Course Syllabus

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GE 410: Component Design
Fall 2016, MWF 1:00-1:50 pm, Transportation Building 101
Instructor: Prof.~James Allison (jtalliso@illinois.edu, www.systemdesign.illinois.edu (http://www.systemdesign.illinois.edu))
TA: Marigold Bays-Muchmore (baysmuc2@illinois.edu)

Office Hours:

- **Professor Allison:** Mondays 2:00 pm - 4:00 pm am, TB 313
- **Marigold Bays-Muchmore:** Tuesdays 2:00 pm - 5:00 pm, or by appointment, TB 406
  - One additional period may be added if some students cannot make either set of office hours.

Prerequisites:

It is imperative that students enrolled in GE 410 have already completed **GE 311**. If you have not, you will need to take GE 410 at a later date. **GE 320** is also a prerequisite. This material will be helpful for hands-on activities that involve mechatronic/dynamic test systems. A prerequisite for GE 320 is CS 101 or another introductory programming course. It is expected that students in GE 410 have basic programming skills. Some homework and project assignments will involve MATLAB programming.

Catalog Description:

Design of basic engineering components: structural members, machine parts, and connections. Principles applied include: material failure (yield, fracture, fatigue); buckling and other instabilities; design reliability; analytical simulation.

Course Objectives:

By the end of this course you should be able to:

- Design mechanical systems based on quantitative analysis (e.g., statics, kinematics, dynamics, stress, strength, stability).
- Learn to think from an engineering design perspective, utilizing engineering analysis tools learned in this and other courses.
- Solve open-ended engineering design problems, including systems that involve multiple interacting components.
- Demonstrate a solid understanding of design, analysis, and selection of basic engineering components (tension members, columns, beams, shafts, power screws, bolted joints, springs, gears, and bearings) using standard design methods and practices.

Notes on the nature of this course:

During this course you will be faced with a number of design problems that involve complicated interactions. For example, changing one element of a system design will influence many other elements of the system, often requiring additional design changes. You will learn design tools and processes that will help you deal with problems involving difficult interactions and complicated change propagation. Regardless of the domain you end up working in after graduation, whether it is mechanical design or something else, the skill of managing complex interactions will be very valuable. The course topics, particularly the semester project, have been selected carefully to help you experience a range of complementary design problems with different types of interactions. In other words, this course is designed to help you reason through complicated design problems with challenging interactions. You will learn these skills by working through mechanical and structural design problems (and gain some mastery of these topics), but the fundamental skills and concepts extend to many other domains beyond mechanical and structural design.

Syllabus Modifications:

The instructor will aim to minimize syllabus changes, especially exam dates. Some minor adaptations may be required as the course proceeds. When possible, potential adaptations are noted on Canvas (e.g., using a different homework problem). Any adjustments made will be announced in class or via Canvas announcement.

Grading:

Final grades are based on how well students meet the objectives outlined above. Homework assignments, exams, and the course project will help the instructor determine how well each student meets the above course objectives.

Grade breakdown:

- Homework: 20%
- Exams: 30%
- Course Project: 40%
- Class Participation: 10%

The general grading scale is:

- 94%-100%: A (A+ possible for exceptional mastery of material)
- 90%-93%: A-
- 87%-89%: B+
- 83%-86%: B
- 80%-82%: B-
- 77%-79%: C+
- 73%-76%: C
- 70%-72%: C-
- 67%-69%: D+
- 63%-66%: D
- 60%-62%: D-
- <60%: F

Your final grade will be at least as high as the above scale indicates based on your overall class score. The instructor may curve final grades (beneficially) if needed to more accurately reflect how well students met course objectives. Specifically, if implemented, the curve would only improve final grades beyond what the above scale indicates.

Homework:

There are 12 homework assignments, and most are due on a Wednesday right at the beginning of class. Sometimes we review homework solutions in class, so no late homework will be accepted. The lowest two homework scores, however, will be dropped. Use these dropped scores wisely (e.g., for unanticipated emergencies). While working on homework in groups is encouraged, please ensure that you know how to work through the homework problems on your own so that you can be well-prepared for the exams and have a good foundation for succeeding in the course project. Exam and project scores are weighted more heavily that homework, so it is in your own best interest to understand the homework problems thoroughly.
Detailed weekly reading assignments and video lecture assignments are listed on **this page** (Pages > Reading Assignments). Please read the appropriate material before class so you can get your questions answered during lecture.

Relatively few homework problems are assigned in this course to allow time for project work and other activities. Very little overlap exists between the assigned homework problems. To help improve your exam performance, you may consider practicing additional homework problems beyond what is assigned. The TA may be a good resource in helping you work through any additional practice problems.

Submission: Electronic submission through Canvas is strongly preferred for homework and project deliverable submissions. You can scan and upload handwritten notes, or submit typed documents. Some assignments require submission of MATLAB files. Electronic submission provides clear documentation of when you turned your assignment in, and it is a significant help for us in documenting student work for accreditation requirements.

- When submitting assignments electronically through Canvas, click on the assignment in Canvas. You will then see a button to click for making your submission. You can resubmit if needed before the assignment deadline.
- For submissions that require multiple files, please put all of the files into a single zip file, and upload that zip file. Please label the individual file names

in a way that makes it easy to identify where your solutions to particular problems are. For example: HWK1_Probs_2.6-.2.16.pdf. Within the files please make very clear what problem solutions your are presenting, especially if multiple problem solutions are contained in a single file.

Hands-on Activities:

Over the course of several semesters we have introduced several hands-on activities, including bolted joint design and testing, gear set design and testing, and dynamic suspension system testing. More information about these projects will be available as the course proceeds. We are working with a specialist in curriculum development and assessment, Mr. Marlon Mitchell, in conjunction with some of these hands-on activities. Mr. Mitchell is a PhD student in Curriculum & Instruction, and you may have an opportunity to meet him later in the semester.

Exams:

There are three in-class exams. There is no final exam - the semester project serves as the cumulative integrative assessment for the course. Course textbooks, printed or copied pages from course textbooks, written notes, and calculators are allowed during the exams. No electronic devices other than calculators are permitted during exams. Exams will consist of both short-answer questions designed to evaluate your conceptual understanding of the material, as well as one or more traditional quantitative problems that are similar to homework problems. This is a format different from what many students are accustomed to. It helps assess conceptual understanding of a wide range of topics. Requiring just one quantitative exam problem for each main topic would require far more time than we have during each exam, so a mix of short answer and quantitative problems.

If you understand the material well you should be able to answer the short-answer questions with little to no referencing of the textbook or your notes. If you have to look up the answer to each question you will run out of time! The exams are open-book/note primarily so that you do not need to memorize all of the many formulas and tables required for working problems in this class. You are expected to have a solid conceptual understanding of the material going into each exam. Do not rely on the textbook to compensate for gaps in conceptual understanding -- you will not be able to complete all the exam problems if you take this approach.

We have attempted to schedule exams around important dates, such as Engineering Expo.

Project:

The course project is a simplified automotive suspension design problem to be completed by project groups of 3 students. If the number of students is not evenly divisible by 3, 1-2 groups of 4 students may be permitted. Having only two students in a group may result in a significant workload. Students may self-select groups. Please aim to form groups where students have complementary skills and interests (e.g., at least one person who is good at programming, at least one person with experience in mechanical or structural systems). Please see PR1 for more information on student introductions that may help with forming groups. Students can message other students in the class through Canvas.

The course project is a significant portion of the overall grade. Please budget your time accordingly and ensure that you contribute sufficient effort toward your group project. The project is well structured to help students complete challenging design tasks within a single semester, but still allows for some creativity and open-endedness, and requires intensive collaborative work.

Several project deliverables are required throughout the semester that will help groups progress toward a final design. These deliverables relate to topics covered in recent lectures. These deliverables are spread out throughout the semester to help you stay on track with the project, reducing the amount of work left to be done at the end of the semester. Please plan ahead for these deliverables with your group. Most of them cannot be completed in a single afternoon/evening of work. Try to work your way through well ahead of time so that you can take advantage of office hours (or asking questions during lecture) to resolve any project deliverable questions.

Please work together as project groups on each project deliverable, and make a single submission as a group for each deliverable. Deliverables will be graded as a group. At the end of the semester each student will submit confidential peer reviews to evaluate the contribution of each group member. If a group member contributes significantly less than the rest of the group his/her project grade may be affected. If in your group a student is contributing significantly less than the others, please work with the instructor to resolve this as early in the semester as possible. Letting this situation slide until the end of the semester is problematic for everyone involved.

Class Participation:

Class participation will be assessed via self-evaluations, completion of in-class activities, and instructor evaluation. Active engagement in class will help ensure that you receive a good class participation score. Vocal participation in class helps everyone's learning experience, but is not the only element of class participation. Active engagement with your project group and with the instructor/TA during office hours are other elements of class participation.

Most in-class activities will not be announced. These are sort of like pop-quizzes, but instead are usually completed working together with other students in class. Make-up is not provided for these activities (providing additional incentive to attend class). Each of these activities is a relatively small amount of your overall grade. You should be able to miss 1-2 of these for important absences (e.g., job interviews, site visits, etc.) without affecting your overall grade. These activities will occur on average less than once per week.

Re-grade Policy:

If you believe a mistake has been made in the grading of a homework assignment or exam, please prepare a written description of this mistake along with the assignment or exam and submit either to the instructor or to a TA within one week of receiving your grade. The instructor reserves the right to re-grade the entire assignment or exam when submitted for consideration of a re-grade.

Textbooks

- **Required**: Shigley's Mechanical Engineering Design (Ninth Edition, Budynas and Nisbett)
  - The newer 10th edition should also work, as long as you translate homework problem numbers and reading sections correctly.
- **Required**: Structural Steel Design (Fifth Edition, McCormac and Csernak)
- Recommended Reference: Machinery's Handbook (29th or 30th edition, Oberg, Jones, Ryffel, McCauley, and Heald)
- Recommended Reference: AISC Manual of Steel Construction} (14th edition, American Institute of Steel Construction)

Note: please be sure to **purchase your own hardcopies of the required textbooks**, as you will need them for exams in addition to reading and completing homework sets. You can either purchase a conventional bound hardcopy, or print required chapters/tables for use during open-book exams if you purchase an e-book. Shigley's will be needed for the first two exams, and the Structural Steel Design text will be needed for the third exam. Required pages from the two recommended references will be provided, although if you think that you might practice machine or steel design professionally in the future, you should consider purchasing your own copies of these references.

Resources for Students With Disabilities

To obtain disability-related academic adjustments and/or auxiliary aids, students with disabilities must contact the course instructor and the Disability Resources and Educational Services (DRES) as soon as possible. To contact DRES, you may visit 1207 S. Oak St., Champaign, call 333-4603, e-mail **disability@illinois.edu (mailto:disability@uiuc.edu)** or go to the **DRES website (http://disability.illinois.edu/)**. If you are concerned you have a disability-related condition that is impacting your academic progress, there are academic screening appointments available on campus that can help diagnosis a previously undiagnosed disability by visiting the DRES website and selecting “Sign-Up for an Academic Screening” at the bottom of the page.

Safety Information

- **What to do in an emergency (pdf) (http://police.illinois.edu/dpsapp/wp-content/uploads/2016/08/syllabus-attachment.pdf)**.
- **Preparedness video** (run/hide/fight).
- Sign up for emergency texts at: ***emergency.illinois.edu (http://emergency.illinois.edu/)***

Assignments Summary:

Date	Details	
Wed Aug 31, 2016	**Homework 1 (https://canvas.instructure.com/courses/1056071/assignments/5074845)**	due by 1pm
	Class Activity 1 - Photo and Introduction (https://canvas.instructure.com/courses/1056071/assignments/5074829)	due by 5pm
Wed Sep 7, 2016	**Homework 2 (https://canvas.instructure.com/courses/1056071/assignments/5074853)**	due by 1pm
Fri Sep 9, 2016	**Class Activity 2 - Fatigue (https://canvas.instructure.com/courses/1056071/assignments/5074830)**	due by 1:50pm
Mon Sep 19, 2016	**Class Activity 3 - Shaft Design (https://canvas.instructure.com/courses/1056071/assignments/5074831)**	due by 1:50pm

Wed Sep 21, 2016	Homework 3 (https://canvas.instructure.com/courses/1056071/assignments/5074854)	due by 1pm
Fri Sep 23, 2016	Exam 1 (https://canvas.instructure.com/courses/1056071/assignments/5074837)	due by 1pm
Wed Oct 5, 2016	Homework 4 (https://canvas.instructure.com/courses/1056071/assignments/5074855)	due by 1pm
	PR1 - Kinematics and force analysis (https://canvas.instructure.com/courses/1056071/assignments/5074862)	due by 1pm
Wed Oct 12, 2016	Homework 5 (https://canvas.instructure.com/courses/1056071/assignments/5074857)	due by 1pm
	PR2 - Linkage design (https://canvas.instructure.com/courses/1056071/assignments/5074863)	due by 1pm
	Class Activity 4 - Spring Design (https://canvas.instructure.com/courses/1056071/assignments/5074832)	due by 1:50pm
Fri Oct 14, 2016	Exam 1 Extra Credit Proposal (https://canvas.instructure.com/courses/1056071/assignments/5074839)	due by 11:59pm
Wed Oct 19, 2016	Homework 6 (https://canvas.instructure.com/courses/1056071/assignments/5074858)	due by 1pm
	PR3 - Spring design (https://canvas.instructure.com/courses/1056071/assignments/5074864)	due by 1pm
Wed Oct 26, 2016	Class Activity 6 - ESPL Report (https://canvas.instructure.com/courses/1056071/assignments/5074833)	due by 1pm
	Homework 7 (https://canvas.instructure.com/courses/1056071/assignments/5074859)	due by 1pm
	PR4 - Stress and deflection analysis (https://canvas.instructure.com/courses/1056071/assignments/5074865)	due by 1pm
Mon Oct 31, 2016	Exam 1 Extra Credit (https://canvas.instructure.com/courses/1056071/assignments/5074838)	due by 4pm
Wed Nov 2, 2016	Class Activity 7 - Transmission Dissection (https://canvas.instructure.com/courses/1056071/assignments/5074834)	due by 1pm
	Homework 8 (https://canvas.instructure.com/courses/1056071/assignments/5148577)	due by 1pm
Fri Nov 4, 2016	Exam 2 (https://canvas.instructure.com/courses/1056071/assignments/5074840)	due by 1pm
Fri Nov 11, 2016	Homework 9 (https://canvas.instructure.com/courses/1056071/assignments/5074860)	due by 1pm
	PR5 - Bearing and shaft design (https://canvas.instructure.com/courses/1056071/assignments/5074866)	due by 1pm
Wed Nov 16, 2016	Homework 10 (https://canvas.instructure.com/courses/1056071/assignments/5074847)	due by 1pm
	PR6 - Progress report (https://canvas.instructure.com/courses/1056071/assignments/5074867)	due by 1pm

Mon Nov 28, 2016	**Class Activity 8 - Plastic Hinges** (https://canvas.instructure.com/courses/1056071/assignments/5074835)	due by 2pm
Fri Dec 2, 2016	**Homework 11** (https://canvas.instructure.com/courses/1056071/assignments/5074850)	due by 11:59pm
Mon Dec 5, 2016	**Homework 12** (https://canvas.instructure.com/courses/1056071/assignments/5074852)	due by 1pm
	Class Activty 9 - Newmark Lab Tour (https://canvas.instructure.com/courses/1056071/assignments/5074836)	due by 11:59pm
Wed Dec 7, 2016	**Exam 3** (https://canvas.instructure.com/courses/1056071/assignments/5074843)	due by 1pm
Tue Dec 13, 2016	**Exam 2 Extra Credit** (https://canvas.instructure.com/courses/1056071/assignments/5074841)	due by 11:59pm
	PR7b - Dynamic Suspension Design (physical testing) (https://canvas.instructure.com/courses/1056071/assignments/5074869)	due by 11:59pm
	Self-evaluation (https://canvas.instructure.com/courses/1056071/assignments/5074872)	due by 11:59pm
Wed Dec 14, 2016	**PR8 - Final report** (https://canvas.instructure.com/courses/1056071/assignments/5074870)	due by 11:59pm
	PR9 - Peer evaluation (https://canvas.instructure.com/courses/1056071/assignments/5074871)	due by 11:59pm
Wed Dec 28, 2016	**PR7a - Dynamic Suspension Design (model-based)** (https://canvas.instructure.com/courses/1056071/assignments/5074868)	due by 11:59pm
	Fall Break (https://canvas.instructure.com/calendar?event_id=1149552&include_contexts=course_1056071)	
	Instructor Evaluation (https://canvas.instructure.com/courses/1056071/assignments/5074861)	