Fundamentals of Mechanics ME 5700
Winter 2005
3.00-4.50 pm, Thursday and Friday, rm 0256 Manoogian

**Instructor:** Professor Victor Berdichevsky
2138 Engineering Bldg.
(313) 577-3905

**Office Hours:** 5-7pm, Thursday; 1.30-2.30 pm, Friday in office;
4.50-5.20 pm, Friday, rm 0256 Manoogian.

**Pre-requisites:** MAT5070 or consent of the instructor

**Textbook:** *Class Notes;*

**Other textbooks:** *Continuum mechanics* by Sedov,
*Introduction to Mechanics of Continua* by Prager, Dover,
*Continuum Mechanics* by Chung,
*Mathematics Applied to Continuum Mechanics* by Segel,
*A First Course in Continuum Mechanics* by Fung.

**Additional readings:** *Thermodynamics of Chaos and Order,* by V. Berdichevsky,
Addison Wesley, 1997, Chapters 1, 2
Course Contents:

**Classical Mechanics:** Prehistory (Gallileo, Newton, Fermat, Bernoulli, Mopertuis); Lagrange’s variational principle and Lagrange’s equations; Legendre’s transform; Hamilton’s variational principle and Hamiltonian equations.

**Thermodynamics:** Thermodynamic description; derivation of equilibrium thermodynamics from classical mechanics (ergodic Hamiltonian systems, equipartition law and temperature, entropy, equations of state, thermodynamic potentials); the laws of non-equilibrium thermodynamics.

**Continuum kinematics and tensor analysis:** Lagrangian and Eulerian coordinates; necessity of curvilinear frames and tensors; notion of a tensor, algebraic tensor operations, Levi-Civita tensor and vector product, covariant differentiation, metric tensor, Christoffel’s symbols; particle trajectory, velocity, acceleration, displacement field, distortion; strain tensor, strain rate tensor, principal axes and invariants of tensor of second order; tensor functions of tensors of second order; vorticity vector, velocity circulation, potential motion.

**Continuum Mechanics:** Integral theorems; momentum equation in integral and differential forms and stress tensor; energy equation in integral and differential forms and heat flux vector; entropy equation for quasi-equilibrium and non-equilibrium processes; basic models of continuum mechanics (ideal incompressible fluid, ideal gas, viscous fluid, heat conduction by moving media, physically and/or geometrically nonlinear elastic bodies, rubber (entropic) elasticity, linear elasticity; thermo-elastic bodies; plasticity models); some properties of fluid motion (Euler’s equation in Lagrangian coordinates, general solution to Euler’s equation, integral and local forms of vorticity conservation).

---

**Grading Policy:** Grades will be based on three closed books/notes mid-term exams (maximum 30 points each) and instructor’s impression about your knowledge based on your class performance (10 points maximum). Each exam will cover all topics completed one week before the exam. The exams will be given after completion the study of classical mechanics and thermodynamics, continuum kinematics and tensor analysis, and continuum mechanics. A student missing a mid-term exam will be given a comprehensive exam during the final exam week. The comprehensive exam may be taken by any student who wishes to substitute the result of one of the previous exams.

**Grades vs. Points:** A > 80, A- > 75, B+> 70, B > 65, B- > 60, C > 55.
Course Learning Objectives:

(Letters in brackets refer to BSME Program Educational Outcomes A - J.
Numbers in brackets refer to the methods of evaluation, with 1 = Homework; 2 = Quizzes & Exams; 3 = Projects & Competitions; and 4 = Presentations)

Students who successfully complete ME 5700 will:
• Know the basic equations and models of continuum mechanics [A,B,C;2,4]
• Learn the language of continuum mechanics [A,B,C;2,4]

Relationship of Course to Program Educational Outcomes:

Strongly contributes to the BSME Program Educational Outcomes that successful students will:

• be able to understand scientific principles and apply them to the practice of engineering [A];
• be able to communicate effectively[B];
• possess the problem-solving skills, background, and confidence necessary to educate themselves continually throughout their careers [C];

Student conduct: It is the responsibility of each student to adhere to the principles of academic integrity. Academic integrity means that a student is honest with him/herself, fellow students, instructors, and the University in matters concerning his or her educational endeavors. Thus, a student should not falsely claim the work of another as his/her own, or misrepresent him/herself so that the measures of his/her academic performance do not reflect his/her own work or personal knowledge. In this regard, cheating will not be tolerated. Cheating includes (but not limited to) any communication (written or oral) during examination and sharing of work, such as using the same models or computer programs or copying work. All homework and projects must be an individual effort unless specifically noted. STUDENTS WHO CHEAT OF ANY ASSIGNMENT OR DURING ANY EXAMINATION WILL BE ASSIGNED A FAILING GRADE FOR THE COURSE. Therefore avoid all appearance of improper behavior.