

# AAE 55300: Elasticity in Aerospace Engineering

Fall 2021, MWF 9:30-10:20 WANG 2579

Course website: <https://purdue.brightspace.com/d2l/home/47928>

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## Course Description

AAE 553 is a fundamental course in the theory of elasticity with emphasis on understanding the governing principles and solution techniques used in the stress analysis of elastic solids and structures, essentially needed for the design of aerospace structures and materials. Cartesian tensors are introduced for formulations of general deformations and states of stress. Constitutive relations and field equations are derived for large deformation and then reduced to small deformation. Simple problems with practical applications are solved.

## Learning Outcomes

On completing this course the student shall be able to:

1. Obtain a working knowledge of tensor and index notation
2. Describe and analyze elastic deformation using the concept of deformation gradient and different definitions of strains
3. Derive the equilibrium equations and boundary conditions in terms of stresses
4. Describe and apply the 3D Hooke's law
5. Formulate 2D and 3D elasticity problems
6. Solve simple elasticity problems exactly

## Prerequisites

Elementary courses in mechanics of materials (AAE 204 and AAE 352 or equivalent), linear algebra, multivariable calculus, and differential equations.

## Textbook

No required textbook. Lectures notes will be provided.

Recommended reading: Elasticity--Theory, Applications, and Numerics (4<sup>th</sup> Edition), Martin H. Sadd. Available electronically through Purdue library Course Reserves.

## Topics to be covered

1. Vectors & tensors (2 weeks)

2. Deformation and strain (3 weeks)
3. Stress (2 weeks)
4. Constitutive relations (2 week)
5. Linear elasticity problems (1 weeks)
6. Sample elasticity problems (5 weeks)

### Grading

Weights: Weekly homework assignments (70%); Final Exam (30%)

Grades: A+: 97-100; A: 94-96; A-: 90-93;

B+: 87-89; B: 84-86; B-: 80-83;

C+: 77-79; C: 74-76; C-: 70-73;

D: 60-69%; F: <60%

*Decimal grades will be rounded (e.g., 93.5 will be rounded to be 94 and 93.4 will be rounded to be 93). Grades will not be curved. Everybody has the possibility to earn an A+!*

**Final Exam:** Final exam will be scheduled by the university. No makeup exam will be provided.

**Homework:** Homework is *essential* for understanding and reinforcing what taught in class as well as applying learned concepts to real-world problems.

1. Approximately one homework set will be assigned each week to practice what you have learned in class. Each problem is 10 points unless otherwise specified. The points counted in the final grade is computed as your total earned points divided by the total points of all homework assignments and multiplied by 70.
2. Homework will be due Wednesday mid-night (11:59 PM EST) and graded homework will be returned the following week unless otherwise specified.
3. Label each assignment with Name, Assignment #, and date clearly.
4. Homework should be done on 8 ½" × 11" paper; "Engineering Pad" sheets are preferred. Students should submit a single pdf file for each assignment (name the file as LastName \_ FirstName \_ HW \_ XX) through Brightspace.
5. Homework must be done in a structured, logical, and orderly manner enabling grader to readily verify steps, equations, and methods used. Headers such as "Given," "Required," and "Solution" are recommended. Provide sketches whenever needed.
6. Show your work to explain your answers. No credit will be given for correct answers without explanation.
7. We will try to accommodate late submittals, but we can only do this if you ask instructor's approval 24 hours in advance if you are facing a situation that prevents you from completing an assignment on time. Late homework without asking permission first will not be graded.
8. Collaboration on the homework is permitted, as learning from peers is a valuable addition to the educational experience. Obtaining help from the Internet is also allowed. **However, each student is responsible for completing his/her own work. Submitted work must be demonstrably independent from that of other students and other resources.**

**Reading:** Reading ahead facilitates comprehension and maximizes the use of the lecture time. Reading expected for each lecture will be announced through the course website.

**Course Forum:** The course website provides a Forum for class discussions. This tool will provide an opportunity to seek help fast and efficiently from classmates, the TA, and the instructor. Rather than emailing questions, please post your questions on the Course Forum. To encourage questions, you can post your questions/answers anonymously.

### **How to Succeed in this Course**

If you want to be a successful student:

- Be self-motivated and self-disciplined.
- Be brave to ask questions.
- Be willing and able to commit to time necessary to get the job done.
- Be able to digest the material taught each class each day.
- Be able to make sense of the material covered. If not, ask!
- Finish reading assignments and attempt homework before coming to class.

In contrast, here are some common behaviors that lead to failing the course.

- Don't read until the night before the class.
- Wait until the last day to begin assignments.
- Forget about deadlines.
- Ignore emails from the instructor and/or your peers regarding course activities.

### **Academic Guidance If You Become Quarantined/Isolated**

If you become quarantined or isolated at any point in time during the semester, in addition to support from the Protect Purdue Health Center, you will also have access to an Academic Case Manager who can provide you academic support during this time. Your Academic Case Manager can be reached at [acmq@purdue.edu](mailto:acmq@purdue.edu) and will provide you with general guidelines/resources around communicating with your instructors, be available for academic support, and offer suggestions for how to be successful when learning remotely. Importantly, if you find yourself too sick to progress in the course, notify your academic case manager and notify me via email or Brightspace. We will make arrangements based on your particular situation. The Office of the Dean of Students ([odos@purdue.edu](mailto:odos@purdue.edu)) is also available to support you should this situation occur.

### **Attendance Policy during COVID-19**

Students should stay home and contact the Protect Purdue Health Center (496-INFO) if they feel ill, have any symptoms associated with COVID-19, or suspect they have been exposed to the virus. In the current context of COVID-19, in-person attendance will not be a factor in the final grades, but the student still needs to inform the instructor of any conflict that can be anticipated and will affect the submission of an assignment or the ability to take an exam. Only the instructor can excuse a student from a course requirement or responsibility. When conflicts can be anticipated, such as for many University-sponsored activities and religious observations, the student should inform the instructor of the situation as far in advance as possible. For unanticipated or emergency conflict, when advance notification to an instructor is not possible, the student should contact the

instructor as soon as possible by email, through Brightspace, or by phone. When the student is unable to make direct contact with the instructor and is unable to leave word with the instructor's department because of circumstances beyond the student's control, and in cases of bereavement, quarantine, or isolation, the student or the student's representative should contact the Office of the Dean of Students via [email](#) or phone at 765-494-1747.

### **Classroom Guidance Regarding Protect Purdue**

The [Protect Purdue Plan](#), which includes the [Protect Purdue Pledge](#), is campus policy and as such all members of the Purdue community must comply with the required health and safety guidelines. Required behaviors in this class include: staying home and contacting the Protect Purdue Health Center (496-INFO) if you feel ill or know you have been exposed to the virus, properly wearing a mask [in classrooms and campus building](#), at all times (e.g., mask covers nose and mouth, no eating/drinking in the classroom), disinfecting desk/workspace prior to and after use, maintaining appropriate social distancing with peers and instructors (including when entering/exiting classrooms), refraining from moving furniture, avoiding shared use of personal items, maintaining robust hygiene (e.g., handwashing, disposal of tissues) prior to, during and after class, and following all safety directions from the instructor.

Students who are not engaging in these behaviors (e.g., wearing a mask) will be offered the opportunity to comply. If non-compliance continues, possible results include instructors asking the student to leave class and instructors dismissing the whole class. Students who do not comply with the required health behaviors are violating the University Code of Conduct and will be reported to the Dean of Students Office with sanctions ranging from educational requirements to dismissal from the university.

Any student who has substantial reason to believe that another person in a campus room (e.g., classroom) is threatening the safety of others by not complying (e.g., not wearing a mask) may leave the room without consequence. The student is encouraged to report the behavior to and discuss next steps with their instructor. Students also have the option of reporting the behavior to the [Office of the Student Rights and Responsibilities](#). See also [Purdue University Bill of Student Rights](#).

### **Academic Integrity**

*Purdue prohibits "dishonesty in connection with any University activity. Cheating, plagiarism, or knowingly furnishing false information to the University are examples of dishonesty." [Part 5, Section III-B-2-a, University Regulations] Furthermore, the University Senate has stipulated that "the commitment of acts of cheating, lying, and deceit in any of their diverse forms (such as the use of substitutes for taking examinations, the use of illegal cribs, plagiarism, and copying during examinations) is dishonest and must not be tolerated. Moreover, knowingly to aid and abet, directly or indirectly, other parties in committing dishonest acts is in itself dishonest." [University Senate Document 72-18, December 15, 1972].*

**Purdue's Honor Pledge: "As a boilermaker pursuing academic excellence, I pledge to be honest and true in all that I do. Accountable together - we are Purdue."**

*Incidents of academic misconduct in this course will be addressed by the course instructor and referred to the Office of Student Rights and Responsibilities (OSRR) for review at the university level. Any violation of course policies as it relates to academic integrity will result minimally in a failing or zero grade for that particular assignment, and at the instructor's discretion may result in a failing grade for the course. In addition, all incidents of academic misconduct will be forwarded to OSRR, where university penalties, including removal from the university, may be considered. Individuals are encouraged to alert the instructor, the TA, or university officials to potential breaches of this value by either emailing [integrity@purdue.edu](mailto:integrity@purdue.edu) or by calling 765-494-8778.*

### **Use of Copyrighted Materials**

*Among the materials that may be protected by copyright law are the lectures, notes, and other material presented in class or as part of the course. Always assume the materials presented by an instructor are protected by copyright unless the instructor has stated otherwise. Students enrolled in, and authorized visitors to, Purdue University courses are permitted to take notes, which they may use for individual/group study or for other non-commercial purposes reasonably arising from enrollment in the course or the University generally.*

### **Nondiscrimination Statement**

Purdue University is committed to maintaining a community which recognizes and values the inherent worth and dignity of every person; fosters tolerance, sensitivity, understanding, and mutual respect among its members; and encourages each individual to strive to reach his or her own potential. In pursuit of its goal of academic excellence, the University seeks to develop and nurture diversity. The University believes that diversity among its many members strengthens the institution, stimulates creativity, promotes the exchange of ideas, and enriches campus life.

### **Accessibility**

Purdue University strives to make learning experiences as accessible as possible. If you have a disability that requires special academic accommodation, please make an appointment to speak with the instructor within the first three (3) weeks of the semester in order to discuss any adjustments. It is important that we talk about this at the beginning of the semester. It is the student's responsibility to notify [the Disability Resource Center](#) of an impairment/condition that may require accommodations and/or classroom modifications.

### **Mental Health Statement**

If you find yourself beginning to feel some stress, anxiety and/or feeling slightly overwhelmed, try [WellTrack](#). Sign in and find information and tools at your fingertips, available to you at any time.

If you need support and information about options and resources, please contact or see the [Office of the Dean of Students](#). Call 765-494-1747. Hours of operation are M-F, 8 am- 5 pm.

If you find yourself struggling to find a healthy balance between academics, social life, stress, etc. sign up for free one-on-one virtual or in-person sessions with a [Purdue Wellness Coach at RecWell](#). Student coaches can help you navigate through barriers and challenges toward your goals throughout the semester. Sign up is completely free and can be done on BoilerConnect. If you have any questions, please contact Purdue Wellness at [evans240@purdue.edu](mailto:evans240@purdue.edu).

If you're struggling and need mental health services, Purdue University is committed to advancing the mental health and well-being of its students. If you or someone you know is feeling overwhelmed, depressed, and/or in need of mental health support, services are available. For help, such individuals should contact [Counseling and Psychological Services \(CAPS\)](#) at 765-494-6995 during and after hours, on weekends and holidays, or by going to the CAPS office of the second floor of the Purdue University Student Health Center (PUSH) during business hours.

### **Emergency Preparation**

In the event of a major campus emergency, course requirements, deadlines and grading percentages are subject to changes that may be necessitated by a revised semester calendar or other circumstances beyond the instructor's control. Relevant changes to this course will be posted onto the course website or can be obtained by contacting the instructors or TAs via email or phone. You are expected to read your @purdue.edu email on a frequent basis. Additional information on general emergency preparedness can be found in the [emergency plan for Wang Hall](#).

### **Disclaimer**

This syllabus is subject to change as class progresses. The change will be announced through course website and updated syllabus will be uploaded to the course website.