1. **Catalog Description**: Credits: 3; Stress-strain analysis and design of machine elements; finite element analysis.

2. **Pre-requisites and Co-requisites**: CGS 2425, EGM 4313 and EGM 3520.

3. **Course Objectives**: This course provides an introduction to finite element analysis and its application in design. It stresses fundamental engineering science principles applied to the finite element method. Students will learn the direct method of deriving stiffness matrices using uniaxial bar elements and one-dimensional heat conduction. Transformation from local to global coordinates is illustrated using trusses. Application of energy principles in deriving finite element equations is illustrated using beam and plane solid elements. MATLAB programs are used to illustrate how the theory of finite elements is translated into computer programs. Two design projects are assigned so that the students can learn to use the technique to practical problems. Upon completion of this course, students are expected to understand basic principles of the finite element method, coupled with a strong foundation and appreciation for its application in design.

4. **Contribution of course to meeting the professional component**

   4A. EML 4500 supports several program outcomes enumerated in the Mission Statement of the Department of Mechanical and Aerospace Engineering. Specific ME program outcomes supported by this course include: (1) Apply knowledge of calculus based physics (ME Program Outcome M1); (2) Using knowledge of advanced mathematics through multivariate calculus and differential equations (ME Program Outcome M2); (3) Be familiar with linear algebra (ME Program Outcome M3); (4) Being able to work professionally in the mechanical systems area (ME Program Outcome M4).

   4B. Mathematical Sciences (15%), Physical Sciences (15%), Engineering Sciences (70%)

5. **Relationship of course to program outcomes**

   This course achieves the following ABET outcomes [note that the outcome number corresponds to the respective ABET outcomes (a) through (k). Also, note that superscripts represent related ME program outcomes]:
   - Apply knowledge of mathematics, science, and engineering [outcome (a), high coverage (35%); method of assessment is specially selected problems on three exams and two quizzes]
   - 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 [outcome (c), low coverage (10%); method of assessment is one project]
   - Identify, formulate, and solve engineering Problems [outcome (e), high coverage (35%); method of assessment is specially selected problems on three exams, weekly homework assignments and projects]
   - Understand professional and ethical responsibilities [outcome (f), low coverage, not assessed]
   - Communicate Effectively [outcome (g), low coverage (5%), one project]
   - Understand the impact of engineering solutions in a global, economic, environmental and societal context [outcome (h), low coverage, not assessed]
   - Recognize the need for, and engage in life long learning [outcome (i), discussion of practical problems using finite elements and developments in the field, not assessed]
   - Use the techniques, skills, and modern engineering tools necessary for engineering practice [outcome (k), high coverage (15%); method of assessment is assignments and projects that use the finite element techniques in practice requiring the use of MATLAB].

6. **Instructor**: Dr. Subrata Roy, Associate Professor, Mechanical and Aerospace Engineering
   336 MAE-B, P.O. Box 116300, Gainesville, FL 32611-6300
   Tel (352) 392-9823/Fax (352) 392-1071, Email: roy@ufl.edu
   http://www.mae.ufl.edu/newwebpage/People/Person.aspx?id=91
   Office Hours: WF 7th Period
7. **Teaching Assistants:**
   - Navya Mastanaiah, Office: MAE-A 224, Phone: 392-7711, Email: mnavya@ufl.edu
     Office Hours: **MWF 4th Period, MW 5th Period**
   - Tomas Houba, Office: MAE-A 224, Phone: 392-7711, Email: tomash6@ufl.edu
     Office Hours: **TR 5th Period, TR 6th Period**

8. **Meeting Times:** MWF 3:00-3:50 pm (8th Period)

9. **Class/Schedule/Homepage:**
   http://cpdlt.mae.ufl.edu/roy/eml4500.htm

10. **Meeting Location:** TUR L005

11. **Material and Supply Fees:** None

12. **Textbooks and Software:**
   - Introduction to Finite Element Analysis and Design, by Nam H. Kim and Bhavani V. Sankar (Required), John Wiley and Sons.
   - An Introduction to MATLAB, by D. F. Griffiths, University of Dundee, ([PDF](#))

13. **Recommended Reading:** None

14. **Course General Outline:**
   **First unit: 4 ½ Weeks (Approx)**
   - Vector And Matrix
   - Vector-Matrix Calculus
   - Matrix Equation
   - Quadratic Forms
   - Eigen Values And Eigen Vectors
   - Maxima And Minima Of Functions
   - Stress
   - Strain
   - Stress–Strain Relationship
   - Equilibrium Equations
   - Boundary Value Problem
   - Compatibility Conditions
   - Strain Energy And Material Failure
   - Distortion Energy Theory
   - The Maximum Shear Stress Theory
   - Maximum Principal Stress Theory
   - Safety Factor

   **Second unit: 6 Weeks (Approx)**
   - Illustration of the Direct Method
   - Uniaxial Bar Element
   - Finite Element Analysis Using MATLAB Program
   - Truss Element in Two–Dimension
   - Truss Element in Three-Dimension
   - Potential Energy of a Beam
   - Finite Element Approximation
   - Weighted Residuals
   - Galerkin Method
   - Principle of Minimum Potential Energy
Third unit: 4 ½ Weeks (Approx)
- Beams and Frames
- Introduction to Fluid Flow and Heat Transfer
- Steady- State Heat Transfer Problem
- Finite Element Approximation
- Convection Boundary Condition
- Steady-State Advection-diffusion (Peclet) problem
- Introduction to Solid Elements
- Types of Two-Dimensional Problems
- Principle of Minimum Potential Energy
- Four Node Iso-parametric Quadrilateral Element

15. Schedule:
   Homework: Every Friday except Exam weeks, due next Friday or the following class day
   Quizzes 5% each: Sept 11, Oct 7, Nov 20
   Exam #1: Sept 23, 2009
   Exam #2: Nov 6, 2009
   Exam #3: Dec 9, 2009
   Project #1: Oct 30, 2009
   Project #2: Dec 14, 2009 (by 9am)

16. Grading:
   Homework: 12%
   Quizzes 5% each: 15%
   Exam #1: 17%
   Exam #2: 17%
   Exam #3: 17%
   Projects 11% each: 22%

17. Grading Scale:
   A 90-100%
   B+ 85-89%
   B 80-84%
   C+ 75-79%
   C 70-74%
   D+ 65-69%
   D 60-64%
   E 0-60%

18. Make-up Exam Policy: There will be no make-up exams. Unless there is a documentable extreme medical emergency, no credit will be given for a missed exam. It is the student’s responsibility to make sure he/she is available to take the exam. All exams with the exception of the Final Exam will be given during the scheduled class times.

19. Honesty Policy – All students admitted to the University of Florida have signed a statement of academic honesty committing themselves to be honest in all academic work and understanding that failure to comply with this commitment will result in disciplinary action. This statement is a reminder to uphold your obligation as a UF student and to be honest in all work submitted and exams taken in this course and all others.

20. Accommodation for Students with Disabilities – Students Requesting classroom accommodation must first register with the Dean of Students Office. That office will provide the student with documentation that he/she must provide to the course instructor when requesting accommodation.
21. **UF Counseling Services** – Resources are available on-campus for students having personal problems or lacking clear career and academic goals. The resources include:
   - University Counseling Center, 301 Peabody Hall, 392-1575, Personal and Career Counseling
   - SHCC mental Health, Student Health Care Center, 392-1171, Personal and Counseling.
   - Center for Sexual Assault/Abuse Recovery and Education (CARE), Student Health Care Center, 392-1161, sexual assault counseling
   - Career Resource Center, Reitz Union, 392-1601, career development assistance and counseling

22. **Software Use** – All faculty, staff and student of the University are required and expected to obey the laws and legal agreements governing software use. Failure to do so can lead to monetary damages and/or criminal penalties for the individual violator. Because such violations are also against University policies and rules, disciplinary action will be taken as appropriate. We, the members of the University of Florida community, pledge to uphold ourselves and our peers to the highest standards of honesty and integrity.