

BU ENG ME 413 Machine Design
Prof. DiBella
Prof. Isaacson
Prof. Koplow

Fall 2009

COURSE INFORMATION SHEET – ALL SECTIONS

(COURSE SYNOPSIS: First part of the Mechanical Engineering capstone design sequence. Static and dynamic failure analysis, including fatigue; load analysis; and factors of safety. Machine elements including fasteners, bearings, and other power transmission elements. Engineering design (product realization) process including customer requirements and problem definition, creativity and conceptual design, feasibility and decision analyses. Cognitive styles and group dynamics. Oral and written communication. Start of capstone design project.)

Instructors: **Prof. Morton S. Isaacson**, Ph. D. (Sect. A1, TR 10-12, PHO 203;
Sect. A3, MW 2-4, PHO 203)
Office: ENG 207 (110 Cummington St.), 353-2825, ISAACSON@BU.EDU
Home: (781) 891-3207 (10 AM – 10 PM, only)

Prof. Michael D. Koplow (Sect. A4, TR 10-12, ENG 202)
Work: Cell: 781-939-5966, MDKOPLOW@BU.EDU
Office: ENG 307 (110 Cummington St.), 353-6616

Prof. Frank DiBella (Sect. A2, MW 6-8, PHO 201)
Work: 781-937-4718, FDIBELLA@CONCEPTSNREC.COM
Office: ENG 307 (110 Cummington St.), 353-6616

Mr. Joe Estano, ME Laboratory Manager
Office: ENG 110, 353-6653, JESTANO@BU.EDU

Mr. David Campbell, ME Laboratory Engineer
Office: ENG 203, 353-3952, DCAMPBEL@BU.EDU

Mr. Mohammad Alibakhshi, Graduate Teaching Fellow
Office: ENG 117, 353-8654, AMIN@BU.EDU

Textbooks: Dieter, G.E. and L.C. Schmidt, Engineering Design, 4th ed., McGraw-Hill, 2009.

Juvinall, R.C. and K.M. Marshek, Fundamentals of Machine Component Design, 4th ed., Wiley, 2006.

Computation Notebook RR 77255 (Green cover, quad 5 to 1", UPC: 070972772557)

Lumsdaine, E., M. Lumsdaine, and J.W. Shelnut, Creative Problems Solving and Engineering Design, McGraw-Hill, 1999. (Recommended)

Recommended shop manual: Machinery's Handbook, 27th ed., Industrial Press, 2004 (Contact Joe Estano for ordering information at a special reduced price.)

(Note: These same textbooks will also be required for ME 414.)

Grading: Tentative Guidelines:

Structural Failure Analysis and Machine Elements (31%)	
Homework and pop-quizzes (<u>Individual</u> , collaboration on HW OK if identified)	10%
Midterm test (<u>Individual</u>)	10%
Final Exam (<u>Individual</u>)	15%
Capstone Project (50%)	
Review of Previous Capstone Project (<u>Individual</u>)	3%
Design Review Meetings (<u>Individual grading</u>)	3%
Project Proposal – Customer requirements/specifications (<u>Group</u>)	15%
Conceptual Design Progress Report I (<u>Group</u>)	2%
Conceptual Design Progress Report II (<u>Individual</u>)	3%
Preliminary Design Proposal – Concept Eval. & Feas. (<u>Group</u>)	20%
General Professional Development (<u>Individual</u>) (19%)	
Participation, Design Journal, Shop, Professional Society	9%
Oral Presentations	10%

Note on required special evening classes for all sections:

(1) Sustainability Seminar – On Tuesday, Oct. 6, 2009, 4-6 p.m., we will be having a special presentation on sustainability given by Dr. Jeff Dahmus of MIT's Material Systems Lab. Issues of energy, water, and environment will become increasingly important to you both in your lives and your careers. Many of you will probably eventually find employment in related professional fields. Even if you go to work for an industry not directly connected to them, however, they will still be important factors to consider in your designs. For example, "In December 2001, Dutch officials seized more than 1.3 million imported Playstations before they could enter the country. The Dutch government feared that the game machines contained too much cadmium in the console's cables . . . Nonetheless, the company put new cables on the products." (Mechanical Engineering Magazine, March 2005). Because this is such an important topic your attendance at the event is required, unless you have a conflicting class or very extenuating circumstances. Regular class lectures will still be held on October 6th and 7th.

(2) Midterm Test – On Monday, October 26, 2009, 7-9 p.m., we will have the Midterm Exam for all sections. Please plan ahead to be available at this time. A make up exam will be given only for class conflicts or very extenuating circumstances. We will not have class during regular times that Wednesday and Thursday.

Note on engineering ethics and plagiarism: As an engineer, you will be expected by other engineers and the public to conduct your self in all professional undertakings according to the professional ethics of engineering. During the spring semester, engineering ethics will be studied in some depth in AM 414. However, since you will be expected to include the consideration of engineering ethics in your capstone designs, which are started during this semester, a copy of the Code of Ethics of Engineers as promulgated by the Accreditation Board for Engineering and Technology (ABET) is included in this course information packet.

Plagiarism is a violation of all professional ethics codes as well as your College's Code of Student Conduct. Plagiarism is the undisclosed use of another's work as your own, without or even with that person's permission. If without that person's permission, this is the additional crime of intellectual property theft. Unless explicitly stated otherwise, such as "group" reports or the special note under homework, below, all of the work you submit for this course is expected to be done individually. This explicitly includes, but is not limited to, the midterm test, the final exam, CAD drawings identified by you as only your work (e.g., as "designer" or "drawn by"), and the Progress Report on Capstone Conceptual Design II due on November 16th or 17th involving the generation and evaluation of alternative conceptual designs. Plagiarizers will be prosecuted.

Note on homework: Theory is important in design. It sets upper bounds on how well we can do and helps us zero in on ranges to be tested in practice. If parts are under designed, they will fail. If they are over designed, they will be too expensive or heavy for use. Applying theory to real parts is a different skill from learning the physics behind the theory. This course stresses the application of theory, and the best way to learn the application is through practice – practice, feedback, and improvement based on this feedback. Homework is a crucial step in the process. First, read the sections in the textbooks given in the course syllabus before each class. Then do the homework when assigned. Finally, apply your knowledge through analyses to verify and optimize your design projects.

It is highly recommended that you try the homework on your own to start. The problem with not doing homework yourself is that you may not clearly determine what you do and do not understand, and so will not learn the material well enough to use it in design, or do it successfully on a test. If you need help, the best source is from the course staff during office hours. They can help determine what it is you are having trouble understanding. If you use other sources of help, including – but not limited to – fellow students, previous solution sets, or solution manuals in electronic, written or other form, you must state at the beginning of your solution for each homework problem what sources of help you used in the solution of the problem. If you do this, it will not affect your homework grade, which will be based on effort. However, if you receive help on any homework problem and do not acknowledge it, this is plagiarism and will subject you to possible action by the College's Student Conduct Committee. Several years ago, eight students in this course were convicted by the Student Conduct Committee on homework plagiarism charges. Please, do not put yourself at risk for this painful embarrassment.

The machine element homework will be out of Juvinall and Marshek, and should be handed in according to standard Aerospace and Mechanical Engineering Department homework format (see below). It will be graded on a 0 – 3 scale, based on the quantity and quality of your effort, and is worth between 5% and 6% of your term grade, enough to change the letter grade. It will usually be due one week after assignment. If it is not handed in on time, without an acceptable excuse, you will receive no credit for it. If you will not be in class on the due date, send it in with another student, leave it with the receptionist in the Aero/Mech Department Office and ask to have it put in the instructors mail box, FAX it to the Department (617-353-5866) addressed to the instructor, or send by regular mail (postmarked by due date).

Doing the assigned problems is the best way to keep up with the class material. It is also the best way to prepare for the midterm test and final exam, which are worth one quarter of your term grade!

Note on pop-quizzes: Some very short pop quizzes in class may be used to improve the effectiveness of the lectures. They will affect your homework grades.

Note on design journal: The engineering design journal is A PERSONAL LOG/DIARY/JOURNAL of the students HANDWRITTEN CALCULATIONS, DRAWINGS, AND NOTES THAT IS TO BE MAINTAINED THROUGHOUT THE COURSE. You should maintain in the notebook a COMPLETE record of your activities related to your capstone project: notes of project group meeting, notes from research related to projects (e.g., interviews, library or internet work, experimentation and testing), development of your design concepts, and analyses. All analyses related to your project should be referenced in the journal. Hand calculations should be done directly in the journal. Computer analyses should be included as problem statements, explanations, and numerical results, with reference to the full analysis contained in a notebook to be appended to the journal or as an appendix in a formal written report. Although it may sound silly, keep the journal with you at all times to record useful ideas that come when least expected, such as those that crop up in your mind in the middle of the night and wake you from a sound sleep. Many good ideas have been lost because they were not written down right away. Every page should be numbered, dated and signed. The Journal will be collected periodically through the semester for grading, as well as at the end of the course. (See the attached Check Sheet for Design Journal Use.)

Note on peer evaluations: There will be written peer evaluations a number of times through the semester. These confidential evaluations, done by all members of a design team, are a way of feeding back to both the course instructors and the individual students how well individuals are functioning as members of teams. These evaluations will affect the “group” portion of your individual course grade.

The capstone projects are too large for one or even two individuals to carry the load. Although teamwork can be difficult at times, it can also be very rewarding. The following is a quote from a recent former student, following graduation. You might note this team almost melted down in the middle of the first semester, but with the course staff’s help ended up with an excellent product and experience – and won the best project award that year.

My experience working on my design team for AM413/414 has left me very eager to work in a team-oriented environment. Prior to that experience, I loathed team projects, and I preferred to work by myself without having to constantly explain myself. This was how I felt when the senior design project started, but over the course of the year I learned to appreciate the value of working in a team, and I think I greatly improved my ability to communicate and cooperate with teammates. Also, I felt very comfortable assuming a leadership position on my team and assuming managerial responsibility. I think I did a good job of recognizing and utilizing the strengths of each one of my teammates. I would like to have more opportunities to work in teams, and, hopefully, I will be given the chance to manage some of those teams.

Note on team leaders: Each team must select a different team leader for each major segment of the design project. The name of the team leader for each

project segment must appear on the cover page of the written report for that segment.

Note on professional designs and prototypes: The key reason for doing a capstone project is to learn, by practice, what goes into producing a reliable, effective, and economically attractive commercial product. Just taking erector set parts and assembling them will result in a product that is too expensive and unreliable for a commercial product. Even if some parts of a project, such as motors, will be purchased off the shelf, you will have to do specialized design of individual parts and integration into an overall system in order to be successful. Please also note that the model or prototype developed for your project is the property of your customer (or the ME Department if you have no identified customer). It is to be left with your customer (or the Department) on completion of the project. This is the professional approach. By accepting the project proposed by your customer, you have entered an implicit contract to produce the product. The customer has been waiting all year for your product, and may well have sought it elsewhere if you had not agreed to supply it, so there is a cost to your customer even if he/she has not paid money for the product. In addition to being of use to your customer, prototypes are important to the Department to show to future students as well as to our accreditors and other visitors.

Note on shop practice and manufacturing: Although it is not the goal of this course to turn you into a crackerjack machinist, designs which are hard to fabricate are poor, if not useless. Therefore, proper shop practice, and the attention to detail it entails, is an important part of the course. The ME Department's technicians, Joe Estano and David Campbell, are excellent machinist and must be consulted by you on all aspects of your project designs.

Note on ASME International (American Society of Mechanical Engineers): Being an engineer is being part of a profession. One of the advantages and responsibilities of being part of a profession is membership in a professional society. As part of your training as a professional in this course, **you are required to become a member of at least one approved professional society.** As mechanical engineering students, we recommend that you join ASME and, hopefully, participate in the activities of the BU student section. If you want to belong to a professional society other than ASME, please check with your course instructor.

Note on professional registration: Professional registration is required in most application areas where engineers have direct contact with the public and are involved in projects that directly affect public welfare. Registration is a three step process: (1) successfully passing the Fundamentals of Engineering (FE) Exam; (2) working in a responsible engineering position for some length of time (usually on the order of four years); and then (3) successfully passing the Professional Engineering (PE) Exam in your specialty area. Even if you are not planning on becoming a registered professional engineer, passing the FE exam can be the edge you need for getting your first job offer.

The FE exam is a general exam covering all aspect of the generally accepted background for engineering. It is at the B.S. level, and most students, who take it, do so towards the end of their senior year. The Mechanical Engineering Department at Boston University has had a policy of subsidizing the cost of the

exam (around \$200) for any department senior who takes the exam and reports his/her grade back to the department. More details about the exam will be made available to you at the start of the spring semester through ME 414 and ASME.

Make-ups: Make-up tests will be given only under extreme circumstances. They must be arranged for in advance of the scheduled exam.

Final Exam: There will be a final exam in this course. Its date will be announced as soon as it is available from the University registrar. **Do not make travel plans for a date prior to the end of exam week, until you know the dates of all your final exams, confirmed by your instructors.**

Drop Date: Wednesday, October 7, 2009 (no “W” on record).

Withdrawal: Thursday, November 12, 2009 (with a “W” on record). **NO WITHDRAWALS WILL BE ALLOWED AFTER NOVEMBER 12TH.**

Incomplete: Incompletes will be permitted only for very extenuating circumstances. They must be arranged for before the end of classes.

INSTRUCTORS' STATEMENT OF COURSE OBJECTIVES:

What is this course all about? What will I learn? How will I use this subject in my future engineering work?

All of these questions could be asked of any of the engineering courses that you encounter, particularly as you study more of the specialized subjects as you get closer to graduation. These questions are never asked more than by the engineering student who begins course work in a mechanical design course. Mechanical design may be considered the culmination (capstone) of your engineering studies. While this course will continue to augment that body of factual knowledge that characterizes an engineer's education, machine (mechanical) design has the student bring to the drawing board all of this engineering 'science', but now combines it with the 'art' (or 'professional' approach) of solving a problem. The solving of a problem (that is: a human need – whether that need be a necessity, a luxury, or simply a curiosity) is the main purpose for engineering and is the essence of the definition of an engineer – a problem solver. Perhaps for the first time in your engineering education, the problem that must be solved does not start with a clear, well-defined problem statement, but must be clarified, quantified, and perhaps even defined as part of the solution process. In addition, the solution of the problem may not stop with a single, definitive numerical answer (to two decimal places), but rather culminates in a device, a system, or an invention – an idea made real – and communicated to others for all to see and to use (and yes, even to criticize).

CONSIDER: “ ...Although our knowledge of physics, mathematics, and the engineering sciences has obviously advanced since the time of Aristotle and Vitruvius there appear to be essential features of engineering design that are fundamentally unchanged. These include the nature of the conceptual design process itself, in which concepts arise as logical acts of creativity rather than as totally logical acts of deduction. Only after they are conceived can design ideas be subjected to the rational analysis that is supposed to filter the bad from the good ideas...” from: ""DESIGN PARADIGMS ... Case Histories of Error and Judgment in Engineering", by: H.Petroski; Cambridge Press, Pg.30

From this course you will learn how to combine ‘art’ and ‘science’ in a way that can produce a device that can effectively solve a problem, whether well specified or not.

You will become familiar with methodologies that have been used successfully by your predecessors to develop products, inventions, machines, mechanical systems: i.e. IDEAS THAT MATERIALIZE INTO FORM and ACTUALLY WORK! This course may, for the first time, make you realize that you now have a sufficient arsenal of science principles, theories and laws that needs now only to be combined with the intrinsic talents that you possess and/or that need polishing in order for you to gain confidence that you can make a contribution as an engineer to solving humanity's needs and wants.

How does an engineering problem get solved? Is there only one method for conceiving, designing, building, testing, manufacturing and putting into service a 'solution' to a real human-need problem? What are the step(s) in a successful design process? Where does my engineering education enter the design process in order to help solve the problem at hand? How do I effectively communicate my solutions to my colleagues as well as the public? What are my responsibilities to the public with regards to safety vs. cost vs. environment vs value? Review the “7 Cs” of Design and Analysis: CREATIVITY, COMPETENCE, CONFIDENCE, COMMUNICATION, COMMITMENT, CULTURE, and CONOSCERE.

All of these topics will be discussed during this course.

IN SUMMARY: The following are two quotations which summarize what this course is preparing you for. The first is from Herbert Hoover, 31st President of the United States, and a graduate of Stanford University in Mining Geology, who worked for many years as an engineer.

“The great liability of the engineer compared to men of other professions is that his works are out in the open where all can see them. His acts, step by step, are in hard substance. He cannot bury his mistakes in the grave like doctors. He cannot argue them into thin air or blame the judge like the lawyers. He cannot, like the architects, cover his failures with trees and vines. He cannot, like the politicians, screen his shortcomings by blaming his opponents and hope that the people will forget. The engineer simply cannot deny that he did it. If his works do not work, he is damned. That is the phantasmagoria that haunts his nights and dogs his days. He comes from the job at the end of the day resolved to calculate it again. He wakes in the night in a cold sweat and puts something on paper that looks silly in the morning. All day he shivers at the thought of the bugs which will inevitably appear to jolt its smooth consummation. (Quoted from American Scientist, July-August, 2006)”

The second quotation, and perhaps the best description of the ultimate goal of this course and its aftermath to you as an engineer and as a human being is by the author (as well as chemist, engineer and holocaust survivor) Primo Levi (taken from: "The Monkey Wrench", A Penguin Book, pg.53)

“ ... We agreed then on the good things we have in common. On the advantage of being able to test yourself, not depending on others in the test, reflecting yourself in your work. On the pleasure of seeing your creature grow, beam after beam, bolt after bolt, solid, necessary, symmetrical, suited to its purpose; and when it's finished you look at it and you think that perhaps it will live longer than you, and perhaps it will be of use to someone you don't know, who doesn't know you. Maybe, as an old man, you'll be able to come back and look at it, and it will seem beautiful, and it doesn't really matter so much that it will seem beautiful to only you, and you can say to yourself: maybe another man wouldn't have brought it off.”

SOME FINAL WORDS OF ADVICE:

Engineering Science Part of This Course

Please keep in mind that the coverage of strength of materials, failure analysis, and machine elements is a very significant aspect of this course. It is worth nearly one-third of your grade. Consider it as a way for you to polish these skills. As a member of the engineering profession you will be expected to be proficient in them. Also, the feedback from former students who have taken the FE exam is that this course is very helpful in preparing them for that exam. Try to keep up with the reading material and assigned work. Read the assigned material at least twice – once before the class and then again after the class is taught. Do not fall behind with the homework – it is the best way to understand the material taught in class and it is the best way to polish your creative design skills.

Transitional Nature of This Course

Our goal is to help you make the transition from the academic learning environment to the professional working environment. This includes learning the basics of the professional mechanical design methodology. This is a systematic way to design products that has been developed by the mechanical engineering profession through much pain and effort. It is the best current practice. But, to learn techniques you must practice them, first on simpler problems and then on more complex ones. This is why we pace you through the various stages of the design

process, rather than let you build the first idea that occurs to you. Please be patient and bear in mind that, in this way, both your learning of the process and the final product you achieve will be improved.

Documentation and Communication

Another major difference between this course and other courses you have had is that here the presentation and documentation of what you have done is as important as what you have done. Most of your previous education has been aimed at your personal learning of academic material. In this course the stress will be on training in application and communication. An engineer almost never works alone, and clear communication is critical – with customers, supervisors, assistants, or fellow team members. **In this course, as in the working world, you must spend as much thought and effort on how you communicate your work (graphical, written, and oral) as you do on the work, itself. Both format and content are important.**

“...You Learn By Your Mistakes...”

Countless engineers and scientists throughout history have experienced this timeless statement. No doubt, as you have progressed from engineering freshman to senior there have been many instances in your academic career when you have given evidence to this constant refrain. In fact, it is true that the most confident, enthusiastic, adventuresome and, yes, even competent engineer/innovator will always look at some failures in a new enterprise as almost inevitable, even after his or her best efforts; otherwise the task-at-hand could probably be done by anyone with much less training. Temporary setbacks must be understood, if not welcomed, by the engineer as simply another step that must be mastered along the path to success. The earlier that an engineer learns about common pitfalls the better it is. This is one of the major positive experiences that a capstone senior design project course is intended to provide. However, this learning experience comes at a price that the student must pay, and that price is accepting constructive criticism from the instructors as the positive contribution to your capstone experience that it is intended to be. Such criticism will come at a time when you are most physically and mentally challenged and it will be incorrectly seen as an intrusion in your “perfect” design, report, or presentation. The Instructors want to assure you that criticism of your hard fought ideas is not given simply to be contrary. The Instructor’s constructive criticism comes from long and pained engineering experiences and is intended to contribute to your work and not take away from it. Such criticisms will have been determined from lengthy, concentrated reviews performed on your written reports, drawings and analysis. Such time is offered not to demean your work but to empathize with and enhance your effort. In effect, the Instructors look upon themselves as your “sixth” team member and hope that their criticisms will be as welcomed by the group as would be any members contributions and suggestions.

Questions

We have seldom heard "stupid" questions in a classroom or office. If you have a question, which you cannot answer after a moment’s serious reflection, ask it!!! Chances are, you are not the only one with this question, and sometimes the answer to one question clears up a key insight on a concept and makes all the difference between success and failure in studying a new subject or in later practice.

BU ENG ME 413
Machine Design I
Prof. DiBella
Prof. Isaacson
Prof. Koplow

Fall 2009
(All Sections)

COURSE SYLLABUS
(8/28/09)

(NOTE: In Reading: D = Dieter, J = Juvinall, L = Lumsdaine)

September

- 2/3 Introduction; Review of Info Sheet and Syllabus; Engineering design process (“product realization process”); Nature and scope of capstone project; Request for capstone project ideas.

Assignment of critical review of previous capstone project and report.

Sign up for shop and SCUDLab orientation immediately – sign up sheets posted outside ENG B07 – orientation sessions will be limited to 10 students and last one hour this Thursday and Friday, and this coming Tuesday – Please note that the shop is extremely busy this semester, and you must sign up for shop sessions and be there on time, or lose credit.

Program Outcomes Assessment.

(Reading: J: Ch. 1; D: Ch. 1 & Sect. 9.3; L: Ch. 1)

- 8/9 Shaft assemblies and components; Geometric tolerance and fits; Report format.
(Reading: J: Ch. 17; D: Sect. 8.6; Handout on fits and tolerance on website)

- 10/14 **Individual written and oral (~3 min.) reports on good and bad aspects of old capstone project and report.**

Bring transparencies explaining your comments.

- 15/16 Written report skills: Format – text and drawings.

Bring final report from previous year’s capstone project to lecture.

(Reading: D: Sect. 9.3; L: pp. 136-143)

- 17/21 Safety factors, Modeling loads, and Buckling.

Written report skills: Engineering analyses.

Bring final report from previous year’s capstone project to lecture.

Candidate capstone project ideas due.

(Reading: J: Ch. 2 & Sects. 5.10-5.15 & 6.11-6.12; D: Sects. 10.2 & 14.6-14.7; L: pp. 136-143)

22/23 Stress & Strain review.
(Reading: J: Chs. 3 & 4)

24/28 Failure analysis – Deflection & Static stress.
(Reading: J: Chs. 5 & 6)

29/30 Failure analysis – Impact.
Candidate capstone projects list distributed to class.
(Reading: J: Ch. 7)

October

1/5 Cognitive styles, team dynamics, and conflict resolution.
Failure analysis – Fatigue (Purely alternating or fully reversed).
(Reading: J: Sects. 8.1-8.8; D: Ch. 4; L: Ch. 4, pp. 121-135)

***6 Special Evening Event for all sections – Sustainability Seminar, 4-6 p.m.**

6/7 Failure analysis – Fatigue (continued).

8/13 Customer requirements, Quality Function Deployment (QFD), House of Quality.
NOTE: Tuesday follows Monday schedule.
Finalize capstone projects and teams.
(Reading: D: Ch. 3; L: Ch. 7 & App. A)

9 CDO Fall Career Fair at GSU, 11 a.m. – 3 p.m.

14/15 Written and Oral Report Skills.
(D: Sects. 9.3.5 & 9.3.6; L: pp. 144-147)

19/20 **Capstone project team meetings on customer requirements.**

21/22 Generation of design concepts; Functional decomposition; Morphological charts
(Reading: D: Chs. 5 & 6; L: Ch. 6 & 8)

***26 Midterm test (Individual – Loading, stress, strain, impact, fatigue).**
NOTE: ALL SECTIONS ON MONDAY, 10/26, 7-9 P.M.
No regular lectures on 10/26 & 27

28/29 Evaluation of design concepts – feasibility analysis.
(Reading: D: Sects. 7.1-7.2.1 & 7.3-7.3.1; L: Ch. 9&10)

November

2/3 **Capstone Project Proposals due (Team oral and written reports – Problem definition, customer requirements, house of quality, reasons for weights in QFD, design objectives, engineering specifications, Gantt chart).**
Design journal grading.
Peer evaluations.

(Choose new team leaders)

- 4/5 Evaluation of design concepts – matrix methods for weighing alternatives (Pugh);
Failure analysis – Fatigue (Fluctuating).
(Reading: J: 8.9-8.17; D: 7.3.2; L: Ch. 11)

- 9/10 **Progress Report on Capstone Conceptual Designs I (Team written
report on functional decomposition)**
Capstone project team meetings for feedback on project proposal reports.

12 Project work time – no class

- 16/17 Failure analysis – Fatigue (Fluctuating, continued).
**Progress Report on Capstone Conceptual Design II (Individual written
reports – morphological chart, and one candidate concept with pros
and cons).**

- 18/19 Failure analysis – Fatigue (Fluctuating, continued)
Machine elements – Screws & Fasteners.
(Reading: J: Ch. 10)

- 23/24 Machine elements – Screws & Fasteners (continued).
Capstone project team meetings – updates on conceptual designs.

- 30/1 Machine elements – Screws & Fasteners (end); Journal bearings (start).
(Reading: J: Ch. 13)

December

- 2/3 Machine elements – Journal bearings and Rolling element bearings
(Reading: J: Ch. 14)

- 7/8 Machine elements – Rolling element bearings.
Program assessments.
Peer evaluations.

- 9/10 **Capstone Project Preliminary Design Proposals due (team oral and written
reports – Team functional decomposition, morphological chart, three
best candidate concepts, feasibility analysis for each, Pugh matrix
weighing of alternatives, and choice of best candidate preliminary
design).**
Design journal grading.

- 11 **Final homework due for all sections on 11th at noon in ME office**

FINAL EXAM DURING EXAM WEEK