Course	ENR210 Continuum Mechanics	Semester	Monsoon Semester 2024
Faculty Name(s)	Bimal Das, Sham Gurav	Contact	bimal.das@ahduni.edu.in, sham.gurav@ahduni.edu.in
School	SEAS	Credits	2
GER Category:	Not Applicable	Teaching Pedagogy Enable:NO	P/NP Course: Can not be taken as P/NP

Schedule

Section 1	08:00 am to 09:00 am	Fri	01-08-24 to 20-09-24
	09:00 am to 10:00 am	Fri	01-08-24 to 20-09-24
	08:00 am to 09:00 am	Mon	01-08-24 to 20-09-24
	08:00 am to 09:00 am	Wed	01-08-24 to 20-09-24
Section 2	08:00 am to 09:00 am	Mon	01-08-24 to 20-09-24
	08:00 am to 09:00 am	Wed	01-08-24 to 20-09-24
	08:00 am to 09:00 am	Fri	01-08-24 to 20-09-24
	09:00 am to 10:00 am	Fri	01-08-24 to 20-09-24

Prerequisite	Not Applicable OR The student must be familiar with high school mathematics such as calculus and algebra

Antirequisite	Not Applicable
Corequisite	Not Applicable
Course Description	This course lays foundation for fundamental theories of continuum mechanics with applications to various disciplines. After defining material and spatial coordinate systems, definitions of various properties of a continuum field are developed. Displacement gradients, strain and stress tensors are defined and explained with associated theories, such as, Hooke's law for elasticity and plasticity. Yield criteria and plasticity will be covered with practical applications. Balance principles for mass, momentum and energy are discussed with applications. Constitutive equations for different types of materials, including solids, fluids, such as, viscous fluids, Newtonian fluids, plastics, etc. are introduced, along with practical applications from various fields.
Course Objectives	The educational objectives of the course are to: CEO1 Learn concept of a continuum and its relevance; CEO2 Learn concepts of strain and stress tensors and their applications; CEO3 Learn fundamental balance equations for mass, momentum, and energy; CEO4 Understand basic equations of elasticity as applied to different continua. CEO5 Learn about models of constitutive equations for solids, fluids and viscous materials; CEO6 Understand the application of continua theories to applications across various disciplines;
Learning Outcomes	After completing this course, a student should be able to, • Use definitions and concepts defined to develop good understanding of continuum mechanics in various fields • Identify various theories of a continuum and their applications to solids (mechanics of solids); • Identify various theories of continuum and their application to fluids (mechanics of fluids); • Interpret various theories and their application to problems from practice for solids, fluids, and viscous materials; • Identify use of continuum mechanics in a variety of applications. • Learn to solve application based problems relating to solid and fluid mechanics • Develop the ability to analyze the behavior of engineering materials

Pedagogy	The course is largely lecture based, using slides and blackboard. Assignments will supplement application of theory learnt. Application of continuum mechanics in practice will be demonstrated by means examples from real world in the form of videos and animations. A few small demonstration experiments will be used
Expectation From Students	• Students must strictly adhere to the lecture schedule. • Any study material given to students should be prepared effectively before coming to sessions. • Students should participate actively in the allotted projects and assignments.

Assessment/Evaluation	• End Semester Examination:
	  ◦ Written - 50%
	• Other Components:
	  ◦ Quiz - 25%
	  ◦ Assignment - 25%

Attendance Policy	As per Ahmedabad University Policy.
Project / Assignment Details	Assignment- 25%- This will be evaluated based on their submission of assignments Quiz- 25% - to assess the students' understanding, application, and integration of the material covered during the course of the lecture
Course Material	Text Book(s) • Continuum Mechanics for Engineers: Theory and Problems, X. Oliver and C. Agelet de Saracibar, 2nd ed., 2017 Edition, • Continuum Mechanics for Engineers, G. T. Mase, R. E. Smelser, J. S. Rossmann, 4th ed., 2020 Edition, CRC Press., Reference Book • Introduction to Continuum Mechanics,, J. N. Reddy, 2015. Edition, Cambridge University Press,, • Introduction to Continuum Mechanics, W. M. Lai, D. Rubin, and E. Krempl, 4th Edition, 2009. Edition, Butterworth Hienemann,, • A First Course in Continuum Mechanics, O Gonzalez, and A M Stuart,, Cambridge University Press,, Year: 2008,

Additional Information	A total of three assignments and two quizzes are to be conducted. The nature of quizzes and assignments will be application-based Questions, simple problems requiring the application of fundamental equations and principles.

Session Plan

NO.	TOPIC TITLE	TOPIC & SUBTOPIC DETAILS	READINGS,CASES,ETC.	ACTIVITIES	IMPORTANT DATES
0					
1	Introduction	Definition of continuum, scope of theoretical treatment considering macroscopic vs microspic behaviour in terms of various mediums such as solid, liquid and gases	Oliver and Saracibar Ch-1	Lecture	
2	Description of motion	material and spatial coordinates, time derivatives, velocity and acceleration	Oliver and Saracibar Ch-1, section 1.3	Lecture	
3	Description of motion	stationarity, trajectory, streamlines, streamtubes, streaklines, material surface, control surface, material volume, control volume.	Oliver and Saracibar Ch-1	Lecture	
4	Strain	Deformation gradient, material and spatial displacement gradient tensors, strain tensors, infinitesimal strain, volumetric strain,strain rate	Oliver and Saracibar Ch-2	Assignment-1	
5	Compatibility Equations	compatibility conditions for infinitesimal strains	Oliver and Saracibar Ch-3	Lecture	
6	forces acting on a continuum body,	body forces, surface forces, stress tensor, Cauchy stress tensor, principal stresses, mean stress, tensor invariants.	Oliver and Saracibar Ch-4	Quiz-1	
7	Linear Elasticity	Linear theory of elasticity, Generalized Hooke's law,	Oliver and Saracibar Ch-6	Lecture	
8	Linear Elasticity	Isotropy, Young's modulus, Poisson's ratio,	Oliver and Saracibar Ch-6	Lecture	

9	Linear Elasticity	solution to the linear elastic problem, displacement and stress formulation, Saint-Venant's principle.	Oliver and Saracibar Ch-6	Lecture	
10	Plasticity	Plasticity, Yield criteria, plastic flow	Oliver and Saracibar Ch-8	Lecture	
11	Plasticity	plastic modulus, deformation theory of plasticity, viscous stress tensor	Oliver and Saracibar Ch-8	Assignment-2	
12	Plasticity	Yield surfaces, failure criteria, nonlinear elastic behavior	Oliver and Saracibar Ch-8	Lecture	
13	Balance principles	Mass transport or convective flux, conservation of mass, mass continuity equation	Oliver and Saracibar Ch-5	Lecture	
14	Balance principles	Reynolds Transport theorem, balance of linear momentum,	Oliver and Saracibar Ch-5	Quiz-2	
15	Balance principles	balance of angular momentum, Energy balance (1st law of thermodynamics for a CV), Entropy balance (2nd law of thermodynamics for a CV).	Oliver and Saracibar Ch-5	Lecture	
16	Fluid mechanics principles	Constitutive equations in fluid equations, Stokesian and Newtonian fluids, constitutive equations in viscous fluids,	Oliver and Saracibar Ch-5	Lecture	
17	Fluid mechanics principles	constitutive equations in Newtonian fluids, hydrostatics, fluids at rest, fluid dynamics, laminar and turbulent flows,	Oliver and Saracibar Ch-9	Assignment-3	
18	Fluid mechanics principles	Navier-Stokes equation, steady flow, irrotational flow, potential flow, the Bernoulli's equation, Kelvin's theorem.	Oliver and Saracibar Ch-9	Lecture	
19	Reflection and Review	Encouraging students to think critically, Summarizing Key Concepts, Q&A Sessions			