Review for Midterm Exam #2

Zhao Section

2026.3.25

- Students must exhibit highest standard of honor. Any misconduct of academic integrity will be addressed.
- The exam is closed-book and closed-notes. There will be three full-length problems and one multiple-choice problem with multiple parts.
- Equation Sheet is posted on course blog and will be handed out in the exam.
- Calculator: please bring the allowed type of calculator as described in syllabus: TI-30X and TI-36X models, fx-115 and fx-991 models.
- **Exam Date & Time: March 26, 2026. Time: 8:00 – 10:00 PM**
- Exam will cover Lectures 13-25 and HW5-7.
- **Exam Room: WTHR200/BRNG1278.**
- Please arrive to exam room at least 15 minutes prior to the start of exam.
- Exam Submission Window (30 Minutes): When you complete your exam, you may use your phone to scan your solution and upload to Gradescope. Specifically, your solutions will be scanned and submitted to Gradescope "ME 323 – S26 – Exam 2". To accommodate the time needed to do this, the deadline to have your exam scanned and uploaded to Gradescope will be 10:20PM (EST), giving 20 minutes to complete this process. The time limit will be strictly enforced.
- Assigning Pages for Your Exam: As part of the submission process, you will need to identify the page numbers for Problem 1, 2, ... separately. If you need extra papers, please use your own but make sure to arrange the pages in the correct order in your submission. Do not submit the equation sheet.

Coverage:

13 W	11-Feb	Beam stresses – equilibrium and flexural stresses	Chap. 10	
14 F	13-Feb	Beam stresses – flexural and shear stresses	Chap. 10	HW. 4
15 M	16-Feb	Review		
W	18-Feb	***Examination 1, 8-10pm: no lecture on Wednesday***		
16 F	20-Feb	Beam stresses – shear stresses	Chap. 10	
17 M	23-Feb	Shear force/bending moment diagrams – determinate structures	Chap. 9	
18 W	25-Feb	Beams deflections– statically determinate structures	Chap. 11	
19 F	27-Feb	Beam deflections - indeterminate structures	Chap. 11	HW 5
20 M	2-Mar	Beam deflections – superposition methods	Chap. 11	
21 W	4-Mar	Energy methods – Castigliano's theorems	Chap. 16	
22 F	6-Mar	Energy methods – Castigliano's theorems	Chap. 16	HW. 6
23 M	9-Mar	Energy methods – Castigliano's theorems	Chap. 16	
24 W	11-Mar	Energy methods – Castigliano's theorems	Chap. 16	
25 F	13-Mar	Shear force/bending moment diagrams – indeterminate structures	Chap. 9	HW 7

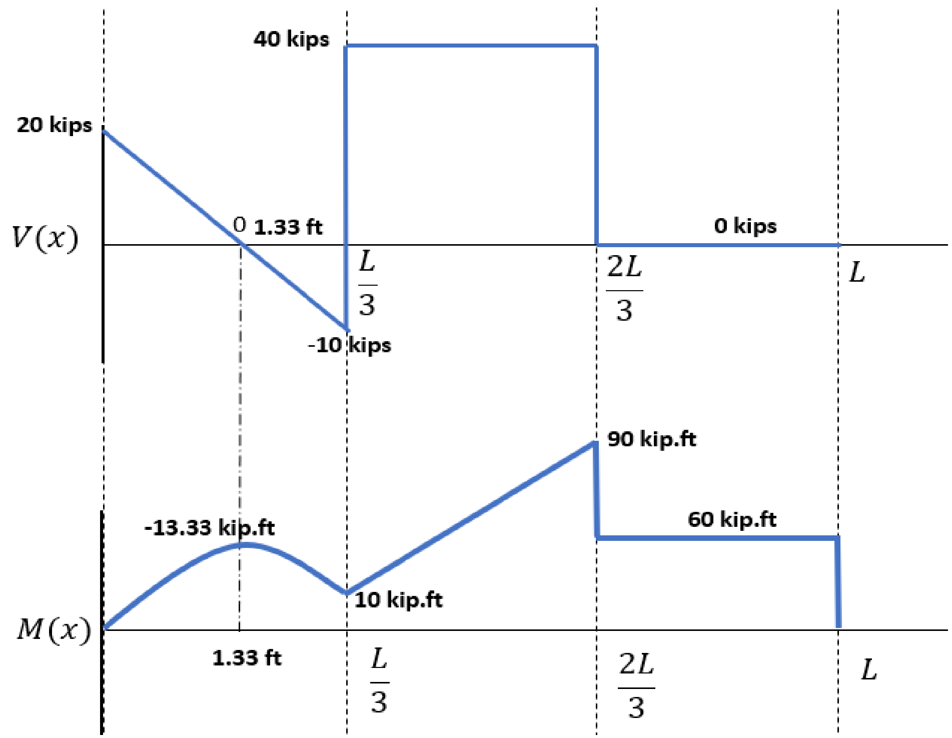
Equilibrium of beams

$$\frac{dV}{dx} = p(x) \quad \Rightarrow \quad V(x) = V(x_0) + \int_{x_0}^{x} p(x)\,dx$$

$$\frac{dM}{dx} = V(x) \quad \Rightarrow \quad M(x) = M(x_0) + \int_{x_0}^{x} V(x)\,dx$$

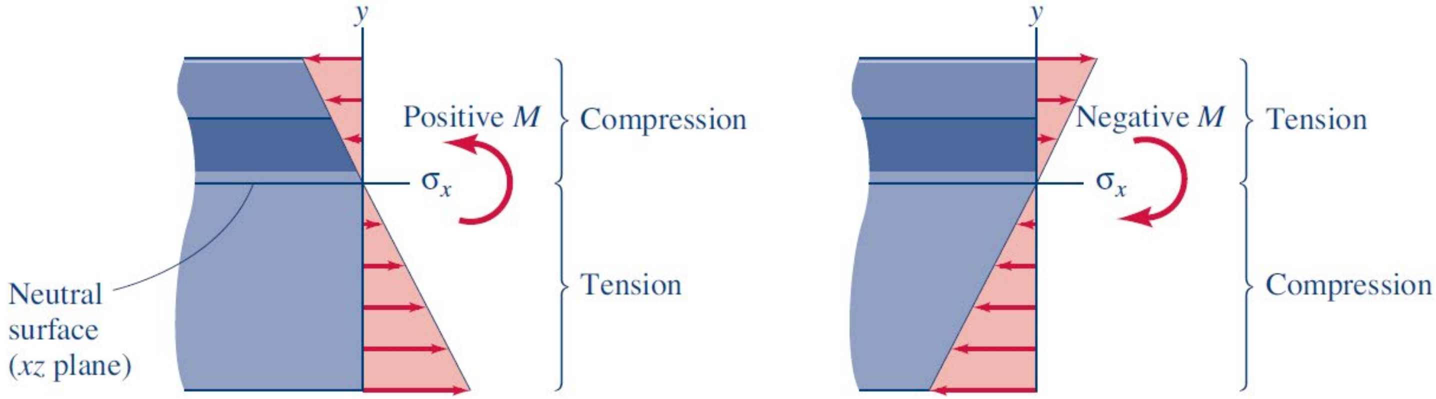
$$V\left(x^+\right) = V\left(x^-\right) + P_0$$

$$M\left(x^+\right) = M\left(x^-\right) - M_0$$



Stress in beams

Flexural stress $\sigma_x = -\frac{My}{I}$ $I = \frac{bh^3}{12}$ (rectangle) $I = \frac{\pi r^4}{4}$ (circle)

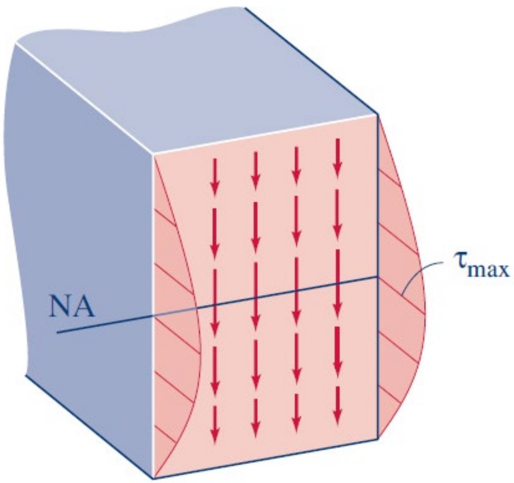


Shear stress

$$\tau(x, y) = \frac{V(x)Q(y)}{It} \qquad Q = A'\overline{y}'$$

$$\tau_{max} = \frac{3}{2}\frac{V}{A} \quad ; \textit{ rectangle}$$

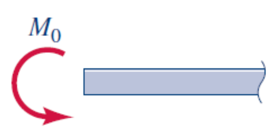
$$\tau_{max} = \frac{4}{3}\frac{V}{A} \quad ; \textit{ circle}$$



Deflection of beams

2nd order integration method: $EIv'' = M(x)$

TABLE 7.1 Boundary Conditions

	Type	Symbol*	2nd Order
BC	Fixed end		$v = 0$ $v' = 0$
	Simple support		$v = 0$
	Free end		No BC
	Concentrated force		No BC
	Concentrated couple		No BC

*These boundary conditions also apply if the boundary under c
the other end of the beam (i.e., $x = L$).

- Superposition method

Energy method

Axial energy $U = \frac{1}{2}\int_0^L \frac{F^2 dx}{EA}$

Torsional energy $U = \frac{1}{2}\int_0^L \frac{T^2 dx}{GI_p}$

Flexural energy $U_\sigma = \frac{1}{2}\int_0^L \frac{M^2 dx}{EI}$

Shear energy $U_\tau = \frac{1}{2}\int_0^L \frac{f_s V^2 dx}{GA}$

Castigliano's 2nd theorem

$$\delta_{P_i} = \frac{\partial U}{\partial P_i} \qquad \theta_{M_i} = \frac{\partial U}{\partial M_i} \qquad \phi_{T_i} = \frac{\partial U}{\partial T_i}$$

- Dummy load
- Indeterminate structures