Department of Mathematics

Course Profile

Course Number: MATH452	**Course Title: Introduction to Continuum Mechanics**
Required / Elective: Elective	**Prerequisites:** None
Catalog Description: Mathematical preliminaries, deformation and various strain measures; kinematics, stress tensors. Balance laws of a continuum; thermodynamics, constitutive relations. Applications to elasticity and fluid dynamics.	**Textbook / Required Material:** Eringen, A.C., Mechanics of Continua, Robert E. Krieger Publishing Company. Inc. New York, 1980
Course Structure / Schedule: (3+0+0) 3/ 7 ECTS	
Mathematical foundations; (Tensors and continuum mechanics, Coordinate transformations, The metric tensor, Matrices, Principal directions of symmetric second-order tensors, Tensors field, Derivatives of tensors.) Analysis of deformation and strain (Particles and points, Continuum configuration, Deformation and flow concepts, Position vector, Displacement vector, Lagrangian and Eulerian Descriptions, Deformation Gradients, Displacement gradients, Deformation and finite strain tensors, Small deformation theory and infinitesimal strain tensors, Compatibility equations) Motion (Motion, Material derivative, Velocity, Acceleration, Path lines, Stream lines, Steady motion, Rate of deformation, Velocity, Material derivatives of some quantities) Analysis of stress: (The continuum concept, Homogeneity, Isotropy, Mass-Density, Body forces, Surface Forces, Cauchy's Stress Principal, The stress vector, State of stress at a point, Stress tensor, Force and moment, Equilibrium). Fundamental laws of continuum mechanics (Conservation of mass, Continuity equation, Linear momentum principle, Equations of motion, Angular momentum principle, Conservation of energy, First law of thermodynamics, Energy equation, Equation of state, Entropy, Second law of Thermodynamics, The Clausius-Duhem inequality, Dissipation function, Constitutive equations). Linear elasticity (Generalized Hooke's law, Strain energy function, Isotropy, Anisotropy, Elastic Symmetry, Isotropic media, Elastic constants, Elastostatics problems, Elastodynamic problems St. Venant's principle, Particular cases) Fluids (Fluid pressure, Viscous stress tensor, Constitutive equations, Stokesian fluids, Newtonian Fluids, Basic equations for Newtonian fluids, Navier-Stokes-Duhem euations, Steady flow, Hydrostatic, Irrational flow, Perfect fluids.)	
Design content: None	**Computer usage:** No particular computer usage required

Course Outcomes: By the end of the course the students should be able to:

1. present the mathematical theory and applications of material sciences and structural analysis **[2,3],**
2. provide a mathematical foundation for further studies in mechanics, material sciences and other branches of science and engineering **[2,4,6],**
3. have the ability of using Continuum Mechanics in modelling engineering problems **[2,3,6].**

[2] demonstrate knowledge of mathematics and mechanics to construct, analyze and interpret real world problems,

[3] demonstrate the ability to apply mathematics to the solutions of problems,

[4] have a basic knowledge of mechanics, information sciences and social sciences,

[6] have a basic knowledge of the main fields of mathematics and mechanics, including differential equations, elasticity theory, fluid mechanics,

Recommended reading:
I-Shih Liu, Continuum mechanics, Berlin ; New York : Springer, 2002

George E. Mase, Theory and Problems of Continuum Mechanics, Schaum's Outline Series, McGraw-Hill Book Company, New York, 1970

Teaching methods: Three hours theoretical presentation with illustrative problem solving.

Assessment methods: Homework, quiz, midterm and final exams.

Student workload:

Pre-reading ....35 hrs

Lectures ……………………………………45 hrs

Preparatory reading ………………….. 40 hrs

Literature review for presentation………… 35 hrs

Team work for presentation ………………20 hrs

TOTAL ……………………………… 175 hrs …… to match 25x7 ECTS

Prepared by: Esin İnan	Revision Date: 08.02.2010