation, independent study, Presenting reports, Presenting researches	present the paper, presentation, written report.
d2. Conduct independently research that advances and extends knowledge in analysis of structural systems.		

IV. Course Content:

A – Lecture Aspect:

Order	Units/Topics List	Learning Outcomes	Sub Topics List	Number of Weeks	contact hours
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IV. Course Content:

A – Lecture Aspect:

Order	Units/Topics List	Learning Outcomes	Sub Topics List	Number of Weeks	contact hours
			• Principle of Virtual Work for Deformable Bodies,		
2	Structural Modeling	a1, a2, b1 b2, b3, c1, d2	• Line Diagrams • Modeling Process (members, nodes, supports, loads, material and geometrical properties) • Load Path • Thermal Effects • Matrix Algebra	1	3
3	Matrix Flexibility Method	a1, a2, b1 b2, b3, c1	• Structure flexibility matrix • Element flexibility matrix • Formation of the structure-flexibility matrix from element-flexibility matrices • Analysis of indeterminate structures • Loads between nodal points	3	9
4	Matrix Stiffness Method (part I)	a1, a2, b1 b2, b3, c1	• Stiffness matrix • Element stiffness matrix • Formation of the structure-stiffness matrix from element-stiffness matrices	2	6
	Midterm Exam			1(8)	3
5	Matrix Stiffness Method (part II)	a1, a2, b1 b2, b3, c1	Direct stiffness method: • trusses, • beams, and • frames	2	6
6	Additional Topics in Matrix Methods	a1, a2, b1 b2, b3, c1, d2	• Support movement (settlement), • Interior hinge, • Elastic support, • Releases in Members, • Elastic Connections.	2	6
7	Plastic Analysis	a1, a2, b1 b2, b3, c1, d2	• Plastic moment, plastic hinge • Plastic behavior of beams • Plastic behavior of frames	1	3
8	Non-Linear Analysis of Structures	a1, a2, b1 b2, b3, c1, d2	• Material nonlinearity, • Geometric nonlinearity, • Iterative methods for nonlinear analysis solution.	1	3
9	Presentation of course-projects	a1, a2, b1 b2, b3, c1, d1, d2	Seminar in Structural Engineering Topics	1	3
	Final Exam			1	3
Number of Weeks /and Units Per Semester				**16**	**48**

B - Laboratory Aspect:

Order	Tasks/ Experiments	Number of Weeks	contact hours	Learning Outcomes
1	**(NA)**			
2				

Number of Weeks /and Units Per Semester			

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	Assignments	5,8,11,13,14,15	15	10%	a1, a2, b1 b2, b3, c1, d1
2	Midterm exam	8	22.5	15%	a1, a2, b1 b2, b3, c1, d1
3	Quizzes	Two times randomly	15	10%	a1, a2, b1 b2, b3, c1, d1
4	Course project	15	22.5	15 %	a1, a2, b1 b2, b3, c1, d1, d2
5	Final exam	16	75	50%	a1, a2, b1 b2, b3, c1, d1
Total			**150%**	**100%**	

VI. Assignments:

No	Assignments	Aligned CILOs(symbols)	Week Due	Mark
1	Matrix Flexibility Method	a1, a2, b1 b2, b3, c1, d1	**5**	**3**
2	Matrix Stiffness Method (part I)	a1, a2, b1 b2, b3, c1, d1	**8**	**3**
3	Matrix Stiffness Method (part II)	a1, a2, b1 b2, b3, c1, d1	**11**	**3**
4	Additional Topics in Matrix Methods	a1, a2, b1 b2, b3, c1, d1	**13**	**2**
5	Plastic Analysis	a1, a2, b1 b2, b3, c1, d1	**14**	**2**
6	Non-Linear Analysis of Structures	a1, a2, b1 b2, b3, c1, d1	**15**	**2**
Total				**15**

VII. Report:

No	Assignments	Aligned CILOs(symbols)	Week Due	Mark
1	**Report (and presentation) in Structural Engineering Topics**	a1, a2, b1 b2, b3, c1, d1, d2	**15**	**22.5**
Total				**22.5**

VIII. Learning Resources and Facilities:

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

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

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2- Essential References.

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3- Electronic Materials and Web Sites *etc*.

-

Educational and research Facilities and Equipment Required

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

-

Other Resources (Specify, e.g. if specific laboratory equipment is required, list requirements or attach a list)
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IX. Course Policies:

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