COURSE SYLLABUS
UK ME/MFS 501-201 WKU ME 499-700 Spring 2019 ONLINE COURSE
Mechanical Design with the Finite Element Method

Instructors:
Primary: Dr. Keith E. Rouch, P.E.
Department of Mechanical Engineering
163 Ralph G. Anderson Building (RGAN)
University of Kentucky
Lexington, KY 40506-0503
Ph. 859-218-0637 /cell-text 859-421-6222
Email: keith.rouch@uky.edu

Co-Instructor: Dr. John R. Baker, P.E.
Paducah Engineering Program
206 Crounse Hall
University of Kentucky
Paducah, KY 42001
Ph. 270-534-3114/cell-text 270-994-7902
Email:john.r.baker@uky.edu

1. COURSE INFORMATION

1.1 Course Description. This course emphasizes mechanical design techniques based on the finite element method, using machine design background as the starting point. Techniques for modeling machine elements or components will be shown in relation to the basic FEM theory. Emphasis will be on quantifying loads and boundary conditions, the resulting stresses and deflections, and relating them to the design allowables, leading to an acceptable design solution. Prerequisite or concurrent: Engineering Standing, ME 344 (Mechanical Design) and ME 205 (CAD graphics); or Graduate Standing or consent of instructor.

1.2 Course Materials

1.2.1. Textbook (required): A First Course in the Finite Element Method 6th ed., by D. L. Logan, ISBN various, Cengage, 2016 (NOTE : There are several options for this text, including the digital version, with or without MindTap, rental or purchase, bookstore or online). Options for Logan text:

FROM CENGAGE "

Here is the link for **University of Kentucky-** www.cengagebrain.com/course/preview/3054460

The First option is for **Cengage Unlimited $120/Semester**- This will allow the students to have access to every single **MindTap** Cengage has to offer. So students can use it for other courses that offer Cengage materials. Most students don't end up purchasing the physical copy, but if they need one we offer a **$7.99 print rental** with the subscription.

The Second Option is only the **MindTap Access for 1 term (6 months) $95.00**

The Third Option is only the **Book for $244.95**

The Fourth Option is **MindTap for 1 term (6 months) and Book $257.95"**

1.2.2.Textbook (this earlier printed edition can be used): A First Course in the Finite Element Method 5th ed., by D. L. Logan, ISBN 9780495668251, Cengage, 2012 (does not include Mindtap e-access)

1.2.3. CANVAS LMS includes all lecture notes, videos, and ANSYS tutorials.

1.3 References (optional):

1. Finite Element Simulations with ANSYS Workbench 19 Theory, Applications, Case Studies, By Huei-Huang Lee, Published Sept 7, 2018, 614 Pages, ISBN: 978-1-63057-088-0 by SDC Publications, available Amazon.

2. ANSYS Tutorial Release 14: Structural & Thermal Analysis Using the ANSYS Mechanical APDL Release 14 Environment, Kent Lawrence, Publisher -- SDC Publications, 2012,
ISBN 1585037613, 9781585037612, Length 178 pages

3. The following link provides a number of ANSYS tutorials for student reference. Please copy and paste the link into the website box of your browser.
https://confluence.cornell.edu/display/SIMULATION/ANSYS+Learning+Modules

4.(Website for listing of ANSYS tutorials) https://www.quora.com/Where-can-I-find-good-Ansys-Mechanical-tutorials

5. Mechanical Engineering Design text, eg Shigley

6. ANSYS Documentation, online help in ANSYS ansys.com/academic

2. COURSE OUTCOMES

Students will be able to:

(a) Use modern computer tools and software to solve engineering problems.
(b) Understand the theory of the finite element method, and the basic concepts of a stiffness matrix and other aspects of structural/mechanical analysis.
(c) Become familiar with matrix algebra and methods of solution of simultaneous linear equations and apply these solution techniques to the finite element method.
(d) Use an existing finite element package for basic types of modeling.
(e) Understand the assumptions, approximations, and limitations involved in using the finite element method in mechanical design.
(f) Understand the role of modern design tools for more efficient and sustainable product design.

3. COURSE TOPICS

1. Introduction, history, background of the finite element method. (5%)
2. Review of matrix techniques (8%)
3. Application of FEM to bar, spring, and beam machine elements (20%)
4. Input requirements, pre and post processing in modeling (15%)
5. Modeling machine elements with 2D, axisymmetric and 3D elements (10%)
6. Determining operating loads, boundary conditions, other modeling requirements (10%)
7. Consideration of design allowables, including considerations of deflection, yield criteria, life expectancy, design interpretation of localized stresses (10%)
8. Basic concepts of FEM in heat transfer, thermal stress, and vibrations in design (10%)
9. Familiarization with capabilities of commercial programs (12%)

4. LMS ACCESS https://uk.instructure.com

All information on the course will be maintained on a CANVAS course website at the University of Kentucky, including course assignments, lecture notes and videos, grades, and other documents. This

course is delivered in a web-based format, and it is essential that students stay current with the material. Videos of lectures will be posted, for viewing on the weekly schedule provided. The course content is arranged in modular form, under the MODULES selection in CANVAS: https://uk.instructure.com

Students enrolled in the course should be automatically included for access, with login being the UK ID and password. Be sure to verify CANVAS LMS access during the first few days of the session.

5. STUDENT INTERACTION

5.1 Students are expected to maintain communication with the instructors through various means:

Web-Conferencing (Zoom)
Personal Meetings (by arrangement)
E-mail or Phone
Canvas Discussion Board (Instructor or other students)

These interactions are expected to be conducted in a professional manner. It is essential that students check e-mail on a daily basis. The e-mail address on Canvas will be used by default, so students must activate e-mail forwarding if they prefer another primary e-mail address. In any communications with the instructors or other students, be sure to follow e-mail etiquette.

5.2 The instructors will normally respond to e-mail or phone calls (received during daylight hours) within four hours of receipt, usually sooner.

5.3 Students are expected to have internet access, and appropriate computer hardware, along with access to software for document creation and editing, and for preparation of presentations. The university recommendations on computer hardware are listed at http://www.uky.edu/ukit/hardwareguide.

5.4 The instructors may schedule periodic interactive web sessions using Zoom, based on student needs. There are two options for audio: 1) If using audio conferencing on the web, students need to have a workable headphone with microphone, and should check out the workability within Zoom prior to the first usage; 2) As an alternative, students may connect audio by telephone (recommended—generally gives better audio quality). This may not be a toll-free connection, and students need to check any impact on toll charges or minutes on their phone plan.

6. COURSE GRADING

The assigned problems are selected to illustrate the concepts and techniques involved in the course. Assignments are to be submitted electronically through Canvas on or prior to the due date, and feedback will be provided on Canvas. A short quiz is provided for each module, with due dates as noted. For homework turned in within a one week period after due date, grades will be reduced by 50 percent. No homework will be credited if more than one week past due, unless instructor approval is granted.

Each student will select a design problem (see discussion) to be solved using the finite element method A brief typed summary of the proposed problem is to be submitted mid-semester, and a written report on the project is due by final exam time. Additional credit for undergraduates will be given for an optional online presentation file submitted the last week of class. A presentation file is required for students receiving graduate credit.

HOMEWORK	15 percent
QUIZZES	5 percent

EXAMS (2)	60 percent
PROJECT	20 percent (18 percent report, 2 percent proposal)
PRESENTATION	Powerpoint (or audio over Powerpoint) required for grad credit as part of report, extra credit 2 percent for undergrads

60 percent of the grade will be based equally on each of the two exams. The exams are intended to assess the student's understanding of the basic concepts and learning outcomes of the course. Exams are closed-book, and only the reference material provided by the instructor can be used. Individual work by students is required.

A numerical score will be assigned for each of the three categories, and weighted per the distribution above to determine the final score. Typically letter grades (undergraduates A, B, C, D, E) will be assigned on the basis of 92, 82, 70, 60 percent cutoffs (A, B, C, E for graduate students). For those students taking the course for graduate credit, a differential in grade assignment compared to that for undergraduates is expected. The level of difficulty in the course project is also expected to be higher for graduate students.

7. FINITE ELEMENT ACCESS

The assigned work will include some manual calculations. Some problems are also to be solved using a finite element program, and access to a FEM program is also required for the course project. The following options exist:

The full ANSYS version, including heat transfer and nonlinear capability, is available in a number of computer labs on the UK campus and Paducah. Several modules are available, including Mechanical APDL, Workbench, and Fluid Dynamics. (Contact the instructor if other options need to be explored – other finite element software may be suitable).

2. Students may obtain a copy of the ANSYS Student edition, at no charge, on the *ansys.com/student website "The renewable twelve-month product license is free and can be downloaded and used by students anywhere in the world. It provides access to versions of ANSYS Multiphysics, ANSYS CFD, ANSYS Autodyn, ANSYS Workbench, ANSYS DesignModeler and ANSYS DesignXplorer that are limited only in the size of the problems that can be solved. The product can be installed on any supported MS Windows 64-bit machine.*

Self guided support and educational materials are also on ansys.com. This will include product installation guides, FAQ's, introductory tutorial and "how to" videos."

NOTE: For ease of installation, download ANSYS version 18 or later release. Version 18 has two options for user interface for the model generation portion, and the DesignModeler option needs to be selected for compatibility with the tutorials (Tools/Options/GeometryInput /DesignModeler). Also, the course will use ANSYS Workbench and APDL, not ANSYS AIM. Also, students are STRONGLY ADVISED to frequently save an archive file .wbpz of their Workbench work; this will assist in resolving any difficulties, and allow prior work to be saved.

8. COURSE PROJECT

Early in the semester, begin giving some thought to a project you could do this semester which will make use of the contents of this course. This will count as a portion of the course grade, and the level of effort should reflect this. Some possible sources for your topic include:

- design projects from other courses which could benefit from design analysis tools

- problems or geometries from other courses which you have taken earlier (stress concentration problems, for example)

- convergence or accuracy studies on specific elements and geometries

- problems from your present employment or research efforts

By mid-semester please submit a written summary of the topic you plan to pursue. If you want to discuss your topic prior to that time, please contact the instructor. You should begin work on it as soon as possible to avoid the end-of-semester crunch. A written report on your project will be expected at the end of the semester, submitted per instructions on Canvas.

9. SUBMISSION OF ASSIGNMENTS:

Scanned copies of assignments are to be submitted using the assignment submittal in Canvas. Homework to be submitted must meet the following guidelines for full credit to be given:

1. Use standard 8 ½ by 11 paper, lined or unlined, or prepare within a word-processing program.
2. Handwritten material must be legible when scanned. Use a suitably dark pen or pencil, and scan to pdf. Do not submit a camera photo unless it is clearly legible.
3. Each assignment is to be submitted on CANVAS as a single file (merge if necessary), preferably in pdf or WORD format. If an ANSYS archive file is to be submitted, this will be a second file.

10. OTHER TOPICS

10.1 Student Conduct: University policy on student conduct, including that regarding academic honesty, plagiarism and cheating will be followed. Use of a cell phone without explicit permission during exams or quizzes is not allowed, and will result in a charge of cheating. Student's work should be individual. For a discussion of the overall issue and guidelines, refer to the document on the website of the Ombud of the University of Kentucky at http://www.uky.edu/Ombud/Plagiarism.pdf,

The Ombud web site also includes a link to a Prentice Hall Companion Website "Understanding Plagiarism" http://wps.prenhall.com/hss_understand_plagiarism_1/0,6622,427064-,00.html. Be sure you understand the expectations of your university in this regard. All exams will be proctored.

For online sections, reading and/or viewing of assigned online material is expected, and failure to do so will affect the final grade, consistent with the university policy; Acceptable reasons for excused absences are consistent with university policy, but are typically:

1) serious illness ;
2) illness or death of family member;
3) University-related trips;
4) major religious holidays;
5) other circumstances found to be "reasonable cause for nonattendance by the instructor."

Students anticipating an absence for a major religious holiday are responsible for notifying the instructor in writing of anticipated absences due to their observance of such holidays no later than the last day for adding a class.

10.2 Classroom and Learning Accommodations:

If you are a person with a documented disability that may require academic modification or accommodation for this course, you must provide the instructor with a 'Letter of Accommodation' from the UK Disability Resource Center. If you are not registered with the Center, you may contact them via email: jkarnes@email.uky.edu or by telephone: (859) 257-2754. You may also visit the DRC website for information on how to register for services as a person with a disability: http://www.uky.edu/DRC.

10.3 Technical Support

For difficulties with LMS or logins, contact the Teaching and Academic Support Center http://www.uky.edu/ukit/atg/tasc or the Information Technology Customer Support Center at https://www.uky.edu/ukit/help, (859)-218-4357, and inform the instructor. If students experience any difficulty with software (other than ANSYS), contact technical support for the software, and inform the instructor. ANSYS support for the academic version is primarily with the instructors.

10.4 Library Support

For library support, contact Distance Learning Library Services http://libraries.uky.edu/DLLS, local phone (859)-257-0500 ext 2171, long distance (800)-828-0439 (option #6), email dllservice@email.uky.edu. For Interlibrary Loan service http://libraries.uky.edu/ILL, WKU students can access their library services.

11. EXAM PROCTORING

A midterm and final exam will be scheduled. For the convenience of students who can come to campus, an exam room will be provided, on the UK campus. Students who cannot come to campus can arrange a proctored site convenient to them, with approval per the proctor approval form.

12. SCHEDULE (refer to CANVAS for calendar schedule)

Module	Topic	Chapter in Logan
1	Introduction	1
2	Matrix Algebra	Appendix A&B
3	Spring Element	2
4	Bar/Truss Element	3
5	Symmetry & Energy Method	3
6	Constant Strain Triangles/ANSYS	6
7	Modeling/Linear Strain Triangles	7, 8
8	Review -- Exam 1	
9	Axisymmetry	9
10	Isoparametric Elements and 3D	10, 11
11	Heat Transfer & Thermal Strain/Stress	13, 15
12	Beam Elements	4
13	Frame Elements	5
14	Dynamics and Non-linear	16

	Review/Presentations	
	Final Exam	