

**University of Nebraska-Lincoln**  
**Department of Biological Systems Engineering**  
**AGEN 324**  
**Mechanics of Materials in Agricultural Engineering**

**Instructor:**

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**Office Hours:**

By appointment

Lecture Time: 8:00 – 9:15 a.m. T, R

Lecture Location: SPL 102 East Campus

**Catalog Description:**

AGEN 324: Mechanics of Materials in Agricultural Engineering (3 credit hr) Lecture. Prerequisites: AGEN 225 and MECH 223.

Development of the concepts of Stress and Strain. Stress analysis of axial, torsional, and bending stresses, combined loading analysis, deflection evaluation, Static and Dynamic Failure Theory

**Learning Outcomes:**

Mechanics of Materials is essentially the determination of stress that develops in loaded members and the deflection of the loaded members that result. This class expands the abilities learned in Statics (MECH 223) by removing the assumption that all loaded members are rigid and can bear whatever force is required. Further, this class expands upon Statics to provide a means to successfully determine the loads in Statically Indeterminate Structures.

Upon successful completion of this course, a student will be able to:

1. Determine stress by loading analysis and from strain gages
2. Estimate deflection from planned loading.
3. Use failure theory to determine design adequacy.
4. Develop an initial understanding of product safety

**ABET Outcomes covered in this class:**

**Outcome 1:** An ability to identify, formulate, and solve complex engineering problems by applying principles of engineering, science, and mathematics.

**Required Materials:**

1. Textbook: Budynas R. G., and J. K. Nisbett. 2019. Shigley's Mechanical Engineering Design, 11<sup>th</sup> Edition. McGraw Hill. New York, New York, USA
2. Engineering Paper
3. Scientific Calculator
4. A straight edge
5. A compass

**Course Structure and Format**

This class consists of three major Units.

Unit 1 consists of an introduction to general stress and strain analysis and applications.

Unit 2 consists of beam analysis, torsion, combined loading, stress concentrations, pressure vessels, press and shrink fits, contact stress, and deflection analysis.

Unit 3 consists of static and dynamic failure theory and design for safety.

### **Policies:**

**Attendance:** Attendance is not required; however, data from past semesters suggests that every two lectures missed on average results in a final grade reduced by one letter grade. Further, the material presented in this class is mostly “unforgiving”. Failure to master the material after each week impedes your ability to learn the new material in the next week. Changes to the class schedule or assignments will be announced in class. Each student is responsible for everything discussed in class.

### **Homework:**

Homework will be assigned on a weekly basis via Canvas. Homework assignments will be scanned and submitted as a .pdf file and graded. Some problems may require a graph. In this case, the graph may be submitted as a separate Excel file. **No late assignments will be accepted.** Unless otherwise specified, collaboration on homework is permitted and encouraged.

### **Exams:**

An exam is planned following each Unit (3 total). Exams are in the format of a one week Take Home Exam and an In Class Exam. Collaboration on Exams is prohibited. In Class Exams are open book, open notes. A minimum of one week notice will be provided of the exact dates. Makeup exams may be arranged at the discretion of the instructor if arrangements are made in advance. Exams are to be individual efforts with no collaboration permitted. The use of problem solving sites (i.e. Chegg, Course Hero, etc.) for exam problems are not permitted and will be checked periodically.

### **Exam and Homework Expectations:**

Practicing engineers are normally not excessively restrained by time or resource material when solving problems. This class will partially simulate this environment through the assignment of weekly homework and take home tests that may be worked at your own pace. For this reason, no assignments will be accepted after the due date and time and a grade of 0 will be recorded for all tests and homework not submitted on time. Good practicing engineers fully document their solutions so that the problems and solutions can stand alone and be easily understood by other engineers that may be called upon in the future to judge the adequacy of a design in new applications, improve the design for performance or cost, address reliability issues, etc. **For these reasons full documentation of all problems and their solutions are required.** Work must be completed on Engineer's Pad paper following a neat and logical format using the Engineering problem solving process. 1) **Given** data and information must be clearly stated; 2) **Find** - What is to be found must be clearly stated; 3) Any **Assumptions** must be stated. Examples: The material is not stressed past the elastic limit, bearings are assumed to be frictionless, etc.; 4) **Figures and or Graphs** as appropriate are required. In this class, often a free body diagram is required. Graphs must contain properly labeled axes, a title or caption, correct units, etc.; 5) All work to solve the problem must be shown in a logical manner; 6) **Units** and where needed, dimensional analysis must be shown; 7) **Sources for equations and any values from tables and graphs** used in the solution must be documented so anyone reviewing the problem solution can locate the original equation or data quickly; 8) Final **answers** should be double underlined and intermediate answers should be single underlined. 9) Rationale for each step solving the problem must be provided. **As a rule, the problem and solution**

**should stand alone and not be dependent upon information given in the assignment.** The rubric below will be used in grading homework and the take home tests. Total homework point values range from 20 to 55. The only exception to use of these standards will be for In-Class tests.

### **Standard Homework and Take Home Test Grading Deductions:**

Failure to use and scan Engineering Paper for submission	30% reduction
Class missing from header (all pages)	-1
Assignment missing from header i.e. Homework 1, 2, 3, etc. (all pages)	-1
Name missing from Header (all pages)	-1
Page number over page total missing or incomplete (all pages)	-1
Failure to use a straight edge for lines, compass for arcs, etc.	-1
Missing "Given" Narrative	-2
Missing "Find" statement that is clear and concise	-2
Missing Diagrams and or FBDs with clear dimensions and labels (when present in solution key)	-3
Failure to double underline final answers or underline intermediate answers	-1
Equation or data source not documented	-1
Lack of acceptable neatness, writing wanders off lines, in margins, misspellings, etc.	-5
Failure to show all work or provide rationale	50% reduction

### **Well-Being:**

UNL offers a variety of options to students to aid them in dealing with stress and adversity. Counseling and Psychological Services (CAPS) is a multidisciplinary team of psychologists and counselors that works collaboratively with Nebraska students to help them explore their feelings and thoughts and learn helpful ways to improve their mental, psychological and emotional well-being when issues arise. CAPS can be reached by calling 402-472-7450. Big Red Resilience & Well-Being (BRRWB) provides one-on-one well-being coaching to any student who wants to enhance their well-being. Trained well-being coaches help students create and be grateful for positive experiences, practice resilience and self-compassion, and find support as they need it. BRRWB can be reached by calling 402-472-8770.

### **Academic Honesty**

Academic honesty is essential to the existence and integrity of an academic institution. The responsibility for maintaining that integrity is shared by all members of the academic community. The University's Student Code of Conduct addresses academic dishonesty. Students who commit acts of academic dishonesty are subject to disciplinary action and are granted due process and the right to appeal any decision. See Student Code of Conduct, Article III, Section B. at <https://stuafs.unl.edu/DeanofStudents/Student%20Code%20of%20Conduct%20May%20Rev%202014%20a.pdf>

### **ADA and Accommodation**

The University strives to make all learning experiences as accessible as possible. If you anticipate or experience barriers based on your disability (including mental health, chronic or temporary medical conditions), please let me know immediately so that we can discuss options privately. To establish reasonable accommodations, I may request that you register with Services for Students with Disabilities (SSD). If you are eligible for services and register with their office, make arrangements with me as soon as possible to discuss your accommodations so they can be implemented in a timely manner. SSD contact information: 117 Louise Pound Hall.; 402-472-3787

**Evaluation Schedule:**

1. Exams – Three (3) exams each worth 100 points
2. Homework – Thirteen (13) Homework assignments worth from 20-55 points each

**Grading breakdown**

<u>Component of Work</u>	<u>Contribution to Semester Average</u>
Homework	25%
Exams	75%

The semester average will be determined as a composite of your class participation, homework, and exams. The portion each contributes to the semester average is shown in the table above. The grade assigned will be based on the semester average as shown in the table below. The instructor reserves the right to adjust the scale.

<u>Semester Average</u>	<u>Grade</u>	<u>Semester Average</u>	<u>Grade</u>	<u>Semester Average</u>	<u>Grade</u>
96.7-100%	A+	83.3-86.7%	B	70.0-73.3%	C-
93.3-96.7%	A	80.0-83.3%	B-	66.7-70.0%	D+
90.0-93.3%	A-	76.7-80.0%	C+	63.3-66.7%	D
86.7-90.0%	B+	73.3-76.7%	C	60.0-63.3%	D-
				0-60.0%	F

University policy regarding marks of I (incomplete) and W (withdraw) will be followed in this course. See SCHEDULE OF CLASSES.

**Diversity & Inclusion**

The University of Nebraska-Lincoln does not discriminate on the basis of race, ethnicity, color, national origin, sex (including pregnancy), religion, age, disability, sexual orientation, gender identity, genetic information, veteran status, marital status, and/or political affiliation.

**Trespass Policy (Regents' Policy 6.4.7)**

The areas of University academic, research, public service, and administrative buildings of the University used for classrooms, laboratories, faculty and staff offices, and the areas of University student residence buildings used for student living quarters are not open to the general public. Any person not authorized to be or remain in any such building area will be deemed to be trespassing on University property and may be cited and subject to prosecution for criminal trespass in violation of Neb. Rev. Stat., § 28-520 or § 28-521.

**Emergency Preparedness:****Fire, Internal Hazardous Materials Release**

- Always evacuate if the fire alarm sounds.
- In the event of an evacuation, gather your personal belongings quickly (purse, keys, cell phone, NCard, etc.) and proceed to the nearest exit.
- Do not use the elevator.
- Move away from the problem, use alternative exits.
- Help those who need assistance moving.
- Be ready to be guided by additional instructions.

**Tornado Warning:** When sirens activate, move to the lowest, interior area of a building or designated tornado shelter.

- Stay away from windows.
- Stay near inside wall when possible.
- Keep calm. Even though a warning is issued, the chance of a tornado striking your building or location is slight.

**Hostile Intruder:**

- Remain calm.
- If it is possible to flee the area safely and avoid danger, do so.
- Notify anyone you encounter to exit the building immediately. Evacuate to a safe area away from the danger and take protective cover. Stay there until help arrives.
- Call UNL Police Department or 9-1-1 with your location if possible. If you cannot get through by phone and have text message capability, text University Police at 41513. Enter the letters **UNLPD** and then type your message. Dispatch will receive and respond to the message.
- If flight is impossible, secure yourself in your space. Barricade doors and block windows. Turn off all the lights, close blinds and close and lock all windows and lock and barricade all doors.
- Seek protective cover for yourself and any others (concrete walls, thick desks, filing cabinets may protect you from bullets).
- Keep calm, quiet and out of sight.
- Silence cell phones (mute or turn off cell phone ringer). Consider turning off radios and computer monitors.
- Do not answer the door. If you do not recognize the voice that is giving instructions, do not change your status (stay put). Unknown or unfamiliar voices may be false and designed to give false assurances.
- Place signs in exterior windows to identify the location of injured persons.
- **Do Not Approach Emergency Responders**—let them come to you.
- Remain where you are until an "all clear" instruction is given by an authorized known voice.

**Evacuate:** if there is a safe escape path, leave belongings behind, keep hands visible and follow police officer instructions.

**Hide out:** If evacuation is impossible secure yourself in your space by turning out lights, closing blinds and barricading doors if possible.

**Take action:** As a last resort, and only when your life is in imminent danger, attempt to disrupt and/or incapacitate the active shooter.

**UNL Alert:** Notifications about serious incidents on campus are sent via text message, email, unl.edu website, and social media. For more information go to: <http://unlalert.unl.edu>.

**Additional Emergency Procedures** can be found here:  
[http://emergency.unl.edu/doc/Emergency\\_Procedures\\_Quicklist.pdf](http://emergency.unl.edu/doc/Emergency_Procedures_Quicklist.pdf)

**Tentative Course Schedule:**

For in class instruction, the following tentative lecture schedule will be followed. If online, Video lectures will be made available through Canvas on the dates shown below.

Period	Date	Topics	Due
1	T 24 Aug	Introduction, Review of Bio-Materials, and Statics	

2	TH	26 Aug	Material Properties and Uniaxial Stress Concepts	
3	T	31 Aug	Statically Indeterminate Structures	HW #1
4	TH	2 Sep Aug	Thermal Effects	
5	T	7 Sep	Stress in Multiple Directions	HW #2
6	TH	9 Sep	(Continued) & Strain Analysis	
7	T	14 Sep	Flexural Stress Development	HW #3
8	TH	16 Sep	Flexural Stress Analysis and 2 plane bending	
9	T	21 Sep	Transverse Shear Stress & Torsion	HW#4
10	TH	23 Sep	Test #1 Review Session	
11	T	28 Sep	<b>Test #1 (in class)</b>	<b>Test #1 TH</b>
12	TH	30 Sep	Combined Loading & Stress Concentrations	
13	T	5 Oct	Pressure Vessels. Press and Shrink Fits	HW#5
14	TH	7 Oct	Contact Stress	
15	T	12 Oct	Deflection by Integration	HW #6
16	TH	14 Oct	Deflection by Superposition	
17	T	19 Oct	Fall Break (no class)	
18	TH	21 Oct	Strain Energy and Castigliano's Theorem	HW #7
19	T	26 Oct	Column Buckling	
20	TH	28 Oct	Test # 2 Review	HW # 8
21	T	2 Nov	Static Failure Theory - Ductile Materials	
22	TH	4 Nov	<b>Test # 2 (in class)</b>	<b>Test #2 TH</b>
23	T	9 Nov	Static Failure Theory- BCM and Brittle Materials	
24	TH	11 Nov	Introduction to Fatigue, Stress Life Method for rotating beams	HW#9
25	T	16 Nov	Modifications for any conditions for fully reversing stresses	
26	TH	18 Nov	Non-Fully Reversing Stress	HW #10
27	T	23 Nov	Combination of Loading Modes	
28	TH	25 Nov	Thanksgiving (no class)	
29	T	30 Nov	Combination of Loading Modes	HW # 11
30	TH	2 Dec	Product Safety	
31	T	7 Dec	GD&T	
32	TH	9 Dec	GD&T	
33	TH	16 Dec	<b>Test # 3 (During Assigned Final Time)</b>	<b>Test #3 TH</b>

**Prepared By:**

Roger Hoy, Biological Systems Engineering Department, Jul 1, 2021