Faculty of Engineering
Department of Mechanical Engineering
COURSE OUTLINE

MECH320 – Mechanics of Solids II

Term – Spring 2016 (201601)

Instructor	**Office Hours**
Dr. Keivan Ahmadi	Days: Wednesday
Phone: 7218694	Time: 11:30 – 12:30*
E-mail:kvahmadi@uvic.ca	Location: EOW 539

* Feel free to stop by EOW 539 at any time that the office door is open. You can also arrange visits with the instructor via email or phone calls to make sure about his availability.

List all prerequisites and co-requisites: MECH 220

LECTURE DATE(S)

Section: A 01/22176	Days: TWF	Time:10:30-11:20	Location: BWC A104

TUTORIAL SECTIONS

Section: T 01/22185	Days: T	Time: 14:30-15:20	Location: ECS125

LAB SECTIONS

Section: B (Multiple)	Days:	Time:	Location:
Lab #1: B01	M	10-11:20	ELW A135
Lab #2: B02	M	13-14:20	ELW A135
Lab #3: B03	M	16-17:20	ELW A135
Lab #4: B04	Th	10-11:20	ELW A135
Lab #5: B05	Th	16-17:20	ELW A135
Lab #6: B06	F	16-17:20	ELW A135
Lab #7: B07	M	17:30-18:50	ELW A135
Lab #8: B08	Th	17:30-18:50	ELW A135

TA Name	**E-mail**	**Office Hours**
Tarek Elgnemi	telgnemi@uvic.ca	ELW A238, T 14:00-15:00
Meysam Karimi	mkarimi@uvic.ca	ELW 102A, W 14:30-15:30
Bahram Mirani	bmirani@uvic.ca	EOW330, W 14:00-15:00
Amir Salar Salehi	ssalehi@uvic.ca	ELW B127, T 14:00-15:00

Required Text
Title: Advanced Mechanics of Materials and Applied Elasticity/ Fifth Edition
Author: Ansel C. Ugural, Saul K. Fenster
Publisher/Year: Prentice Hall, 2003.
Reference Materials: Electronic lecture notes and lab manuals will be posted on Coursespaces. Note that the lecture notes are half-blank and will be filled in during the lectures.

Learning Outcomes next page

COURSE OBJECTIVES:

This course introduces the general form of stress and strain tensors and their properties in 3D solids. Also presented in this course are the fundamentals of elasticity theory and their applications in studying the stress, strain and deflection distributions in practical 2D problems. The topics of this course will prepare the students to conduct stress and strain analysis in engineering problems, and then use the results to determine the failure threshold of mechanical structures.

LEARNING OUTCOMES: At the end of this course, students will be able to:

1- Describe a state of stress and strain using matrix or tensor notations.
2- Manipulate a given state of stress or strain in order to resolve the normal and shear components along specific planes in 3D
   - Calculate 3D principal stresses, strains and their corresponding directions for a given stress or strain tensor
   - Calculate the normal and shear stresses on a 3D oblique plane for given set of principle stresses
3- Describe the Generalized hook's law for Stress-Strain relations in 3D
   - Formulate and apply the generalized hook's law for homogeneous isotropic materials in 2D problems
4- Describe the strain-displacement and stress-strain relations and the equilibrium and compatibility equations in the theory of elasticity; and apply them to determine the stress and deflection distributions in 2D problems
   - Identify and formulate the boundary conditions in 2D problems
   - Use Airy's stress functions to determine the stress distribution in 2D problems
   - Compose the equilibrium, compatibility and stress-strain equations in the polar coordinate system
   - Solve the equations of equilibrium and compatibility in the polar coordinate system to determine the distribution of the stress in the regions close to concentrated external loads
   - Determine the stresses and deflections in Euler-Bernoulli beams under pure bending
   - Apply the inverse solution method to determine the stress distribution in bending of beams with Asymmetrical cross section
   - Apply the method of transformed sections to approximate the composite cross-section of a beam with an equivalent unified cross-section
   - Apply the Prandtl stress functions to determine the stress and deflections of prismatic beams under pure torsion
   - Determine the stress distribution in Axisymmetrically loaded structures such as thick-walled cylinders and rotating annular solid disks
   - Select the appropriate stress concentration factor from lookup tables in 2D problems
5- Apply various brittle and ductile failure criteria to determine the failure threshold in 2D and 3D problems
   - Describe the mechanism of fracture and crack propagation in brittle materials
   - Determine the appropriate stress intensity factor from lookup tables and apply it to assess the fracture threshold in 2D problems
6- Distinguish between static and dynamic loads
7- Construct a Finite Element Model for 2D truss structures by computing the stiffness matrix of the element, transferring it to the global coordinate system, assembling the global stiffness matrix and using it to compute the nodal deflections under external loads.

Weight & Date(s) of Assessments:	Weight	Date
Assignments:	(5 assignments x 3%=%15) + %5 project	See the course schedule at the end of the document
Labs	%10	As indicated in the lab schedule available online
Mid-term	%20	Thursday, Feb 4th , 2016 19:00-21:00, ECS 123 (tentative)
Final Exam	%50	Date: TBA

* Note: a passing grade is required for the Final Exam, in order to pass the course.

ASSIGNMENTS

The course includes five assignments that will cover sample problems from the textbook, and other material. It should be noted that completion of sample problems from the textbook will assist students in preparing for the mid-term and final exams. Students are encouraged to review additional textbook problems, beyond those assigned. Assignment solutions will be posted online after the assignments' due date. Assignments release and due dates are indicated in the course schedule available at the end of the document (also in coursespaces). The assignments must be submitted to MECH 320 drop box before 17:00 of the due date. <u>Late submissions will not be accepted.</u>

LABORATORIES

Each laboratory session has been divided randomly into student groups. These groups will be maintained throughout the term. One lab report must be submitted per group, per laboratory. The lab reports will be due exactly one week after the completion of the scheduled lab session and will be submitted into MECH320 drop box.

- You must prepare in advance of the laboratory to be able to complete the lab on time.
- Lab Schedule and Lab Manual are posted on coursespaces

Lab #	Subject	Start	Due (5 pm)
1	Studying stress distribution using Photoelasticity	See the lab schedule posted on coursespaces	On week after the completion of the lab session
2	Combined bending and torsional loading of beams	See the lab schedule posted on coursespaces	On week after the completion of the lab session
3	Impact testing	See the lab schedule posted on coursespaces	On week after the completion of the lab session

PROJECT:

The course includes one project in which the students will use COMSOL Multiphysics software to study the stress, strain and displacement distributions in two selected problems using Finite Element Analysis. The projects will be conducted individually. Four problems will be offered in this project and each student will select two problems to solve. An online instruction will be provided to guide the students through modeling and analysis in COMSOL. The software is available in the undergraduate computer lab located at ELW B228. The project reports must be submitted to MECH 320 drop box before the final exam (TBA).

NOTES:

Note 1: Self-contained (with no wireless communication capability) calculators are allowed in all exams. The instructor highly recommends a calculator specifically capable of handling: (i) systems of equations, and (ii) matrix operations. Students should note, however, that the grading of the assignment, test, and lab problems in this class will be based heavily on the methodology applied in calculating the final solution. A significant proportion of assignment and test marks are awarded based on a clear and logical description of the entire solution process. Using such grading criteria, specification of the correct numerical solution constitutes a small portion of the allotted marks.

COURSE LECTURE NOTES

Unless otherwise noted, all course materials supplied to students in this course have been prepared by the instructor and are intended for use in this course only. These materials are NOT to be re-circulated digitally, whether by email or by uploading or copying to websites, or to others not enrolled in this course. Violation of this policy may in some cases constitute a breach of academic integrity as defined in the UVic Calendar.

Assignment of E grade and supplemental examination for this course will be at the discretion of the Course Instructor. The rules for supplemental examinations can be found in the current Undergraduate Calendar.

GENERAL INFORMATION

Note to Students:

Students who have issues with the conduct of the course should discuss them with the instructor first. If these discussions do not resolve the issue, then students should feel free to contact the Chair of the Department by email or the Chair's Secretary to set up an appointment.

"**Attendance**

Students are expected to attend all classes in which they are enrolled. An academic unit may require a student to withdraw from a course if the student is registered in another course that occurs at the same time.

An instructor may refuse a student admission to a lecture, laboratory, online course discussion or learning activity, tutorial or other learning activity set out in the course outline because of lateness, misconduct, inattention or failure to meet the responsibilities of the course set out in the course outline. Students who neglect their academic work may be assigned a final grade of N or debarred from final examinations.

Students who do not attend classes must not assume that they have been dropped from a course by an academic unit or an instructor. Courses that are not formally dropped will be given a failing grade, students may be required to withdraw and will be required to pay the tuition fee for the course." UVic Calendar, (2015) http://web.uvic.ca/calendar2015-09/FACS/UnIn/UARe/Atte.html

Accommodation of Religious Observance (AC1210)
http://web.uvic.ca/calendar2015-09/GI/GUPo.html

Discrimination and Harassment Policy (GV0205)
http://web.uvic.ca/calendar2015-09/GI/GUPo.html

Faculty of Engineering, University of Victoria
Standards for Professional Behaviour

"It is the responsibility of all members of the Faculty of Engineering, students, staff and faculty, to adhere to and promote standards of professional behaviour that support an effective learning environment that prepares graduates for careers as professionals…."

You are advised to read the Faculty of Engineering document Standards for Professional Behaviour which contains important information regarding conduct in courses, labs, and in the

general use of facilities.
http://www.uvic.ca/engineering/current/undergrad/index.php#section0-23

Cheating, plagiarism and other forms of academic fraud are taken very seriously by both the University and the Department. You should consult the Undergraduate Calendar for the UVic policy on academic integrity.

Policy on Academic Integrity
http://web.uvic.ca/calendar2015-09/FACS/UnIn/UARe/PoAcI.html

Course Schedule

MECH 320 - Mechanics of Solids II - Spring 2016 Calendar			
Lecture	**Date**	**Topic:**	**Assignments**
1	Tuesday, January 5, 2016	Introduction, Concept of Stress and Strain	
2	Wednesday, January 6, 2016	Stress Tensor, Force Resultants	
3	Friday, January 8, 2016	Review: 2D Stress Transformation, Principal Stress, 2D D.E.'s of Equilibrium,	
4	Tuesday, January 12, 2016	3D Stress Transformation	
5	Wednesday, January 13, 2016	3D Principal Stress and Directions	
6	Friday, January 15, 2016	Stress on 3D Oblique Plane, Octahedral Stress, Boundary Conditions	Assignment 1 is posted
7	Tuesday, January 19, 2016	Stress-Strain Relations, Derivation of 2D and 3D Strain (normal and shear), Eqns of Compatibility	
8	Wednesday, January 20, 2016	2D and 3D Strain Transformation and principal strains	
9	Friday, January 22, 2016	Review Hooke's Law and Poisson Effect, Derivation of Generalized Hooke's Law	Assignment 1 is due
10	Tuesday, January 26, 2016	St. Venant's Principle, Introduction to the Theory of Elasticity	Assignment 2 is posted
11	Wednesday, January 27, 2016	Theory of Elasticity, 2D Elasticity, Airy's Stress Function, Inverse Method by Polynomials, Example Problems	
12	Friday, January 29, 2016	Continue Example Problems	
13	Tuesday, February 2, 2016	Polar Coordinate representation of Stress and Strain	Assignment 2 is due
14	Wednesday, February 3, 2016	Stresses due to Concentrated Loads	

15	Friday, February 5, 2016	Stress Concentrations, Theory of Elast. to Derive Stress around Hole in Plate, Stress Concentration Factors	
READING WEEK			
16	Tuesday, February 16, 2016	Failure Criteria: Basic Concepts, Failure Modes for Brittle and Ductile Mat.	
17	Wednesday, February 17, 2016	Max Shear Stress Theory, Von Mises, Max Principle Stress Theory, Mohr's Theory	
18	Friday, February 19, 2016	Introduction to Fracture Mechanics	Assignment 3 is posted
19	Tuesday, February 23, 2016	Impact and Dynamic Loads	
20	Wednesday, February 24, 2016	Beam Theory, Bernoulli-Euler Bending Theory, Theory of Elasticity applied to Beams	
21	Friday, February 26, 2016	Bending of Beams with Asymmetrical Cross-Section	Assignment 3 is due
22	Tuesday, March 1, 2016	Composite Beams	
23	Wednesday, March 2, 2016	Torsion of Prismatic Beams, Solution with Theory of Elasticity	
24	Friday, March 4, 2016	Prandtl's Membrane Analogy	Assignment 4 is posted
25	Tuesday, March 8, 2016	Axisymmetrically Loaded Members, Theory of Elasticity for Derivation of Thick Walled Cylinders	
26	Wednesday, March 9, 2016	Thick Walled Cylinders with Internal/External Pressure, Interference Fit of Composite Cylinders	
27	Friday, March 11, 2016	Rotating Solid and Annular Disks	Assignment 4 is due
28	Tuesday, March 15, 2016	Introduction to the Finite Element Method, Definitions, Outline of Procedure	
29	Wednesday, March 16, 2016	Modelling 1-D Spring Elements	
30	Friday, March 18, 2016	FEM: Assembling Total Stiffness Matrix, Applying Boundary Conditions	
31	Tuesday, March 22, 2016	FEM: 2D Truss Structures with 1-D Bar Elements	
32	Wednesday, March 23, 2016	Local Element and Global Stiffness Matrix, Transformations	Assignment 5 is posted

	Friday, March 25, 2016	EASTER HOLIDAYS	
33	Tuesday, March 29, 2016	FEM: Example of Plane Truss with Bar Elements	
34	Wednesday, March 30, 2016	Post Solution Analysis of Stress, Example of Beam-Elements	
35	Friday, April 1, 2016	Course Review	Assignment 5 is due
			Project is due on the day of Final Exam