

MECH 340 - Mechanical Engineering Design Spring 2008

- Instructor: Dr. Michael Ward, OCNL 407, mward@csuchico.edu ph: 898-4888
- Office: M,Tu 2-3; Thurs 2-4
Class: MWF 11-11:50 THMA 106
Activity: Section 1) W 2-2:50 Section 2) W 3-3:50 OCNL 254
- Prerequisites: Successful completion of MECH 100, 100L; MECH210, CIVL 311 (with a grade of C- or higher) Students who have not met the prerequisites will be dis-enrolled from the course unless given permission through the department.
- Textbook: *Machine Design: An Integrated Approach, 3rd Ed.*
Robert L. Norton, Prentice Hall (Third Edition 2006)
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| Course | Homework | 10% |
| Grade: | Design Projects* | 40% |
| | Exams** | 50% |
- Homework: Homework problems will be due two class meetings following their assignment. Equation solving software (*TK Solver, or other*) is required on certain homework problems and is optional on others. Cooperation with others on homework is encouraged. Homework is due at the beginning of class. *Late Homework is not accepted.*
- Design Projects: Both individual and small group design projects will be assigned. Individual projects are to be solved *without* cooperation of others - *individually*. The design projects will give you an opportunity to integrate material from this course with prior coursework, and to consider various aspects of mechanical design. They will vary in scope from "open-ended" textbook assignments to more comprehensive design projects that might be considered to be a preliminary design for an actual product.
- *Design Project Grading: Design projects in MECH 340 are used to assess your ability to carry out an engineering design. This includes carrying out the technical aspects of a design, and communicating the results in both graphical and written form. Refer to the attached design project grading rubric. Note that not all projects have the same value; larger and more complex design projects are worth more than smaller ones. To obtain a passing grade (D or higher) in the course:
- 1) an average grade of C is required on all design projects
 - 2) a grade of C is required on the Written Summary Report of selected design reports
 - 3) A grade of C is required on the Graphical Presentation of selected design reports
- Collectively these demonstrate minimal competency in mechanical design. Completion of design projects, unlike homework assignments, is mandatory for successful completion of the class. All design projects must be carried out to receive a passing grade in the course. Late projects will have points deducted, but will be graded and credited.

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- Exams: Five in-class exams will be given. Each exam will be open-book, open-notes. Dates will be announced in class. You are responsible for the assigned text material, assigned reference material, computer related material, and material covered in lecture. The course is progressive and each exam can often include prior course material.
- **Exam
- Grading: Exams in MECH 340 are used to assess your ability to “*apply knowledge of math, science, and engineering*” An average grade of C- is required on the exams to obtain a passing grade in the course. Failure to achieve a C- average grade in the exams will result in an F in the course.
- Plagiarism: With computer based assignments, it is often tempting and convenient to copy the work of others. This is plagiarism and is not tolerated. Incidences of plagiarism will be referred to student judicial affairs, and can result in failure in the course to long-term suspension from the University. Refer to Student Rights and Responsibilities section of the University Catalog, or ask your instructor if you are unclear about a specific situation.
- Reference: *Mechanical Engineering Design*
(2 hr reserve) Joseph Shigley and Charles Mischke, McGraw Hill, 7th Edition (2004)
- Fundamentals of Machine Component Design*
Robert Juvinal and Kurt Marshek, John Wiley, 3rd Edition (2000)
- Fundamentals of Machine Elements*, Bernard Hamrock, et. al., McGraw Hill, 1999.
- Search Engines: With component catalogs on-line, you will want to take advantage of search engines to find industrial components. A few useful examples:
- Fundamentals: <http://www.efunda.com/home.cfm>
Design: <http://www.machinedesign.com>
Components : <http://www.designinfo.com>
<http://www.mcmaster.com>
<http://www.thomasregister.com>
<http://www.sdp-si.com>

Course Organization

This course is divided into two primary parts. The first is intended to help you synthesize concepts from a number of previous courses, including materials engineering and strength of materials in particular. New knowledge regarding mechanical failure mechanisms, failure theories, and reliability theory will be added. The second part of the course applies this knowledge and is intended to give you experience with a variety of "standard" machine components that are used frequently in mechanical design. MECH 340 also develops a formal design process, adding analytical methods, economic constraints, and more realistic design considerations to help you develop a personal design methodology based on "best practices."

Design Notebooks and Design Reports

Design notebooks are your design "diary." They are a record of your ideas, decisions, supporting analysis, and your notes regarding product information such as catalog, web, or vendor information. The notebooks are not intended to be neat in the presentation sense - but are intended to be a relatively complete record of your work on a given project. Entries should be dated and signed. Practice documenting your designs in MECH 340 will give you practice in good project documentation in professional practice. You will be asked to submit your notebook for some of the design projects.

For all design projects in MECH 340, you will be asked to submit a separate design summary that is word processed. This should be written in the form of a memo to me (your supervisor who is a busy person!) briefly "selling" your design solution. It is "outcomes" not "process" oriented. It should include your results, critical assumptions, decisions, sketches and/or formal drawings, and enough of an overview of your design that the reader can quickly grasp your final solution. Use tables and plots to summarize raw data or analysis. It is not a step by step narrative of what you did to arrive at your solution. It is a summary of what your final design outcome is, what it looks like, how it works, what the goals for the design were, and what specifications were used. It is also a "sales" memo that can highlight the features of your design solution and why the boss should accept it as the "best" approach to the problem.

Design Drawings

Design drawings are expected to conform to the MMEM Department drawing standards, described in detail on the department website:

http://www.ecst.csuchico.edu/_depts/mem/documents/Department_Drawing_Standard.pdf

Templates for SolidWorks drawings which conform to the Department Standards for Working Drawings are available on the College of Engineering, Computer Science, and Construction Management computer network in the folder Y:_MEMEM Dept Drawing Standards. The available files are:

1. MMEM Standard Drawing Template - Size A.slddrt
2. MMEM Standard Drawing Template - Size B.slddrt
3. MMEM Bill Of Materials Template.sldbomtbt
4. MMEM Revision Table Template.sldrevtbt

MECH 340 Course Objectives - For students to:

- 1) Learn a process for designing mechanical systems with a balance of the conceptualization and detail design phases of the process.
- 2) Synthesize and apply concepts from the engineering sciences including statics, dynamics, strength of materials, and materials science.
- 3) Practice choosing parameters for a mechanical system (e.g., dimensions and material properties) based upon a set of performance specifications.
- 4) Learn how to determine allowable stresses in a component based upon an appropriate theory of failure and a reasonable set of assumptions including factors of safety where appropriate.
- 5) Learn how to mathematically model a selection of common mechanical components in order to predict particular performance measures and to utilize equation solving software to streamline the analytical solution process.
- 6) Have opportunities to be creative, and at the same time, mindful of the constraints imposed by material limitations, manufacturing, standard practices, codes and standards.
- 7) Be introduced to the concepts of uncertainty and reliability in design, as they pertain to material properties, manufacturing processes, and applied loads.

MECH 340 Course Outcomes: - Students shall be able to:

- 1) Apply energy methods to relate the steady-state input/output characteristics of machines to relate quantities such as torque, force, velocity, and angular velocity.
- 2) Determine stresses in straight, slender bodies caused by combinations of axial, shear, bending, and torsional loads.
- 3) Determine stresses in curved beams.
- 4) Determine miscellaneous stresses in machine components such as direct shear, tearout, and bearing stresses that occur commonly with interconnected machine parts.
- 5) Apply stress concentration factors where appropriate.
- 6) Determine principal stresses due to combinations of simple stress states.
- 7) Size components using static failure theory.
- 8) Size components using fatigue failure theory.
- 9) Estimate and apply appropriate factors of safety for a given machine environment and loading, and apply them in selecting materials and sizing selected machine components.
- 10) Determine the appropriate size of a rotating shaft for infinite-life strength.
- 11) Select components such as bearings, gears, springs, threaded fasteners, clutches and brakes based on accepted practice and theory for particular machine elements.

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MECH 340 Design Project Assessment

Design Project Quality Assessment						
Evaluation Measures	Inadequate	Adequate	Proficient	Superior		
Scale:	1-2	3	4	5	Score	
Written Summary Report						
1	<u>Organization & Format</u> - organized, complete, with figures, summary tables and graphs. Proper use of appendices and referencing as appropriate	disorganized, or incomplete; difficult to follow, lacks summaries	mostly organized and complete including adequate summaries and references	well organized with clear summaries and references	superior organization, summaries, references; thorough and professional	
2	<u>Style</u> - Design outcomes focused, not a process narrative, uses 3rd person. Understands purpose and audience	Narrative style, disjointed, or lack of focus, or 1st person	adequate writing style with some discontinuity	cohesive writing style	exceptionally well written, cohesive, interesting	
3	<u>Spelling, punctuation, capitalization, and grammar</u>	numerous significant errors, disruptive	some notable errors, but not disruptive	few minor errors if any	exceptionally well written without errors	
Design Process and Technical Content						
4	<u>Problem Introduction, Definition, Goals & Specifications</u> - problem clearly introduced & defined, goals & specifications are relevant and are clearly stated with justification	difficult to understand - poor introduction and definition objectives and specifications unclear	introduction, definition, goals, specifications mostly complete and clear	good design introduction and definition; clear goals and specifications	superior introduction and definition; superior goals and specifications developed and justified	
5	<u>Consideration & Evaluation of Alternatives</u> - alternative concepts devised, evaluated, iterated, selection rationale based on specifications - all evidence of using the design process to meet objectives	some alternatives considered but evaluation is weak or selection appears arbitrary	evidence of consideration of alternatives, adequate evaluation and selection process	clear evidence of consideration of alternatives, good evaluation and selection using specifications	superior consideration and evaluation of alternatives using specifications - thorough and effective	
6	<u>Creativity, Constrained Innovation</u> - Creative yet practical - reflects clear understanding of limitations and constraints	little evidence of creativity or significant misunderstanding of constraints	acceptable solution without major misconceptions	creative; effective solution with clear understanding of constraints	superior creativity demonstrated; reflects in depth understanding of constraints	
7	<u>Detailed Design</u> - includes concept to component development, material selection, part selection, appropriate analysis to determine parameters; sketches, results summarized in graphs or tables	inadequate - design is lacking details or supporting information, or with significant errors	design has sufficient detail, but lacking clarity or with minor errors	design clearly developed in good detail, supported by sketches, equations, graphs, etc. without errors	design based on superior decisions, correct, effective analysis and supporting material	
8	<u>Use of Information Resources</u> - Effective use of technical information or product information	little evidence that information resources were used	adequate evidence that information resources were used	clear evidence that information resources were used effectively	superior use of information resources	
Graphical Presentation						
9	<u>Drawings</u> - part drawings, assembly drawings, schematic diagrams, flowcharts as needed to convey design details	marginally adequate drawings; lack important information	acceptable drawings that convey most information needed to understand design	good drawings with proper dimensions that convey detail for prototype fabrication	superior drawings with dimensions and tolerances	
10	<u>Assembly Drawings</u> - Exploded view assemblies showing subassemblies and/or parts, clear spatial relationships, Bill of Materials (BOM)	marginal assembly drawings, missing elements, BOM, or unclear relationships	acceptable assembly drawings	good assembly drawings	superior assembly drawings	
11	<u>Part Drawings</u> - Top, front, side and ISO views in proper locations, fully dimensioned, title blocks	marginal - missing important dimensions or views	acceptable - contains all views, all dimensions	good - contains all views, all with proper dimensions	Superior - proper views, dimensions and tolerances	
TOTAL SCORE						