Mechanics of Materials, ESC 201m, Spring 2026

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Expertise: Biomechanics and bioengineering Office: 714 email: David.Wootton@cooper.edu

Class Meetings: Mondays 2:00 - 3:50, 1/26 – 5/11 (except 2/16 class meets Tuesday 2/17) Rm 427

Wednesdays 2:00 – 2:50, 1/21 – 5/14 (except 3/11), Rm 427

Office hours: Tuesdays 9:30 – 10:30, Thursdays 11-noon. Or by appointment.

Following are the requirements for the successful completion of this course:

1. **Class Meetings**
   1. Attend the class meetings given each week, and take careful notes.
   2. Attend office hours at least once, for professional development, advice, help with homework, to socialize, etc.
   3. Ask critical and general questions in class, and participate as fully as possible.
2. **Supplementary Materials**
   1. Homework and exam solutions will be posted on Teams.
   2. Lecture notes (powerpoint) will also be posted on Teams. You may find it convenient to download and print these, to mark up with additional notes and to work example problems.
3. **Homework Problem Assignments**
   1. Weekly homework assignments will be assigned on Wednesdays, discussed during the following class and office hours, and usually due at the end of class the following Wednesday for grading. Most problems are puzzles related to the previous and/or current week’s lecture material, and the exams. Timely homeworks are required to get full credit (worth 15%).
   2. **FORMAT** Use the following format for your solutions. (1) Sketch the Problem. (2) List and define known and unknown variables. (3) Briefly (1-3 sentences) explain the principles used to solve the problem. (4) Solve the problem symbolically. (5) Substitute numbers with units and simplify to solve for numerical. (6) Check your solution (units, magnitude, and direction). (7) Briefly discuss to value of the solution. If you don’t trust your solution, explain why; if your solution has limitations, discuss these briefly.
   3. Include your name, date, homework assignment number, and time spent solving homework.
   4. **References and Acknowledgements:** You must submit your own homework solution. But you may discuss or work on the problems with other students. If you do, list all students with whom you collaborated. DO NOT work in large groups or turn in photocopies of the solutions of others: (a) this is plagiarism if not acknowledged properly; (b) it is against class rules because it won’t help you to learn the material; (c) homework is only 15% of your grade anyway, compared to 55% for the midterm and final exams.
   5. Homework will be checked for completion, and one selected problem will be graded and returned the following Friday during lecture break. Grading will be on 5, 4, N scale. You are encouraged to return a revised solution next week for regrade in case of a 4 or N grade.
   6. Homework solutions will be posted to Teams. **Please check your homework solutions**. Bring any questions to office hours or class meetings.
   7. No late submission of homework assignments will be accepted without prior permission.

1. **Design/Analysis Project**
   1. To practice application of mechanics principles to design, you will also work on a design project during the term.
   2. The project will count 15% of the course grade.
   3. You may collaborate in teams of 2 or 3 on project (collaboration is encouraged).
   4. The problem will be to design, build, and test a specific component using a given set of materials. The project will be specified after the midterm. The design success will be based on either strength or stiffness, divided by the weight, to promote efficiency.
   5. You may use software (eg SolidWorks Simulation or ANSYS) to analyze your design, but since you probably don’t know what the software is doing to solve for the stresses, and these programs are subject to a variety of user errors, you will need to check/justify the software calculations using the analytical methods you learn in ESC201.
   6. A project final report will include engineering drawings of your design, your design model equations and calculations used to determine your design, images of your design as built, a description of the test rig, the test results. You will compare your model estimates to the test results, and suggest any improvements to the design or model that might improve a second iteration, in the discussion section.
   7. Don’t be surprised if I ask you about your project during the final exam.
2. **Labs**
   1. You will complete 1 or 2 1-hr lab experiments in small groups, and generate short lab reports for each.
   2. In Lab T, you will measure angular deflection of a shaft under torsional load, and shear strain on the shaft surface. In Lab B, you will measure the deflection of a metal beam loaded at the tip, and the strain on the beam surface. In the lab reports, you will explain your measurements using the theory that you are learning in class.
   3. Each team will need to schedule times to complete the labs with Professor Rodas or Giglia or Wootton.
3. **Testing**
   1. There will be a two-hour mid-term examination given during a Monday class meeting period around week 8 of the term; you may bring your notes and text, and it is suggested that you summarize your notes for efficient access during the exam. Computers are permitted if needed for text access or spreadsheet access; they must be on Airplane Mode.
   2. A take home final comprehensive examination will be completed during final exam week. A 1-hour in-class exam building on the final exam and key course concepts will also be scheduled. You will be able to refer to your final exam during the in-class exam.
4. **Time Management**
   1. As a rule of thumb, you should expect to spend 3 hours per credit hour, outside of class time, for any engineering college course.
   2. This means expect to spend 9 hours per week on reading, homework, office hours, discussions, and preparation for exams. Note time spent on your homework assignments, and let the instructor know if the course takes significantly more outside time.
5. **Grading**
   1. **Homework** on-time completion and selected solution grading will weigh **15%** of the overall grade. You may skip one on-time homework without penalty; otherwise the lowest homework grade will be dropped.
   2. **Design Project**will weigh **15%** of the overall grade.
   3. **Laboratory reports** will weigh **15%**
   4. One **mid-term exam** will weigh 2**0%**
   5. The **final examination** covers all Chapters and weighs **35%** of your overall term grade.
   6. A **Concept Self-Assessment**completed at the start and end of the course counts as one perfect homework grade.
   7. **Extra Credit:** Any student who first identifies an instructor **mistake** during lecture, or a mistake in the textbook/solutions (not already found in the published errata or by the instructor or a classmate) will receive **1%** **extra credit (ie 1 course point)**. Pay attention and be critical.
   8. The **final grade** follows the established policy of: A ≥ 90%; B ≥ 80%; C ≥ 70%; D ≥ 60%, and a lower grade will require the student to retake the course.
6. **Diversity and Inclusion**

“We are committed to Peter Cooper’s radical commitment to diversity and value, living and working in a diverse community. We value, encourage, and promote all aspects of human differences, fostering a culture that embraces a broad variety of personal circumstances, experiences, perspectives, and opinions.” (Cooper Union Engineering Core Values).

Treat your colleagues in this course with respect, even if you have a disagreement with their opinion or perspective, or a criticism of their work. If you find the design, instruction, or specific experiences within the course that result in barriers to your inclusion or accurate assessment of achievement, please notify the instructor or department chair (Professor Baglione) as soon as possible, and/or contact the Title IX officer.

1. **Makeup classes for religious holidays**

Please let the instructor know if there are religious holidays which prevent you from attending class. It is possible to arrange a makeup class if enough students need to miss a class due to a religious holiday.

1. **Accommodation for Students with Disabilities**

My goal is for each of you to pass the course with a satisfactory grade and understand the course material so that you can put it into practice as an engineer, and special arrangements are sometimes required to demonstrate student learning while being fair to all students in the course.

Students with disabilities or who need special accommodations for this class are required to provide me with a letter from the Dean of Students immediately at the start of the course so that arrangements can be made. Cooper Union has limited resources and extra time is required for such arrangements to be feasible. In order to receive accommodations for an exam, you must notify me in writing at least two weeks before they are needed, and you must also be registered with the Dean of Students. Students will not be afforded any special accommodations retroactively, i.e., for academic work completed prior to disclosure of the disability to me and the Dean of Students.

Mechanics of Materials, ESC 201m

# Course Outline Spring 2026

Suggested Text Books: Beer FP, Johnston ER, et al, Mechanics of Materials, 4th or later ed, McGraw Hill. (Suggested reading and homework problems are from Beer et al 4th edition. Later editions are very similar.) Or Gere, Mechanics of Materials, 6th edition or later, Thompson.

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| **Wk** | **Date** | **Reading** | **Class Topics** | **Deliverables (Weds)** |
| **1** | **1/21** | 1.1-1.10 | Overview. Normal and Shear Stresses. | Concept Rating Form + Picture & Blurb (Friday) |
| **2** | **1/26**  **1/28** | 1.13  2.1 - 2.5 | Pin Joint Stresses. Factor of Safety  Axial Load and deformation. | (Review ME101). HW 1 |
| **3** | **2/2**  **2/4** | 2.6 - 2.9  2.10 – 2.17 | Solving statically indeterminate problems  Thermal Strain and Stress. Hook’s Law, Stress-Strain Relations | HW 2 |
| **4** | **2/9**  **2/11** | 2.18 - 2.20  3.1 – 3.4 | Stress Concentration Factors | HW 3 |
| **5** | **2/18** | 3.4 – 3.8 | (Presidents Day Monday. No class)  Torsion in axisymmetric shafts | (homework holiday) |
| **6** | **2/23**  **2/25** | 3.12-13 + class notes 4.1 – 4.4 | Torsion 2  Torsion in thin-walled shafts. | HW 4 |
| **7** | **3/2**  **3/4** | 4.5 – 7 | Intro to Pure Bending  Midterm Exam | (Exam Covers Ch 1 – 3, HWs 1-4) |
| **8** | **3/9** | 4: 12 – 15  5.1-5.2 | Area Moment of inertia, Parallel Axis Thm  Beam Design for Bending Strength  (Wed 3/11 is a Friday Schedule) | HW 5 |
| **9** | **3/16**  **3/18** | - | Spring Break | Have Fun |
| **10** | **3/23**  **3/25** | 5.3-4, 5.6 | Beam Design for Bending Strength | HW 6 |
| **11** | **3/30**  **4/1** | 6.1-6.7 | Shear in Beams; Stress Flow  Shear in Thin-walled Members | HW 7; Project D1 |
| **12** | **4/6**  **4/8** | 7: 1 – 8, 7.10-13  (8) | Stress Transformations  Mohr’s Circle revisited, strain gages | HW 8 |
| **13** | **4/13**  **4/15** | 9.1-9.5 | Yield and Failure Criteria  Deflection in Beams | HW 9 |
| **14** | **4/20**  **4/22** |  | Deflection in Beams II  Stability of Columns | HW 10 |
| **15** | **4/27**  **4/29** | 9.7-9.8  10.1 – 4 | Stability of Columns  Project Testing | HW 11 |
| **16** | **5/4**  **5/6** | 5-7 | Energy Methods (time permitting)  Course Summary | Project |
| **17** | **5/11**  **5/14** | 12 | Takehome Final Exam. Short Oral Final Exams. | Concept Rating Form “After” |

**Helpful advice**

* **TAKE NOTES DURING LECTURE!** Get a three-ring notebook (preferably D-ring) and a three-hole punch to keep course syllabus, lecture notes, quizzes and exams organized to facilitate studying for the final. Use a compass or a circle template to draw figures.
* I encourage you to work on homework and some additional problems in teams. Discuss your solutions to become conversant and literate in solid mechanics. Then write your own solution in your own words and pictures so that you understand and can communicate to the instructor and colleagues.
* If you get stuck on a particular problem, move on to another for a time. Your brain is a multiprocessor. Typically it is easier to see a solution the second or third time you look at a problem. (Therefore don’t wait for the last day to work on homework.)
* After reading the problem, try to describe in one or two statements how you are approaching the problem, even before you solve it (you can always change your approach later if it doesn’t work). There are 3 reasons to do this: (1) psychologists tell us that this approach (“metacognition”) helps you learn, because you start organizing your knowledge at a higher level, (2) you can communicate more efficiently with fellow students and colleagues, and (3) you will get better grades.
* Although most problems in the text involve numerical solutions, solve problems symbolically prior to substituting values. Carry units in your numerical solutions, and check your work and your units. I will grade harshly if you disregard units; making quantitative calculations without units is unprofessional and has led to historic failures (like the Mars probe crash due to NASA units error). Similarly, clearly note if variables are vectors or scalars.
* Write neatly. If your method of solution is not neat or if you are unsure of your answer, redo the problem and put a box around your answer at the end.
* Quiz and some exam problems will be taken directly from or based on those assigned. Work ahead to reduce your workload near the end of the term.
* Use office hours to get hints on problem solving or to give hints to the instructor. Use email for pressing questions when office hours are not available. And work with several classmates to share some information; just be sure that you can do similar work on your own for quizzes and exams.

ESC 201 M Mechanics of Materials: ABET Syllabus and Course Context

Description: Introduction to solid mechanics; analysis of stress and deformation. Extension; flexure; torsion. Axisymmetric problems, beam theory, elastic stability, yield and failure theory.

Textbook: Beer FP, Johnston ER, et al, Mechanics of Materials, 4th or later ed, McGraw Hill, 2009.

Instructor: David Wootton, Professor of Mechanical Engineering.

Goals:

1. To introduce concepts of mechanical stress, strain, stiffness, strength, stability, and factor of safety.
2. To develop skills for analysis of the mechanics of simple structural components.
3. To develop skills for design of simple structural components for specified strength, stiffness, and stability.

Prerequisites by Topic: ME101 Statics. ESC 210 Materials Science.

Class Topics:

1. Overview and Summary (1 hour)
2. Stress and Strain (2 hours)
3. Axial Members (5 hours)
4. Torsional Members (4 hours)
5. Area moments of inertia (2 hours)
6. Beams and Bending (8 hours)
7. Stress Transformations and Failure Criteria (5 hours)
8. Deflection of Beams (5 hours)
9. Elastic Stability of Columns (5 hours)
10. Energy Methods (4 hours)
11. Quizzes and Tests (4 hours)

Computer usage:

1. Optional use of solidworks for design project
2. Optional use of computer spreadsheets and finite element software for design project

Objectives:

1. An understanding of normal and shear stress and strain.
2. An understanding of the concept of stress concentration.
3. An understanding of the origins and effects of thermal stresses and strains in structures.
4. An understanding of common mechanical failure modes (yield, fracture, fatigue, and buckling).
5. An understanding of the relationships between loads, member dimensions, material properties, member deformations, and member stress distributions.
6. An ability to design a structural member based on stiffness, strength, or stability criteria.
7. An ability to analyze a multicomponent structure to determine loads and moments applied to constituent members.
8. An ability to model thermal stresses and strains in simple structures.
9. An ability to develop useful analytical design formulas for structure members based on a variety of practical performance criteria.

Assessments: Two 2-hour examinations; weekly homework exercises, pop quizzes; before/after concept survey (student self-assessment), design project, lab report

Course contents related to program outcomes:

1. Primary outcome:

1. *an ability to apply knowledge of mathematics, science, and engineering*

● Students solve a wide variety of engineering analytical problems using their understanding of mechanics, and various mathematical approaches.

2. Secondary outcomes:

*(c) an ability to design a system, component, or process to meet desired needs within realistic constraints such as economic, environmental, social, political, ethical, health and safety, manufacturability, and sustainability*

● Students design beams, plates, shafts, columns, and simple fixtures to meet a variety of real-world specifications and constraints.

● Students redesign components of an existing folding bicycle (or alternative subject) based on mechanics principles.

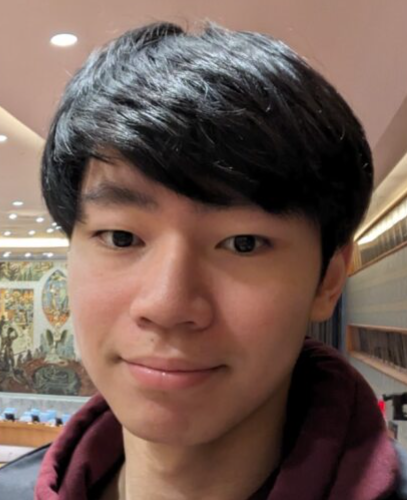
*(e) an ability to identify, formulate, and solve engineering problems*

● Students learn to formulate analytical problems leading to design formulas applicable to a variety of engineering problem scenarios.

● Students learn how to choose the best analytical approach to solve different types of engineering problems based on design objectives and constraints.

● Students identify specific components in their design project that can be improved using analytical approaches developed in the course, then apply these approaches to improve mechanical performance.

 David Brohkin



Osacar Chen



Ethan Chia



Katherine Chung



Joshua Eah



Sheik Islam



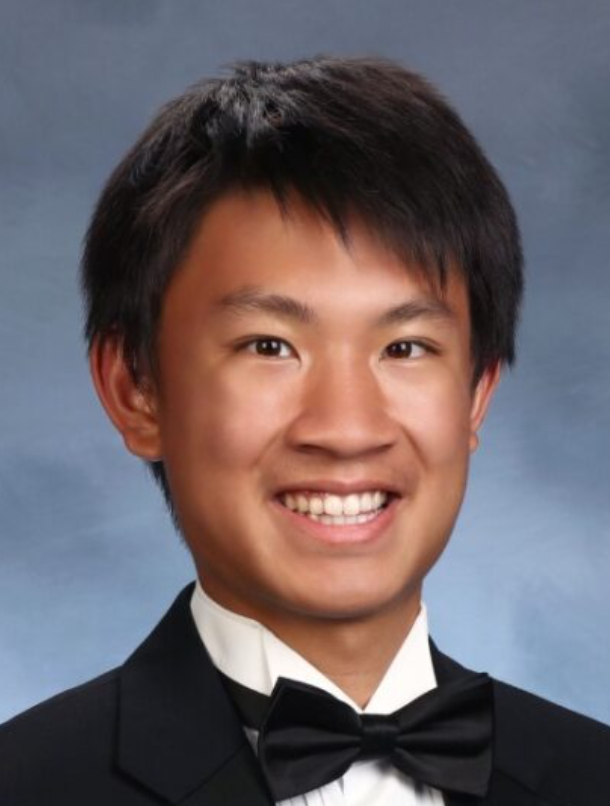
Hyungkyu Lee



Jake Peyser



Rishima Pokhorel



Dylan Qiu



Sadia Rahman



Ray Ramadhar



Brayan Ramos Vicente



Amber Sun



Clarence Tang



Antonio Velez



Vanessa Wu



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