APPLICATION FOR NEW COURSE

1. Submitted by College of Engineering Date 3/28/07

   Department/Division offering course Mechanical Engineering

2. Proposed designation and Bulletin description of this course

   a. Prefix and Number ME-514 b. Title* Computational Techniques in Mechanical System Analysis

   *NOTE: If the title is longer than 24 characters (including spaces), write A sensible title (not exceeding 24 characters) for use on transcripts Comput Mech Sys Analysis

   c. Lecture/Discussion hours per week 3.0 d. Laboratory hours per week 0.0

   e. Studio hours per week 0.0 f. Credits 3.0

   g. Course description

   Computer-based methods of analyzing mechanical systems are studied. The studies include the numerical solution techniques on which the analyses are based. Linear and nonlinear static and dynamic structural systems are analyzed. Finite element and other engineering software packages are used.

   h. Prerequisites (if any)

   ME-340 or graduate standing

   i. May be repeated to a maximum of _____ (if applicable)

4. To be cross-listed as

   _____ Prefix and Number _____ Signature, Chairman, cross-listing department

5. Effective Date Spring, 2008 (semester and year)

6. Course to be offered ☐ Fall ☑ Spring ☐ Summer

7. Will the course be offered each year? ☑ Yes ☐ No
   (Explain if not annually)

8. Why is this course needed?

   As computer-based methods of system analysis continue to be more broadly used in industry and research, graduate students and upper level undergraduates can benefit from a course exposing them to the types of solutions that can be obtained with software that also provides a background for understanding the basis for the solutions.

9. a. By whom will the course be taught? John R. Baker

   b. Are facilities for teaching the course now available? ☒ Yes ☐ No
   If not, what plans have been made for providing them?

APPLICATION FOR NEW COURSE

10. What enrollment may be reasonably anticipated? 10-15

11. Will this course serve students in the Department primarily? ☑ Yes ☐ No

Will it be of service to a significant number of students outside the Department? ☐ Yes ☑ No
If so, explain.

Will the course serve as a University Studies Program course? ☐ Yes ☑ No

If yes, under what Area? _____

12. Check the category most applicable to this course

- ☐ traditional; offered in corresponding departments elsewhere;
- ☑ relatively new, now being widely established
- ☐ not yet to be found in many (or any) other universities

13. Is this course applicable to the requirements for at least one degree or certificate at the University of Kentucky? ☑ Yes ☐ No

14. Is this course part of a proposed new program: ☐ Yes ☑ No
If yes, which?

15. Will adding this course change the degree requirements in one or more programs? ☐ Yes ☑ No
If yes, explain the change(s) below (NOTE – If "yes," a program change form must also be submitted.)

16. Attach a list of the major teaching objectives of the proposed course and outline and/or reference list to be used.

18. If the course is 400G or 500 level, include syllabi or course statement showing differentiation for undergraduate and graduate students in assignments, grading criteria, and grading scales. ☑ Check here if 400G-500.

19. Within the Department, who should be contacted for further information about the proposed course?

Name John R. Baker Phone Extension 270-534-3114

APPLICATION FOR NEW COURSE

Signatures of Approval:

April 25, 2007 Date of Approval by Department Faculty	Reported by Department Chair
04/21/08 Date of Approval by College Faculty Approved UC 10/7/08	Reported by College Dean
*Date of Approval by Undergraduate Council	Reported by Undergraduate Council Chair
*Date of Approval by Graduate Council	Reported by Graduate Council Chair
*Date of Approval by Health Care Colleges Council (HCCC)	Reported by HCCC Chair
*Date of Approval by Senate Council	Reported by Senate Council Office
*Date of Approval by University Senate	Reported by Senate Council Office

*If applicable, as provided by the Rules of the University Senate

Rev 7/06

ME 514
Computational Techniques in Mechanical System Analysis

COURSE DESCRIPTION:
This course includes theory and application for computer-based methods of analyzing mechanical systems. The primary software tools used are the finite element software, ANSYS, and MATLAB. Linear and nonlinear static and dynamic structural systems are analyzed. Numerical solution techniques are studied.

INSTRUCTOR:

John Baker, Extended Campus Program - Paducah
Crounse Hall, Room 206
Phone: Office (270) 534-3114; Cell (270) 994-7902
Email: jbaker@engr.uky.edu
FAX: (270) 534-6292

PREREQUISITES: ME-340

REFERENCES: There is no required textbook for the course. Some helpful references are listed below:

1. D.L. Logan: A First Course in the Finite Element Method, 3rd Edition, Brooks/Cole Thomson Learning, 2001.
2. Thomson and Dahleh, Theory of Vibration with Applications, 5th Edition, Prentice-Hall Inc., 1998.
3. Belytschko, Liu, and Moran, Nonlinear Finite Elements for Continua and Structures, John Wiley and Sons, Ltd., 2000.

GRADING:

Scale

Undergraduate Students		Graduate Students	
90%-100%	A	90%-100%	A
80%-89.9%	B	80%-89.9%	B
70%-79.9%	C	70%-79.9%	C
60%-69.9%	D	0%-69.9%	E
0%-59.9%	E		

Distribution

Undergraduate Students	
Homework	25%
Application Projects	45%
Midterm Exam	15%
Final Exam	15%

Graduate Students	
Homework	20%
Application Projects	40%
Final Project	10%
Midterm Exam	15%
Final Exam	15%

NOTES

- The instructor will be available at other times, in addition to those listed above, for office hours. Students are encouraged to stop by the office, call, or send an email, whenever help is needed. Feel free to call on the cell phone on evenings and weekends.

- Students are responsible for checking their email regularly for course announcements and possible added handouts and other course information.

- The grading scale shown is a guideline, so adjustments may be made.

- Late assignments will not typically be accepted. They will only be accepted at the instructor's discretion under unusual circumstances. In some cases, portions of homework may be submitted via emailed to the instructor. Pages of assignments must be stapled together when hard copies are turned in.

- Students taking the course for graduate credit will be assigned a final project. Students taking the course for undergraduate credit will not complete a final project. This difference is reflected in the separate grade distributions on the previous page for graduate and undergraduate students.

- There will be one midterm exam and a final exam. Make-up exams will only be given in special circumstances. If any student cannot attend class, for some excusable reason, on one of the exam dates, it is essential that the instructor be notified as soon as possible, so that other arrangements can be made. Anyone who misses an exam without being granted approval in advance may receive a grade of zero for the exam.

COURSE GOALS:

The primary goals of the course are to provide students with an understanding of the types of mechanical system analyses that can be carried out with modern software tools and with an understanding of the basic mathematical approaches used in the analyses. Also, students will become familiar with methods for performing analyses efficiently, such as through automating the analysis process by writing macros, which is useful, for instance, in a design optimization study.

COURSE OUTLINE

I. Introductory and Review Material
- a) System Equations in Coupled Second Order Form
  - i) Spring-Mass-Damper Systems – Equations from FBD's using Newton's 2nd Law
  - ii) System Equations in Matrix Form
- b) Finite Element Method
  - i) Element Formulations
  - ii) Use of Superposition to Obtain Global System Equations
- c) Software Tools
  - i) Overview of ANSYS Software
  - ii) Overview of MATLAB Software

II. Linear System Computer-Based Solutions
- a) Static Systems
- b) Dynamic Systems
  - i) Modal Analysis
  - ii) Forced Harmonic Response Analysis
  - iii) Transient Analysis
    - Numerical integration schemes (Central Difference, Newmark's Method, Runge-Kutta)
    - Methods of transient analysis in ANSYS: Full Model, Reduced Model, Mode Superposition.

III. Nonlinear System Computer-Based Solutions
    a) Static Systems
        i) Large deflection
        ii) Material nonlinearity
        iii) Contact
    b) Dynamic Systems

IV. Selected Advanced Application Examples
    a) Cut-Displacement Boundary Condition in FEA
    b) Nonlinear Parametric Response of Flexible Structures
    c) Coupled-Field Finite Elements for Modeling Piezoelectric Material Mounted on Structures
    d) Impact Analysis Using Explicit Dynamics FEM (ANSYS/LS-Dyna)

TEACHING OBJECTIVES

The primary teaching objectives for the course are to provide students with:

- An understanding of the types of mechanical system analyses that can be carried out with modern software tools.
- An understanding of the basic mathematical approaches used in the analyses.
- An understanding of the differences in linear and nonlinear system analysis.
- Familiarity with the widely-used software tools, ANSYS and MATLAB.
- Familiarity with methods for performing analyses efficiently, such as through automating the analysis process in ANSYS by writing macros, which is useful, for instance, in a design optimization study.
- Familiarity with basics of structured programming by writing short programs using MATLAB.