MEEN 368(300) – Solid Mechanics in Mechanical Design
Course Syllabus ● Summer 2012

Lecture/Recitation Sessions: 11:00AM –12:50PM TR, 205 ENPH/CAIN;

Instructor: Dr. Won-jong Kim, 221 MEOB, wjkim@tamu.edu, 845-3645
Office Hours: TR 12:50–2:00 PM, or by appointment
Teaching Assistant: TBA
Office Hours: TBA; Office: TBA
Required Textbook: *Shigley's Mechanical Engineering Design*, 9th Edition,
Richard G. Budynas and J. Keith Nisbett, McGraw-Hill, 2011.
Useful References: (these will be used sparingly in MEEN 368 but are usually required for MEEN 401)
Roark's Formulas for Stress and Strain, 7th Edition,
Warren C. Young & Richard Budynas, McGraw-Hill, 2002.
Mark's Standard Handbook for Mechanical Engineers, 11th Edition.
Eugene A. Avallone, Theodore Baumeister, Ali Sadegh, McGraw-Hill, 2007.

Catalog Description:

Solid Mechanics in Mechanical Design. (2-2). Credit 3. Stress analysis of deformable bodies and mechanical elements; stress transformation; combined loading; failure modes; material failure theories; fracture and fatigue; deflections and instabilities; thick cylinders; curved beams; design of structural/mechanical members; design processes.

Prerequisites: CVEN 305; MEEN 357 and MEEN 360 or registration therein; jr. or sr. classification.

Grading:		**10-pt. Scale:**	
	25% Homework, Quizzes, In-Class Work		A = 90-100
	25% Exam 1 (to be given week 5)		B = 80-89
	25% Exam 2 (to be given week 8)		C = 70-79
	25% Final Exam (comprehensive, August 2, 2012, 205 ENPH/CAIN)		D = 60-69
	100%		F = 0-59

Exams:

The emphasis on Exams will include not only problem-solving abilities, but also a significant number of questions to check understanding of basic concepts, definitions, fundamental knowledge, and design implications. At least one problem on each Exam may be graded solely on the basis of answer accuracy; that is, no partial credit will be given for methodology, approach, or preliminary calculations. The purpose of this is to instill a healthy appreciation for the importance of getting correct final answers to engineering problems. It is also intended to provide extra motivation for checking, double-checking, and evaluating the reasonableness and accuracy of answers.

Exam Re-evaluation Policy: If there are questions about exam grades, they need to be submitted in writing within three days of the day when exams are returned graded. After three days, the grade will be considered final.

Absences:

Work missed due to absences will be excused only for University-approved activities in accordance with TEXAS A&M UNIVERSITY STUDENT RULES (see http://student-rules.tamu.edu/rule07). Students are encouraged to read all of Rule 7 and to become familiar with stipulations, including student responsibilities. Please be aware that in this class any "injury or illness that is too severe or contagious for the student to attend class" will require "a medical confirmation note from his or her medical provider" even if the absence is for an injury or illness less than 3 days (see 7.1.6.2 Injury or illness less than three days.) Further, students must also submit a completed "Explanatory Statement for Absence from Class" form. That is, both 7.1.6.2a and 7.1.6.2b must be followed. Specific arrangements for make-up work in such instances will be handled on a case-by-case basis. Lecture notes are not posted online.

Academic Misconduct will not be tolerated and, if any instances arise, they will be handled according to TEXAS A&M UNIVERSITY STUDENT RULES (student-rules.tamu.edu/rule20) and pursued as severely as possible.

Homework, Quizzes, In-Class Work:

Homework will be assigned and collected roughly once per week and typically graded for content, neatness, methodology, and accuracy. Partial credit will be given in most cases. In some instances, homework may be just 'checked-in' and not 'graded in detail' (e.g., using a 0-1-2 scale). This will at least provide a measure of effort and participation and should also create additional motivation for working all homework problems. Homework is due at the beginning of the class on the due date. Late homework will not be accepted nor graded. Full credit can only be considered for a University-approved excuse. In addition to homework problems from the text, supplemental (instructor devised) problems will also be assigned. Some homework problems will require design work and as such will not necessarily have unique solutions. These will be more open-ended assignments requiring significant problem definition, engineering judgment, and decision making, and interpretation. In addition, more comprehensive problems may be assigned periodically and are intended to provide opportunities for more extensive work of this kind. Quizzes may be given periodically to provide an in-class opportunity to demonstrate problem-solving skills similar to homework or design problems. Additional in-class work will be assigned occasionally as well. Some quizzes and other in-class work may be administered without advance notice.

Homework Guidelines:

Prepare formal solutions on 8-1/2" x 11" 'engineering problem paper.' Work submitted on paper torn out of a spiral notebook will not be accepted. Each homework assignment should have a cover page containing pertinent details, such as: name, course & section, HW assignment number (or equivalent), due date, and the Honor Pledge with a signature. All pages should be stapled together. All work should be presented on one side of the paper only. Begin each new problem on a new sheet. Problems should be organized in the same order as assigned, unless specified otherwise. Your name, course, section number, and due date must appear at the top of each page. The current page number as well as the total number of pages in the assignment must appear in the upper right corner of each page. The format for each problem solution should generally consist of:

Given: Summarize the problems statement and include all information that is known about the problem using complete sentences. Include sketches or diagrams as appropriate.

Required: State what you have been asked to determine in complete sentences.

Figures: **Almost every problem in this course will require detailed Free-Body-Diagrams in support of your solution!** Draw all figures clearly and neatly, use a straight-edge if needed. Show an appropriate and consistent set of units, number each figure, and when appropriate, refer to a figure by its number in the solution.

Solution: Present your solution in a logical and methodical manner. Clearly indicate answers by including the variable designation, the numerical value (with units!), and by 'boxing' the answer. Also include any summarizing comments, observations, or conclusions in sentence form as may be appropriate.

It is recommended that you make copies of all homework submitted for your personal records and would be very helpful in the case of question regarding the process of your homework. These copies may also help you study for major exams that will almost surely be given prior to the return of all of the relevant graded homework.

Academic Integrity Statement

Aggie Honor Code: "An Aggie does not lie, cheat, or steal, or tolerate those who do."

Upon accepting admission to Texas A&M University, a student immediately assumes a commitment to uphold the Honor Code, to accept responsibility for learning and to follow the philosophy and rules of the Honor System. Students will be required to state their commitment on examinations, research papers, and other academic work. Ignorance of the rules does not exclude any member of the Texas A&M University community from the requirements or the processes of the Honor System. For additional information please visit: aggiehonor.tamu.edu

All assignments, examinations, or other work turned in in this course shall include the following Honor Pledge signed by the student:

"On my honor, as an Aggie, I have neither given nor received unauthorized aid on this academic work."

In this class, you must neatly print the Honor Pledge yourself (from memory on exams).

Americans with Disabilities Act (ADA) Policy Statement

The Americans with Disabilities Act (ADA) is a federal anti-discrimination statute that provides comprehensive civil rights protection for persons with disabilities. Among other things, this legislation requires that all students with disabilities be guaranteed a learning environment that provides for reasonable accommodation of their disabilities. If you believe you have a disability requiring an accommodation, please contact Disability Services, in Cain Hall, Room B118, or call 845-1637. For additional information visit http://disability.tamu.edu.

Functional Prerequisites -- major expectations:

Basic stress analysis, Mohr's circle, principal stresses.
Stress-strain and strain-deformation relations; deflections and stiffness calculations.
Assumptions and limitations; stress and deformation analysis of:
axial bars, beams in bending, torsional members, thin-walled pressure vessels.
Mechanical behavior of materials, failure mechanisms (i.e., MEEN 360, or equivalent).
Free-body diagrams and equilibrium analysis.
Dynamics of particles and plane motion of rigid bodies.
Spelling; grammar; listening skills, study skills.
Computer skills (word-processing, spreadsheets, presentations, plotting, web/internet).

Major Topics: **Text Sections**

Brief overview and review of design, factor of safety, "failure", materials, material properties ..... [Ch. 1 & 2]

Load and Stress Analysis review, reinforce, and extend ..... [Ch. 3 plus instructor notes]
- FBD's, equilibrium, stress, strain, Mohr's circle, principal stresses .....[3-1 to 3-7]
- Stresses for uniaxial loading, bending, shear, torsion ..... [3-9 to 3-12]
- Combined Loading .....[notes]
- Stress concentration, pressure vessels, rotating rings, thick cylinders ..... [3-13 to 3-16]
- Curved beam stresses, contact stresses; more Combined Loading ..... [3-18 to 3-19]
- Stress-strain, strain-displacement, deformations, thermal stresses .....[3-8, 3-17; notes]

Deflections, Stiffness, and Instability review, reinforce, and extend ..... [Ch. 4 plus instructor notes]
- Deflections due to axial loading, torsion, bending, and combined loads (superposition) .....[4-1, 4-2; notes]
- Deflections due to bending .....[4-3 to 4-6]
- Strain Energy and Castigliano's Theorem for deflections .....[4-7 to 4-10; notes]
- Buckling, instabilities, shock and impact .....[4-11 to 4-18; notes]

Static Loading Failure Theories and Design ..... [Ch. 5 plus instructor notes]
- Material strength, ductile & brittle failure theories ..... [5-1 to 5-11]
- Structural Design .....[notes]
- Fracture mechanics, reliability approach, summary ..... [5-12 to 5-14]

Variable Loading Failure and Design Considerations ..... [Ch. 6 plus instructor notes]
- Fatigue failures and types/regimes, LEFM .....[6-1 to 6-6]
- Classical S-N diagram approach; finite & infinite life, modifying factors ..... [6-7 to 6-10]
- Fluctuating stresses (non-zero mean), torsion, combined loading ..... [6-11 to 6-14]
- Cumulative fatigue, surface fatigue, reliability approach, summary ..... [6-15 to 6-18]

Design Processes/Considerations and Additional Topics
- Shaft design .....[Ch. 7]
- Screws, fasteners, bolted joints .....[Ch. 8]
- Welded joints, mechanical springs..... [Ch. 9 & 10]

COURSE LEARNING OUTCOMES

General Objectives

Students completing MEEN 368 should be able to demonstrate a competence in general stress analysis and introductory design principles and implications. Proficiency and understanding in the following specific areas is described in more detail in the next section:

A. Basic stress analysis in three dimensions
B. Stress analysis for curved beams & thick cylinders
C. Deflections of beams and other structures
D. Buckling and instability
E. Designing to avoid static failure for ductile and brittle materials
F. Designing to avoid failure under variable loading
G. Shaft analysis and design
H. Threaded fasteners, welded joints, springs

Specific Learning Outcomes

A. Basic stress analysis in three dimensions

1. Determine the principal normal & shear stresses, and the orientation of principal planes for uni-axial, bi-axial, and tri-axial stress states
2. Determine stresses on a plane having any orientation relative to reference, or coordinate-aligned, planes
3. Analyze stresses in a loaded structure occupying 3-dimensional space, and thus subjected to multiple stress types and modes (axial, torsional, bending, shear), i.e., for "combined loading"
4. Understand and apply generalized Hooke's law, including thermal stresses; determine deformations, change in size, shape, dimensions

B. Stress analysis for curved beams & thick cylinders

1. Calculate the normal stresses due to bending of curved beams and know when these conditions apply
2. Calculate the tangential (hoop) and radial normal stresses in a thick-walled cylinder due to internal and/or external pressure

C. Deflections of beams and other structures

1. Determine deflections for loaded structures occupying 3-dimensional space, and thus experiencing multiple deformation modes (axial, torsional, bending, shear)
2. Determine deflections in beams using superposition and double-integration (with and without singularity functions)
3. Use Castigliano's theorem to calculate deflections of beams, structures, indeterminate members, curved members

D. Buckling and instability

1. Analyze and design for column buckling
2. Analyze and design for other forms of buckling and instability

E. Designing to avoid static failure for ductile and brittle materials

1. Describe the basic features of ductile and brittle material behavior and failure
2. Describe in words and equation form the main ductile and brittle failure theories and use them for analysis and design
3. Use the reliability approach for analysis and design
4. Use the fracture mechanics approach for analysis and design under static loading conditions

F. Designing to avoid failure under variable loading

1. Understand the types of failure modes due to variable/dynamic loading and classify them appropriately
2. Use the fracture mechanics approach to calculate lifetimes
3. Apply the classical S-N diagram approach for reversed loading for analysis and design
4. Extend the S-N diagram approach to non-zero mean stresses and multi-dimensional stresses
5. Analyze fatigue behavior for multiple stress levels (cumulative fatigue)
6. Use the reliability approach for reversed loading