ME 383 - MECHANICAL COMPONENT DESIGN
WINTER 2012
Course Web Site: http://classes.engr.oregonstate.edu/mime/winter2012/me383-001

Instructor:

Professor I.Y. Tumer
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Web: http://web.engr.oregonstate.edu/~itumer/
Office Hours: Thursdays 10-12 or by appointment (made by email)

Class Hours:
Lectures (Rogers 230): TR 8:00-9:15
Labs (*Design Studio*, Rogers 228): T 10:00-11:50; 12:00-1:50; 2:00-3:50

Teaching Assistants:

BRYAN O'HALLORAN Email: ohallorb@onid.orst.edu Office Hours: Fri 2-4pm Covell 129	***JOE PIACENZA*** Email: piacenzj@engr.orst.edu Office Hours: During lab	***BRYAN HRYWNAK*** Email: hrywnakb@onid.orst.edu Office Hours: Wed 10-12pm Covell 129

Course Learning Outcomes:
Upon successful completion of this course, students will be able to:

1. Reverse engineer a real product and analyze external forces
2. Select and apply an appropriate static failure theory to a machine component
3. Select and apply an appropriate dynamic (fatigue) failure theory to a machine component
4. Select mechanical components for a given load situation and analyze for failure
5. Perform a competitive analysis and provide insights on risk and reliability
6. Communicate analysis results and basic engineering concepts

In ME 382 techniques to develop original designs was emphasized. The focus in ME 383 is on machine component analysis, specifically, analysis techniques used to predict a component's failure and/or factor of safety. Reverse engineering of a product will be used as the vehicle for real product analysis. Note that ME 316 is a prerequisite for this course, and as such, it is assumed that you know this material well. ***If not, it is strongly recommended that you review the material from ME 316 in the first week of the term!*** **Note that all information about the course will be posted on the course website.**

Text:
Required: *Shigley's Mechanical Engineering Design,* 9h edition, Budynas & Nisbett, McGraw-Hill
Reference Books: *Machinery's Handbook*, 25th edition & *Marks' Mechanical Engineering Handbook*

Prerequisites: ME 316, ME 382

Student Conduct: See: http://oregonstate.edu/admin/stucon/regs.htm

Accommodations:
Accommodations are collaborative efforts between students, faculty and Services for Students with Disabilities (SSD). Students with accommodations approved through SSD are responsible for contacting the faculty member in charge of the course prior to or during the first week of the term to discuss accommodations. Students who believe they are eligible for accommodations but who have not yet obtained approval through SSD should contact SSD immediately at 737-4098.

Grading:

Exams (individual exams)	40%
Quizzes	20%
Project (group)	40%*
Total Grade	100%
* Project grade breakdown:	
Display Model	10%
Presentations	10%
Lab Assignments	5%
Written Report	15%
Total Project Grade	40%

Individual Grade:

There will be ***2 exams*** in this course and ***no final exam***. Exams are on **Thursdays** and will be 75 minutes long**.** There will be specific sets of HW problems assigned at the beginning of each week, with solutions posted at the end of that same week. The HW will not be graded. ***However, there will be a 15-minute quiz on Thursdays every week based on the homework assignments of the previous week (on Thursdays except when there are exams.) There will be absolutely NO MAKE-UP EXAMS OR QUIZZES. Note that the lowest quiz grade will be dropped.*** The exam material will largely be based on material covered during the lectures, up to the lecture preceding the exam date, problem sets assigned as HW, and sample problems in the textbook. ***You are strongly encouraged to work them all as they are likely to appear in exams and quizzes verbatim.*** Note that the TAs will hold office hours to answer questions on the HW problems and class exercises every week. Pay them a visit!

Group Grade:

Project Requirements

In addition to the exams, ME 383 is built around a team project to analyze an existing product for safety and reliability to determine whether it was designed in a satisfactory fashion, or whether redesign is necessary to improve the product to meet the engineering requirements. ***The class lectures cover only part of the information needed to conduct the necessary analyses; the balance of this information will come from unassigned portions of the text and library sources.*** It is your responsibility to find and read this material!

Project completion involves the following tasks:

1. Work and turn in team-based lab assignments.
2. Select a mechanical product for study--something one or more of you is familiar with. The product must have at least 5 moving parts and must **not** be made of plastic. Your team must obtain a functioning version of the product to work with. An assembly manual, service manual, and/or other product documentation is also helpful. Final approval of your product selection will be given by Professor Tumer on Friday.
3. Disassembly: Take product apart, clean it, and understand and describe how it works.
4. Generate a set of presumed engineering requirements for the product. You will have to estimate much of the information on engineering requirements. Note all assumptions.
5. Generate a functional decomposition of the product, noting all assumptions.
6. Create free body diagrams in all critical operating modes. The free body diagrams must be of the entire product and all the major components. To do this will require characterization of the power source(s), losses and loads. Note all assumptions made.

7. Find the stresses at critical points in the product. You must find at least five of the most critical points. These points should involve different loading types: tension, compression, shear, bending and torsion.
8. Perform static and dynamic failure analyses on the product. The analyses may include strength, stiffness, wear, material selection, and manufacturing.
9. Recommend improvements for redesign of the product to makes it safer/more reliable.
10. Prepare a written report detailing your findings and recommendations (see below).
11. Create a display model that visually and kinesthetically communicates your findings and recommendations (see below).
12. Present analysis results and findings using display model.

Project Evaluation

The team project component of this course includes: Lab working sessions/briefings, project report, display model, and middle school presentation.

i. *Lab Work Sessions:* You will be responsible for specific deliverables at each lab session in the form of written documents to show the TAs, accompanied by presentations as needed. It is critical that you turn in a written explanation of your methods and results for each assignment. The lab assignments will have direct correlation to the content of the final written report, and as such, should be done in a neat and clear fashion, and turned in to the TAs at the start of your next lab session as an assignment. The lab assignments will be graded on a 1-3 scale, based on content and effort. The following is the breakdown for each lab:

   Lab Session 1: Team Introductions and Contact Information, Team Contract; Project proposal (due Friday of first week for approval by Dr. Tumer)

   Lab Session 2: Functional decomposition (see ME 382), Engineering requirements (see ME 382); operational description of device

   Lab Session 3: Free Body Diagrams & Force Analysis; Failure Modes Analysis

   Lab Session 4: Stress Analysis; Materials Lab Measurements

   Lab Session 5: Static Failure Analysis

   Lab Session 6: Fatigue Failure Analysis

   Lab Session 7: Final recommendations; Display model and report discussion

   Lab Session 8: Exec summary & final report discussion

   Lab Session 9: Display Models

   Lab Session 10: Final Team Presentations

ii. *Project Report:* The written project report must be computer-generated with a maximum length of 10 pages (Times Roman, single line spacing, 12-point font, 1-inch margins). The primary audience for this report is an imaginary company who is interested in understanding and analyzing the failure potential and reliability of the product you have selected. Your audience will use the report to decide whether to invest in this product as is, or invest in a redesign to make it more reliable. Be sure to calibrate the quality and level of your writing to effectively address this readership. A report-grading rubric will be provided. Pay close attention to the rubric contents when preparing your report. The project report must contain the following sections:

   1) 1-page executive summary

2) Introduction and description of the system studied: What is the purpose of the analysis study and the report? What is your system? What does it do? How does it work? How might it fail/how has it failed in the past (show historical sources)? How would you expect it to fail (show failure modes analysis)?

3) Discussion on the functional decomposition and requirements

4) Force characterization and free body diagrams

5) Static and dynamic failure analysis

6) Discussion of reliability and risk aspects: why was the system designed to the factor of safety you've computed? (Compare to engineering requirements and functional decomposition. Compare to findings about past failure cases in Section 2.) What needs to be redesigned and why?

7) Conclusions and recommendations to your bosses: summary of your system, the analysis results, and the system's failure potential; insights on how you would design the device better; recommendations on whether your company should invest in this product further.

8) Appendices with engineering requirements, functional decomposition, FMEA, and appropriate detailed analysis and drawings (not part of the 10-page limit)

Note also that all calculations included in the report should be annotated with a written explanation and all associated assumptions should be noted. Calculations lacking this explanatory information will be disregarded.

iii. *Project Display Model*: You will modify your product so that the internal parts are visible and product operation can be demonstrated in a display model for an oral presentation. You must also mount the model for display. Plastic-laminated diagrams and text describing the system and its operation should be affixed to the display model. The target audience for the display model are current & future ME students. So be sure to calibrate the quality and level of your diagrams and text to effectively address these viewers. Additional details and the model-scoring template will be provided.

iv. *Project Presentations*: You will deliver a professional presentation of your project using your device where you will explain the basic concepts of stress, force, and static and fatigue failure, as well as describe your specific device and your analysis results.

Peer Evaluation of Teamwork Contribution

To ensure fair grading of the team-produced deliverables, the overall team project grades will be corrected for each student with a weighting factor. This factor will be developed through each team member's confidential evaluation of all team members (including themselves) for the percent of his/her contribution to production of the project report, display model, and middle school presentation. The evaluations will be averaged by the instructor to find each student's contribution and the weighting factor made proportional to it. See course web site for team evaluation form.

WEEK	LECTURE TOPICS & EXAMS	HW & LABORATORY ACTIVITIES
Week 1 **1/10-1/12** **Chap. 1,2,3**	Introduction & Review of Basics Stress Analysis **HW 1: Stress analysis** **Quiz 1: Review**	Lab1: Team assignment and introductions Team contract done in lab **Project Proposal due on Thursday, 1/12 by 5pm**
Week 2 **1/17-1/19** **Chap. 3**	Stress Analysis & Force Analysis **HW 2: Stress states/Mohr** **Quiz 2: Stress Analysis**	Lab 2: Functional Decomposition & Device Operational Description & Eng Reqs Begin disassembly/cleaning
Week 3 **1/24-26** **Chap. 5**	Failure Modes Analysis; Reliabil **HW 3: Static/Force analysis** **Quiz 3: Mohr Circle**	Lab 3: Force Analysis Results Failure Modes Analysis Results
Week 4 **1/31-2/2** **Chap. 5,6**	Static Failure Analysis **HW 4: Static analysis** **Quiz 4: Static/Force Analysis**	Lab 4: Force/Stress Analysis Conduct Materials lab measurement
Week 5 **2/7-9** **Chap. 6**	Static/Fatigue Analysis **HW 5: Static & Fatigue analysis** **EXAM 1: Stress & Static Failure Analysis**	Lab 5: Stress/Static Failure Analysis
Week 6 **2/14-16** **Chap. 13,14**	Fatigue Analysis Applications: Gears/Springs **HW 6: Fatigue analysis** **Quiz 5: Static/Fatigue failure analysis**	Lab 6: Static Failure Analysis Conduct Team Health Assessment
Week 7 **2/21-23** **Chap. 14,10**	Fatigue Analysis Applications: Gears/Springs **HW 7: Gears/Springs** **Quiz 6: Fatigue Analysis/Applications**	Lab 7: Dynamic Failure Analysis Results
Week 8 **2/28-3/1** **Chap. 10, 11**	Applications: Gears/Springs **HW 8: Gears/Springs** **Quiz 7: Applications**	Lab 8: Evaluation and Recommendations Display Model & Project Report Discussion **Executive Summary due on Friday, 3/2 by 5pm**
Week 9 **3/6-8**	Applications: Bearings **HW 9: Bearings** **EXAM 2: Fatigue Failure Analysis & Apps**	Lab 9: Display model preparation **Display models due on Monday, 3/12 by 5pm**
Week 10 **3/13-15**	Advanced: Failure Detection & Monitoring Reliability analysis **Quiz 8: Bearing reliability**	Lab 10: Final Team Presentations **Final Report due on Friday, 3/16 by 5pm**