1. Department, Course Number, and Course Title:

MECHANICAL ENGINEERING

ME 402 ADVANCED MECHANICS OF MATERIALS

2. Designation:

Required	☐	Elective	☑
Lower Division	☐	Upper Division	☑

3. Course Description: Basic concepts; unsymmetrical beam bending, shear flow; energy methods; the finite element method; theories of failure; introduction to theory of elasticity, plane elastostatic problems; torsion of prismatic cylinders

4. Prerequisites: ME 323 (Machine Design I), MATH 215 (Differential Equations).

5. Text and Materials: Advanced Strength and Applied Stress Analysis, Second Edition, Richard G. Budynas, McGraw-Hill, 1999.

6. Course Objectives: Seniors in M.E. will learn and understand concepts and principles, and methods of analysis, drawn from advanced strength of materials, and from elementary theory of elasticity. They will apply these concepts, principles, and methods to design.

Course Outcomes

- Ability to determine bending stresses for beams with unsymmetrical cross sections.
- Ability to determine bending and shear stresses for beams with thin-walled open sections.
- Ability to analyze the stresses in thick-walled pressurized cylinders.
- Ability to analyze deflections for linearly and nonlinearly elastic structures.
- Elementary understanding of the finite element method, and ability to use commercial FEM software.
- Ability to apply failure theories to brittle and ductile materials.
- Ability to perform deformation, stress and strength analyses for linearly elastic, machine and structural elements, under combined loading.
- Ability to calculate principal stresses and principal directions.
- Understanding of plane-stress and plane-strain problems, and torsion problems, within theory of elasticity.
- Awareness of the complexities and limitations of advanced strength of materials and the theory of elasticity.
- Ability to apply concepts and methods of analysis from advanced strength of materials and theory of elasticity to design situations.

7. Topics Covered: (in Order of Presentation)

- Review of some basic concepts: stress, strain, strain-stress relations. Strain-displacement relations.
- Review of axial loading, bending of beams with symmetrical cross sections.
- Introduction to the Finite Element Method: one-dimensional and two-dimensional spring element. Application to trusse
- Area moments of inertia; pure bending of unsymmetrical beams; more on beam transverse shear stresses; shear flow in open, thin-walled beams, shear center; thick-walled pressurized cylinders, press fits.
- Energy methods: work, strain energy, complementary energy, Castigliano's first theorem, complementary-energy theorem, Castigliano's second theorem.
- The Finite Element Method continued, one-dimensional truss element, triangular plane-stress element.
- Stress-strain diagram; theories of failure; factor of safety.
- Introduction to the Theory of Elasticity
- Plane elastostatic problems, the Airy stress function; torsion of prismatical cylinders, St. Venant's torsion function

8. Class Schedule:

Number of Sessions per week:	2
Duration of each session:	1 hour 40 minutes

9. Contribution of course to meeting the professional component:

This course is part of the 25 units of upper division technical electives required for the mechanical engineering

program.

Engineering Science	2 units
Engineering Design	2 units

10. Relationship of course to program objectives:

This course relates to the program objectives by contributing to the following measurable outcomes at the level indicated for all engineering graduates:

Knowledge outcomes:

- an ability to apply knowledge of mathematics, science, and engineering (abet a)
- a knowledge of computer aided design and simulation software

Skill outcomes:

- an ability to design a system, component, or process to meet desired needs within realistic constraints such as economic, environmental, social, political, ethical, health and safety, manufacturability, and sustainability (abet c)
- an ability to communicate effectively (abet g)
- an ability to use the techniques, skills, and modern engineering tools necessary for engineering practice (abet k)
- an ability to think in a logical sequential process

Attitudes Outcome:

- an understanding of responsibility and accountability
- a desire to be a professional that exhibits values, dedication and a need for continual improvement
- a desire to be a flexible and adaptable team player (collaborative attitude)

11. Prepared by: Stephen F. Felszeghy 05/2005