Sana'a University
Faculty of Engineering
Mechanical Engineering Department
Mechanical Engineering Program

32. Course Specification of Mechanics of Materials-II

I. Course Identification and General Information:						
1.	Course Title:	Mechanics of Materials – II.				
2.	Course Code & Number:	ME234.				
3.	Credit hours:	C.H				TOTAL CR. HRS
		Th.	Seminar/Tu.	Pr	Tr.	
		2	2	-	-	3
4.	Study level/ semester at which this course is offered:	Third Year-First Semester.				
5.	Pre –requisite (if any):	ME111 & ME131**.**				
6.	Co –requisite (if any):	None.				
7.	Program (s) in which the course is offered:	Mechanical Engineering Program.				
8.	Language of teaching the course:	English Language.				
9.	Location of teaching the course:	Mechanical Engineering Department.				
10.	Prepared By:	Associate Prof. Dr. Khalil Al-Hatab.				
11.	Date of Approval:					

II. Course Description:

This course is an extension of the theories and applications of the principles of mechanics of materials taught in Mechanics of Materials-I. This course introduces the concepts, equations and methods used to perform stress, strain and displacement analysis of an elastically deformed body and is essential to the design function. The course covers the following topics: analysis of stress and strain, generalized Hooke's law, combined loading and static failure criteria, deflection of beams, buckling of columns, thick-walled cylinders and rotating disks.

III. Alignments of the Course Intended learning outcomes (CILOs)		Referenced PILOs
a1	Depict an advanced and applied background knowledge developed in the physical, mathematics, sciences and engineering to solve real world	**A1.** Demonstrate knowledge & understanding of Mathematics, Science, and Engineering relevant to Mechanical Engineering.

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	problems related to stress analysis and design area.	
a2	Illustrate knowledge developed in the mechanics of materials to solve open-ended problems that contain superfluous or insufficient information and require development of additional data for stress analysis function.	**A2.** Clarify general principles of design, design techniques, and characteristics of engineering materials and components.
a3	Identify modern knowledge tools, analytical skills, software packages (i.e., SolidWorks, Abaqus, …etc.) and graphical method in the elementary solutions to the problems within more complex geometries, loading and boundary conditions.	**A4.** Understand knowledge tools and analytical skills in solving problems relevant to Mechanical Engineering
b1	Integrate background knowledge to identify, formulate, analyses and solve problems relevant to structural machine members such as: shafts, beams, columns, thick-walled cylinders and rotating disk.	**B1**. Apply the principles of engineering, basic science and mathematics to model, analyze, design, and realize physical systems, components or processes in innovative ways.
b2	Analyze stresses and strains at point in 2D and 3D, calculate tangential, radial, and longitudinal stresses and determine slope deflection and critical buckling load.	
b3	Examine stress analysis and design the mechanical components taking into account three realistic mechanical concerns: strength (factor of safety, static failure theories), stiffness (maximum allowable deflection) and stability (critical buckling load).	**B2.** Design the Mechanical systems or processes within realistic constraints such as economic, environmental, social, political, ethical, health and safety, manufacturability and sustainability.
c1	Apply skills in using the most widely applied commercial software packages (Fortran, SolidWorks & ABAQUS) and some of its advanced functions.	C**1.**Use the various techniques, skills, equipment and modern engineering tools and methods necessary for Mechanical Engineering practice.

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c2	Interpret the graphical method to compute and construct the slopes and deflections, Mohr's circle and illustrate stress variations over the cross-section of the members.	
c3	Prescribe technical reports that describe the context and significance of the stress analysis of real-world problems and the procedures/ methods used to solve them and apply the results for the services.	**C2.**Conduct experiments; analyze data and present results for various mechanical systems.
d1	Cooperate in groups and function on multi-disciplinary teams.	**D1.**Show capability to work in stressful environments, work productively within a team and possess leadership skills.
d2	Review searches of literature for a real-world problem, select the project idea, use databases and analytical and computing skills tools as well as, evaluate information and evidence from various sources.	**D4.** Perform searches of literature, use databases, as well as, evaluate information and evidence from various sources.
d3	Assess to share ideas and to communicate and present scientific results effectively with other in both oral and written format through the practice of performing presentations and technical reports.	**D5.** Communicate effectively both orally and in writing technical reports.

(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- Depict an advanced and applied background knowledge developed in the physical, mathematics, sciences and engineering to solve real world problems related to stress analysis and design area.	Lectures, tutorials seminars	Examinations, homework presentations

a2- Illustrate knowledge developed in the mechanics of materials to solve open-ended problems that contain superfluous or insufficient information and require development of additional data for stress analysis function.	Lectures, tutorials, software packages , projects	Examinations, , homework presentations, individual and group project reports.
a3- Identify modern knowledge tools, analytical skills, software packages (i.e., SolidWorks, Abaqus, …etc.) and graphical method in the elementary solutions to the problems within more complex geometries, loading and boundary conditions.	Lectures, tutorials, Seminars, software packages (i.e., solidwork, MDSolids …etc) projects.	Examinations, homework presentations, individual and group project reports

(B) Alignment Course Intended Learning Outcomes of Intellectual Skills to Teaching Strategies and Assessment Strategies:

Course Intended Learning Outcomes	Teaching strategies	Assessment Strategies
b1- Integrate background knowledge to identify, formulate, analyses and solve problems relevant to structural machine members such as: shafts, beams, columns, thick-walled cylinders and rotating disk.	Lectures, tutorials, seminars, projects	Examinations, homework, presentations, individual and group project reports
b2- Analyze stresses and strains at point in 2D and 3D, calculate tangential, radial, and longitudinal stresses and determine slope deflection and critical buckling load**.**	Lectures, tutorials, seminars, projects	Examinations, homework, presentations, individual and group project reports
b3- Examine stress analysis and design the mechanical components taking into account three realistic mechanical concerns: strength (factor of safety, static failure theories), stiffness (maximum allowable deflection) and stability (critical buckling load).	Lectures, tutorials, seminars, projects	Examinations, homework, presentations, individual and group project reports

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© 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- Apply skills in using the most widely applied commercial software packages (Fortran, SolidWorks & ABAQUS) and some of its advanced functions.	Lectures, laboratory, seminars, software packages (Fortran, SolidWorks & ABAQUS) projects, small group	Examinations, laboratory reports, presentations, individual and group project reports.
c2- Interpret the graphical method to compute and construct the slopes and deflections, Mohr's circle and illustrate stress variations over the cross-section of the members.	Lectures, laboratory, seminars, projects, small group	Examinations, laboratory reports, presentations, individual and group project reports.
c3- Prescribe technical reports that describe the context and significance of the stress analysis of real-world problems and the procedures/ methods used to solve them and apply the results for the services.	Lectures, laboratory, seminars, projects, small group	Examinations, laboratory reports, presentations, individual and group project reports.

(D) Alignment Course Intended Learning Outcomes of Transferable Skills to Teaching Strategies and Assessment Strategies:		
Course Intended Learning Outcomes	Teaching strategies	Assessment Strategies
d1- Cooperate in groups and function on multi- disciplinary teams.	seminars, projects, small group	Presentations, Reports

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d2- Review searches of literature for a real-world problem, select the project idea, use databases and analytical and computing skills tools as well as, evaluate information and evidence from various sources.	Seminars, assignments, projects.	Presentations, Reports
d3- Assess to share ideas and to communicate and present scientific results effectively with other in both oral and written format through the practice of performing presentations and technical report	Seminars, assignments, projects.	Presentations, Reports

IV. Course Content:

A – Theoretical Aspect:

Order	Units/Topics List	Learning Outcomes	Sub Topics List	Number of Weeks	Contact hours
1.	Analysis of Stress.	a1, a2, a3, b1, b2, c1,c2,d3	– Course overview and Introduction. – Conditions of Equilibrium. – Definition and Components of Stress. – Variation of Stress Within a Body. – Equations of Equilibrium. – 3-D Stress Transformation. – Principal Stresses in 3-D. – Normal and Shear Stresses on an Oblique Plane. – Octahedral Stresses. – Boundary Conditions.	2	4
2.	Analysis of Strain and Material Properties.	a1, a2, a3, b1, b2, c1,c2,d3	– Introduction. – 3-D Strain. – Equations of Compatibility. – Transformation of 3-D Strain.	2	4

			– Engineering Materials. – Elastic Versus Plastic Behavior. – Hooke's Law and Poisson's Ratio. – Generalized Hooke's Law. – Measurement of Strain: Strain Gage. – Strain Energy. – Saint-Venants Principle.		
3.	Combined Loading & Static Failure Criteria.	a1, a2, a3, b1, b2, b3, c1,c2, d3	– Combined Loading. – Failure by Mode. – Ductile Failure Criteria. – Brittle Failure Criteria.	2	4
4.	Deflection of Beams (1).	a1, a2, a3, b1, b2, b3, c1,c2, d3	– Introduction. – The Elastic Curve. – Boundary Conditions – Method of Integration. – Use of Discontinuity Functions. – Method of Superposition.	1	2
5.	Mid-Term Exam.	a1, a2, a3, b1, b2, b3, c1,c2, d3	– The First 4 Chapters.	1	2
6.	Deflection of Beams (1).	a1, a2, a3, b1, b2, b3, c1,c2, d3	– Introduction. – The Elastic Curve. – Boundary Conditions – Method of Integration. – Use of Discontinuity Functions. – Method of Superposition.	1	2
7.	Deflection of Beams (2).	a1, a2, a3, b1, b2, b3, c1,c2, d3	– Method of Superposition. – Moment-Area Method.	1	2
8.	Buckling of Columns.	a1, a2, a3, b1, b2, b3, c1,c2, d3	– Introduction. – Stability of Structures.	2	4

			– Buckling of Pin-Ended Columns. – Columns with Other End Conditions. – Critical Stress: Classification of Columns. – Eccentric Loading Columns.		
9.	Thick-Walled Cylinders and Rotating Disks.	a1, a2, a3, b1, b2, b3, c1,c2, d3	– Thick-Walled Cylinders Under Pressure. – Compound Cylinders: Press or Shrink Fits. – Rotating Disks of Constant Thickness. – Disk Flywheels.	3	6
10.	Final Exam.	a1, a2, a3, b1, b2, b3, c1,c2, d3	All the Chapters.	1	2
Number of Weeks /and Units Per Semester				**16**	**32**

B- Tutorial Aspect:

Order	Units/Topics List	Learning Outcomes	Sub Topics List	Number of Weeks	Contact hours
1.	Analysis of Stress.	a1, a2, a3, b1, b2, c1,c2,d3	– Course overview and Introduction. – Conditions of Equilibrium. – Definition and Components of Stress. – Variation of Stress Within a Body. – Equations of Equilibrium. – 3-D Stress Transformation. – Principal Stresses in 3-D. – Normal and Shear Stresses on an Oblique Plane. – Octahedral Stresses. – Boundary Conditions.	2	4
2.	Analysis of Strain and Material Properties.	a1, a2, a3, b1, b2, c1,c2,d3	– Introduction. – 3-D Strain. – Equations of Compatibility. – Transformation of 3-D Strain. – Engineering Materials. – Elastic Versus Plastic Behavior. – Hooke's Law and Poisson's Ratio. – Generalized Hooke's Law. – Measurement of Strain: Strain Gage. – Strain Energy. – Saint-Venants Principle.	2	4
3.	Combined Loading &	a1, a2, a3, b1, b2, b3, c1,c2, d3	– Combined Loading. – Failure by Mode. – Ductile Failure Criteria.	2	4

	Static Failure Criteria.		– Brittle Failure Criteria.		
4.	Deflection of Beams (1).	a1, a2, a3, b1, b2, b3, c1,c2, d3	– Introduction. – The Elastic Curve. – Boundary Conditions – Method of Integration. – Use of Discontinuity Functions. – Method of Superposition.	2	4
5.	Deflection of Beams (2).	a1, a2, a3, b1, b2, b3, c1,c2, d3	– Method of Superposition. – Moment-Area Method.	1	2
6.	Buckling of Columns.	a1, a2, a3, b1, b2, b3, c1,c2, d3	– Introduction. – Stability of Structures. – Buckling of Pin-Ended Columns. – Columns with Other End Conditions. – Critical Stress: Classification of Columns. – Eccentric Loading Columns.	2	4
7.	Thick-Walled Cylinders and Rotating Disks.	a1, a2, a3, b1, b2, b3, c1,c2, d3	– Thick-Walled Cylinders Under Pressure. – Compound Cylinders: Press or Shrink Fits. – Rotating Disks of Constant Thickness. – Disk Flywheels.	3	6
Number of Weeks /and Units Per Semester				**14**	**28**

V. Teaching Strategies of the Course:

- Active Lectures.
- Project.
- Tutorials.
- Software Packages (i.e., SolidWorks, Abaqus …etc.).
- Interactive Class Discussions.

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- Exercises and Home Works.
- Problem Based Learning.

VI. Assignments:

No	Assignments	Aligned CILOs(symbols)	Week Due	Mark
1.	Homework 1.	a1, a2, a3, b1, b2, c1,c2, d3	2nd	1.25
2.	Homework 2.	a1, a2, a3, b1, b2, c1,c2, d3	3rd	1.25
3.	Homework 3.	a1, a2, a3, b1, b2, c1,c2, d3	4th	1.25
4.	Homework 4.	a1, a2, a3, b1, b2,b4, c1, c2, d2	5th	1.25 1.25
5.	Homework 5.	a1, a2, a3, b1, b2, b3, c1,c2, d3	6th	1.25
6.	Homework 6.	a1, a2, a3, b1, b2, b3, c1,c2, d3	7th	1.25
7.	Homework 7.	a1, a2, a3, b1, b2, b3,b4, c1, c2, d2	9th	1.25
8.	Homework 8.	a1, a2, a3, b1, b2, b3, c1,c2, d3	10th	1.25
9.	Homework 9.	a1, a2, a3, b1, b2, b3, c1,c2, d3	11th	1.25
10.	Homework 10.	a1, a2, a3, b1, b2, b3, c1,c2, d3	12th	1.25
11.	Homework 11.	a1, a2, a3, b1, b2, b3, c1,c2, d3	13th	1.25
12.	Homework 12.	a1, a2, a3, b1, b2, b3, c1,c2, d3	14th	1.25
Total				**15**

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.	Homework 1 to Homework 12.	2nd to 14th	15	10%	a1, a2, a3, b1, b2, b3, c1,c2, d3
2.	Real Problem Presentation.	5th to 11th	15	10%	a1, a3, b1 c1, c2, c3, d1, d2,d3
3.	Project Report and Presentation.	4th , 5th , 6th ,11th , 14th	15	10%	a1, a3, b1 c1, c2, c3, d1, d2,d3

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4.	Quiz 1- Quiz 3.	4th ,7th,11th	10	6.67%	a1, a2, a3, b1, b2, b3, c1,c2, d3
5.	Mid-Term Exam.	8th	20	13.33%	a1, a2, a3, b1, b2, b3, c1,c2, d3
6.	Final Exam.	16th	75	50%	a1, a2, a3, b1, b2, b3, c1,c2, d3
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. Course notes and power point presentations
2. A.C. Ugural, 2008, "Mechanics of Materials", 1st ed, Wiley.
3. Ansel C. Ugural, Saul K. Fenster, 2012, "Advanced Strength and Applied Elasticity', 5th Edition, Prentice Hall.

2- Essential References.

1. Srinath L.S., 2009, "Advanced Mechanics of Solids", 3rd Edition, Tata McGraw-Hill.
2. Boresi, A.P. and Sidebottom, O.M., 2010, "Advanced Mechanics of Materials", 7th Edition, John Wiley.
3. Huei-Huang Lee, 2014, "Mechanics of Materials Labs with SolidWorks simulation 2014", SDC Publications.
4. J.R. Barber, 2001, "Intermediate Mechanics of Materials", McGraw-Hill.
5. R. Budanis, et. Al., 1999, "advanced strength and applied stress analysis", McGraw-Hill.

3- Electronic Materials and Web Sites *etc*.

1- Software packages: Abaqus & SolidWorks
2- http://web.mst.edu/~mecmovie/

I. Course Policies:

1	**Class Attendance:** - The student should be attending not less than 75% of total contact hours of the subject, otherwise he will not able to take exam and be considerd as an exam failure. If the student is absent due to illness, he/she should bring an approved statement from university Clinic.
2	**Tardy:**

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	- For lateness in attending the class, the student will be initially notified. If he repeates late in attending class he will be considered absent.
3	**Exam Attendance/Punctuality:** - The student should attend the exam on time. He is permitted to attend the exam half one hour from exam beginning, after that he/she will not be permitted to take exam and he/she is considered absent in the exam.
4	**Assignments & Projects:** - In general one assignment is given after each chapter of a course. The student should submit the assignment on time, mostly one week after giving the assignment
5	**Cheating**: - For cheating in exam, the student is considered as failure. In case the cheating is repeated three times during study the student will be disengaged from the Faculty
6	**Plagiarism**: Plagiarism is the attending of the student the exam of a course instead of other student. If the examination committee proved a plagiarism of a student, he will be disengaged from the Faculty. The final disengagement of the student from the Faculty should be confirmed from the Student Affair Council of the university.
7	**Other policies:** - The mobile phone is not allowable to be used during class lecture. It must be switched off, otherwise the student will be ordered to leave the lecture room. - The mobile phone is not allowed to be taken during the examination time. - Lecture notes and assignments may be given directly to students using soft or hard copy.

Reviewed By	**Vice Dean for Academic Affairs and Post Graduate Studies: Asst. Prof. Dr. Tarek A. Barakat** **President of Quality Assurance Unit: Assoc. Prof. Dr. Mohammed Algorafi** **Name of Reviewer from the Department: Assoc. Prof. Dr. Abdul-Malik Momin**
	Deputy Rector for Academic Affairs Asst. Prof. Dr. Ibrahim AlMutaa **Assoc. Prof. Dr. Ahmed Mujahed** **Asst. Prof. Dr. Munasar Alsubri**

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