

BE 3320 MECHANICAL DESIGN FOR BIOLOGICAL ENGINEERING

Fall 2015 Class Syllabus

Instructor: Steven G. Hall, Ph.D., P.E. (licensed in Mechanical Engineering in New York and Louisiana), Associate Professor, Biological and Agricultural Engineering, Room 143 EB Doran. 225-578-1049; 225-281-9454 cell. Shall5@lsu.edu; sghall@agcenter.lsu.edu. Office hours: T 1:30-2:30 and Th 9 - 10AM or by appointment.

TA: No formal TA is assigned to this course; RA's may assist: Daniel Smith dsmi112@lsu.edu; Charles Malveaux cmalve2@lsu.edu; Gabe Rivera griver3@lsu.edu; Melody Thomas mtho135@lsu.edu; Marlon Greensword mgree15@lsu.edu; **Departmental TA:** Anna Charron Dugas acharron@lsu.edu

Location: Lectures 12:30--1:30 T/Th 2218 Taylor

Moodle site: <http://moodle2.lsu.edu/course> (look for BE3320)

Labs 1:40-4:30 W/Th 138 Ag. Metals or shopTh; 106 AgMetals or shop

Description: BE 3320 Mechanical Design for Biological Engineering (3 credits)

Prerequisites: CE 3400; ME 3133 or CE 2460. Philosophy of machine design for power machinery, materials of construction, frame designs, biological engineering, selection of machine elements, and guided projects in machine design and analysis.

Textbook: Shigley's Mechanical Engineering Design, Budynas and Nisbett, 9th Edition, (SI) McGraw Hill, 2010. Fundamentals of Engineering (FE) Reference Handout. www.ncees.com.

References: ASABE Standards; Commercial literature, Statics, Dynamics, Strength of Materials and Properties texts; Autodesk; Autodesk Inventor (available on machines in computer lab)

Class goals: To learn and apply techniques of machine design to relevant mechanical and biological engineering challenges, and to use these creative skills to effectively communicate technical, written and oral aspects of this work.

Communication Intensive Course: This has been certified Communication-Intensive (C-I) course which meets the requirements set forth by LSU's Communication across the Curriculum program, including

- instruction and assignments emphasizing informal and formal [writing] and [visual];
- teaching of discipline-specific communication techniques;
- use of draft-feedback-revision process for learning (on two formal projects);
- practice of ethical and professional work standards;
- 40% of the course grade rooted in communication-based work; and
- a student/faculty ratio no greater than 35:1.

Students interested in pursuing the LSU Distinguished Communicators certification may use this C-I course for credit. For more information about this student recognition program, visit www.exc.lsu.edu.

CxC studio contacts: David ‘Boz’ Bowles dbowles@lsu.edu; Warren Hull whull1@lsu.edu

ABET class: 2 hours engineering design, 1 hour engineering sciences.

ABET Objectives: a) apply knowledge of math, science, engineering; b) analyze and interpret data; c) design a system/component; e) identify, formulate and solve engineering problems; f) understand professional and ethical responsibility; g) communicate effectively; k) use techniques, skills and modern engineering tools necessary for engineering practice.

Prerequisites: Statics; Dynamics; Strengths of Materials; word processing; spreadsheet; AutoCAD; Inventor.

Academic Integrity: Students are expected to comply with the Code of Student Conduct throughout this course, see lsu.edu website.

Grading:

You are responsible for your own attendance and work. Make-up exams may be allowed by consent of instructor. Final grades will be assigned as follows:

Lab reports, notebook, homework:	10%
Two design projects:	30%
Project presentations/videos:	10%
Midterm exams:	25% (10, 15)
Final exam:	25%

Grade distribution based on >90=A; 80-90=B; 70-80=C; 60-70=D; <60 = F

“plus” grades for top 3 points (e.g. 97-100 = A+); “minus” for lower 2 points (90-92 = A-)

Class Topics:

Class period	Date	Subject
01	Aug 25	Class Introduction, Syllabus Review, Professionalism and Ethics
Students sign up for “class preview” (1 per class; 2 per lab)		
02	Aug 27	Design Philosophy, Technical Writing (Bowles)
03	Sept 1	Strengths of Materials Review
04	Sept 3	Statics Review: Load and Stress Analysis
Labor Day	Sept 7	
05	Sept 8	Review: Deflection and Stiffness
06	Sept 10	Drawing: Autocad and Inventor (Visit CxC lab, Warren Hull)
07	Sept 15	Failure Analysis I (Thom Tremblay from Autodesk)
08	Sept 17	Failure Analysis II (Fatigue failures/dynamics review)
09	Sept 22	Shaft and Drive Train Analysis & Design Project Introduction
10	Sept 24	Fasteners: Machine screws and bolts, rivets, adhesives
11	Sept 29	Welding and Bonding Technique Project 1 Due
12	Oct 1	Springs and Spring Design and Analysis
13	Oct 6	Bearings & Lubrication
14	Oct 8	Project II Proposal due Oct 8
15	Oct 13	Midterm Exam
16	Oct 15	Design and Drawing Day
17	Oct 20	Gears I: Fundamentals
18	Oct 22	Gears II: Gear trains/force analysis
19	Oct 27	Gears III: Spur and helical gears
Fall Holiday Oct 29-Nov 2		
20	Nov 3	Bevel and worm gears

21	Nov 5	Design Project Draft Due at 4:30
22	Nov 10	Couplings/Brakes
23	Nov 12	Belts and Pulleys (Final Projects Due Nov 13 by 4:30)
24	Nov 17	Wire and Rope Elements (Presentations)
25	Nov 19	Power Transmission (Presentations)
26	Nov 24	Finite Elements Analysis Review (Presentations)

(Thanksgiving: Give Thanks!) Nov 25-30

29	Dec 1	Project II Presentations or guest lecture
30	Dec 3	Review for Final
Final Exam:	Dec 10	12:30-2:30

Laboratory Schedule

Note: All Laboratory Reports are due by the beginning of lab 1 week later.

Class period	Date	Subject
01	Aug 26/27	No labs (Review Autodesk Inventor independently)
02	Sept 2/3	Shop Safety and Lab Introduction, Visit CxC lab (Hull, Bowles)
03	Sept 9/10	AutoCAD and Inventor Review
04	Sept 16/17	Project Design/Drawing Day: Work on Project 1
05	Sept 23/24	Springs, Hinges, and Fasteners

Project 1 due Sept 25 by 4:30 PM

06	Sept 30/Oct 1	Autonomous Vehicle Analysis and Design Improvement
07	Oct 7/8	Work on Design

Project Proposal II Due Oct 9 by 4:30 PM

08	Oct 14/15	Welding and Soldering A: Permanent Joints/DW
10	Oct 21/22	Design work/W&S B
11	Oct 28/29	Fall Break
12	Nov 4/5	Small Engines A: Analysis and Assembly/DW

Final Project Report Due: Nov 13, by 4:30

12	Nov 11/12	Design Work/SE B
13	Nov 18/19	Project Presentations

(Thanksgiving: Give Thanks!) No Labs Nov 25/26

14	Dec 2/3	Final Lab: Final Design Presentations; Debrief
----	---------	--

Final Exam: Dec 10 12:30-2:30

Communication Intensive Philosophy for BE 3320 Design Course

As professionals in service to the world, engineers need not only solid competence in technical skills, but excellent communication skills to both understand and convey ideas to a variety of audiences. Some specific examples include both conceptual development of designs for particular products and the presentation of those designs to potential clients, to other engineers, and to more general public audiences. At the same time, engineers need not only competence but excellence in their technical field. In this case, that means learning how to design three dimensional components, analyze these components with appropriate technical software, including stress analysis, dynamic simulations and related areas.

We view the inclusion of the communication intensive designation in this course as not being in competition with technical excellence, but enhancing it. These components of learning are intended to be synergistic. For example, learning is often enhanced by the opportunity to share, teach or present one's work. Additionally, critical feedback from class members as well as instructor can enhance clarity in both learning and communication. Practical examples of this include the additional organization required to provide a top quality presentation of technical work. Other ways that communication can enhance technical activity is by focusing functionality and clarity of the technical information. By comparison, the technical work, especially the simulations and analyses are ways that figures and videos can help convey needed information.

In summary, the concept is that communication components of this course will enhance engineering skills and vice versa: development of skills in engineering design software allow better presentations that will prepare students for excellent professional work in industry, classroom, and government. In addition, coverage of professional, technical, communication and ethical issues will be included and the synergistic interaction between these should enhance each aspect.

In practice, you will be provided with in-class time to review technical writing, and you will have a chance to visit the CxC Engineering Lab with Warren Hull. I also recommend you to avail yourselves of the services of these labs for practicing presentations, putting videos together and other communication related work, as you will have technical, written and oral components as a significant part of the course.

Practical Aspects of Communication Intensive BE 3320, and Schedule

Fall 2015

Homeworks and exams include written components which allow students to express their ideas in written and graphical format. An early INDIVIDUAL design project will be due in late September (see syllabus for details on dates), and will help familiarize students with the software (Inventor and related technologies) we will be using to assist with numerical stress analysis of mechanical components. A short presentation by each student will allow the opportunity to share in verbal format with other students. A standard feedback form will allow other students to provide critical constructive feedback to presenters which can be used in later projects. A final design project due in November focuses on graphical, verbal, written techniques, as well as interpersonal skills.

One example of a homework that is expected in written format is a review of a professional and/or standards organization related to engineering design. Specific examples of such organizations include ASABE, AES, SAE, or any organization that addresses an engineering profession, organization or other group.

The midterm and final exams will each include written components and/or essay type questions. However, as appropriate for a technical course, significant technical and numerical content will also be evaluated on exams and homeworks.

Writing assignment 1, BE 3320

Choose from the list provided on Moodle, one standard or professional organization related to this course. Go to their website and/or write/call the organization. Write a 1 page summary of the organization including the following:

- 1) Name of organization
- 2) Address (web and physical if available)
- 3) Mission or purpose
- 4) History
- 5) Audience
- 6) Specific services provided
- 7) Conferences or events
- 8) Publications
- 9) Standards if appropriate
- 10) Current or future activities
- 11) Additional information as appropriate
- 12) Be prepared to give a 1-2 minute summary of your organization
- 13) Submissions will be collated and posted on Moodle for your review

Write in text format, using Chicago style guide. Include references in author/date style per CxC website.

Grading Rubric for Writing Assignment in BE 3320	Possible Points	Points Received
Writing meets assigned specifications	15	
Writing is clear organizationally/structurally	15	
Reasoning is logical	15	
Writing includes evidence, details, examples	15	
Language is appropriate for audience and purpose (general/eng)	10	
Wording, phrasing, sentence structure and spelling are correct	15	
Details (address/web/etc. are included and appropriate)	15	
Overall Assessment	100	
Overall priorities for revision (if draft) or final comments		

BE 3320: Mechanical Design for Biological Engineering

Project 1, Fall 2015

Objectives: To refresh memory of the basic drawing functions of Autodesk Inventor.
To learn and practice the tools in Autodesk Inventor that will assist in mechanical design, such as Stress Analysis, Dynamic Simulation, and Drawings.
To explore the effects of stress on simple mechanical tools

Problem: Find a purely mechanical, easy-to-dimension item to draw and analyze via Autodesk Inventor tools. The device should have at least one moving part (when a “small” force is applied to the part it will move). Some example items are a potato peeler, paint roller, rotary cutter, scissors, vernier caliper, retractable pen, a locking door with frame, etc.

You will need to:

- draw the parts of your item,
- assemble the parts,
- run a dynamic simulation using the forces you assume to most likely impact the normal motion of the item, and
- run a simulation using the forces that you assume will most likely cause your device to fail. (dulling of blades, fracture of support structure, etc)

Constraint: You cannot use a pre-drawn part from the Autodesk Inventor Tutorial files or from the web.

For Help: Go to: Inventor Help (F1 while in program) and select the “Try It Tutorials” and go through:

- “Creating a Part” - for making **Standard.ipt** part files
- “Creating Assemblies” – for assembling the parts into an the item in **Standard.iam** files
- “Preparing Final Drawings” – for setting up the Orthographic and Assembly drawings, **Standard.idw** files
- “Introduction to Dynamic Simulation”

What to turn in:

A 5-page report with the following:

- Summary of drawing procedure (Why you picked your tool, strategy to drawing, etc)
- Summary of analysis procedure
- Assumptions made during analysis procedure.
- Explain what forces (torques, constraints) may be involved in the functioning of the item
- How does the item interface with biological materials and what affect could the stresses on the part impact the biological material and vice versa.

In the Appendices,

- Stress Analysis report (html) of each important structural and mechanical part using the information from the dynamic simulation

- Orthographic Drawings of each mechanically important part
- Isometric Drawing of the assembly

And posted to (Moodle forum),

A video of each of the dynamic simulations (*.avi may work; **.wmv or other “compressed” format preferred****), using the appropriate force loads and constraints

Project due as stated in syllabus

Partial list of grading components:

- **Device choice**
- **Description of device (written complementing drawings)**
- **Drawing of device (orthographic and isometric drawings)**
- **Dimensioning**
- **Qualitative description of actual forces, likely stress and failure points**
- **Assumptions made to simplify analysis (written)**
- **Stress analysis report of each important component (especially those likely to fail, and assumptions made to decide on these parts)**
- **Qualitative description of actual dynamics of system**
- **Assumptions made to simplify dynamic simulation**
- **Calculations used to simplify dynamics**
- **Video of dynamic simulations**
- **Qualitative description of biological interface(s), including biomechanical forces, viscous and elastic forces and other forces expected**
- **Qualitative description of expected (and creative) failure modes**
- **Analysis of safety constraints of device, possible injuries to human or other biological or mechanical components, as well as safety aspects built into device**
- **Comments on possible redesign to enhance functionality, manufacturability (draw-ability), assembly, cost, safety, etc.**

Rubric for grading below.

Grading Rubric for Technical Project Assignment in BE 3320	Points Possible	Points Received
Technical drawings meet specifications	15	
Dimensioning is correct	10	
Layout is logical and clear	10	
Writing is clear organizationally/structurally	15	
Writing correlates with specifics of drawings/analyses	10	
Language is appropriate for audience and purpose (general/eng)	10	
Stress analysis is appropriate and accurate	15	
Animations work appropriately	15	
Overall Assessment	100	
Overall priorities for revision (if draft) or final comments		