Arch 314
Structures I

Fall 2025 Recitation 004

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TAUBMAN COLLEGE

Recitation 004

Welcome to session 9!

- Final Report
- Quick Recap of this week's lecture
- Homework Review (#12 Shear and Moment Diagrams)
- Lab: Moment Diagrams

Feel free to ask questions anytime

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Bridge

Due Dates:

- ~~Preliminary Report - 10.10~~
- ~~Bridge Testing - 11.03~~
- **Final Report* - 11.25**
  (right before Thanksgiving break)

*Make sure to refer to the **scoring rubric and final report guidelines** on Structures website to see what you need to include + how GSI's will grade your paper!

FINAL REPORT REQUIREMENTS	150	
Preliminary Design Development	**20**	
How initial (preliminary) bridge design was developed	4	
How initial (preliminary) member sizes were chosen	4	
Why bridge design was or was not adjusted from preliminary design	4	
Why member sizes were or were not adjusted from preliminary design	4	
Discussion of how pre-analysis of initial bridge impacted the final design	4	
Revised Bridge Design Analysis	**50**	
Internal axial force calculations/modeling (with proper design loading indicated) (Dr. Frame acceptable)	10	
Derivation of member cross-sectional areas from axial forces	10	
Member size selection from available stock	4	
Est. weight calculation of bridge - including members, glue & fasteners	6	
Method of joints/sections calculation for at least 1 joint (@ reaction is usually easiest based on truss geometry, but could be done elsewhere)	10	
Member crushing calculations/check (show work) using $F'_c=P/A$	4	
Prediction of capacity of bridge and mode of failure	6	
Illustration of Tested (Revised from Preliminary) Design	**20**	
Cross-section of bridge	4	
Elevation(s) of bridge	4	
Dimensions and units labeled in elevation and cross-section	4	
Member sizes labeled (with dimensions)	4	
Member stresses labeled (with units)	4	
Testing Results	**30**	
Weight and height of bridge	5	
Capacity of bridge	5	
Observations of testing	6	
Description of mode of failure	5	
Images of failure	5	
Following the guidelines	4	
Post-Testing Analysis	**30**	
Comparison of testing with predicted capacity and modes of failure	10	
Discussion of discrepancies between results	10	
Suggested improvements for future designs with reasoning discussed	10	
FINAL GRADE	**250**	

Up to 20 pts may be withheld for a lack of clarity or professional quality. **8.5"x11" PAPER ONLY!**

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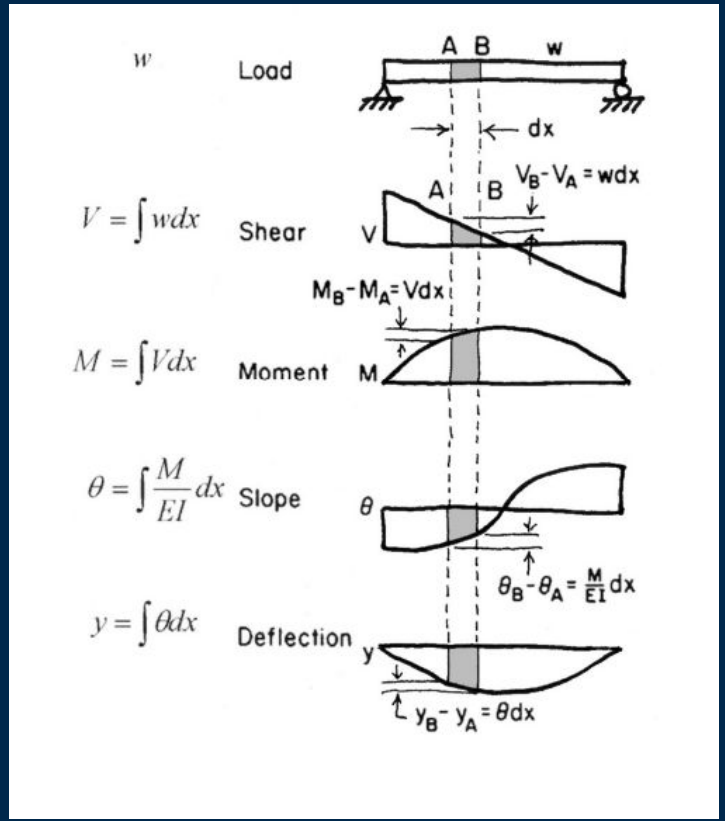
Lecture: Shear and Bending - Pt 1 (11/10)



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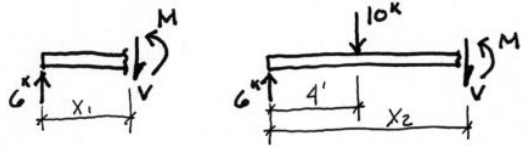
Lecture: Shear and Bending - Pt 1 + Pt 2 (11/10 + 11/12)

Methods to Determine Values of Shear and Moment

1. Equilibrium Method
   - Select a point along the beam
   - Cut a section and draw the FBD
   - Solve for the internal shear and moment forces at the section
2. Integration of Equations
   - Write the equation of the load function
   - Integrate load equation to get shear equation
   - Solve integration constant (use end reaction)
   - Integrate shear equation to get moment equation
   - Solve integration constant (use point with zero moment, e.g. end point)
3. Semi-graphical Method
   - Draw load diagram and solve end reactions with equilibrium equations.
   - Start at left and construct the shear diagram using point loads and areas on load diagram
   - Calculate areas of shear diagram to find change in value on moment diagram
   - Find points of zero moment to begin moment diagram, e.g. end points
4. Superposition of Equations
   - Break the loading into standard cases
   - Use given equations to solve shear and moment for each case
   - Add the cases to get combined values of original loading

1. Equilibrium Method - example



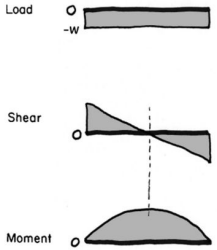
2. Shear and Moment by Integration - example

One method of solving shear and moment forces is to write the loading equation and solve the integration equations for the shear and moment. One problem using this method can be finding the constant of integration, particularly with discontinuous load functions.

$$-w$$

$$V = \int w dx$$
$$V = -wx + C$$
$$V = -wx + \frac{wl}{2}$$

$$M = \int V dx$$
$$M = -\frac{w}{2}x^2 + \frac{wl}{2}x + C$$
$$M = -\frac{w}{2}x^2 + \frac{wl}{2}x$$



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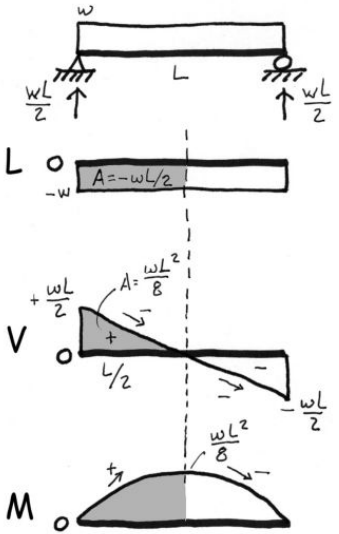
Lecture: Shear and Bending - Pt 1 + Pt 2 (11/10 + 11/12)

3. Shear and Moment by Semi-graphical Method – diagram relationships

By recognizing the diagrammatic relationships between curves and their derivatives and integrals, shear and moment diagrams can be constructed based on areas and slopes of those curves.

Moving from Upper to Lower Diagrams:

- The area between any two points on the upper diagram is equal to the change in value between same points on the lower diagram.
- The degree of the curve increases by one for each diagram.
- The value on the upper diagram is equal to the slope of the lower diagram.
- Where the upper diagram crosses the 0 axis, the lower diagram is at a maximum or minimum.
- Points of inflection or “contraflexure” (between + and – curvature) on the elastic curve (deflected shape) are points of zero moment.



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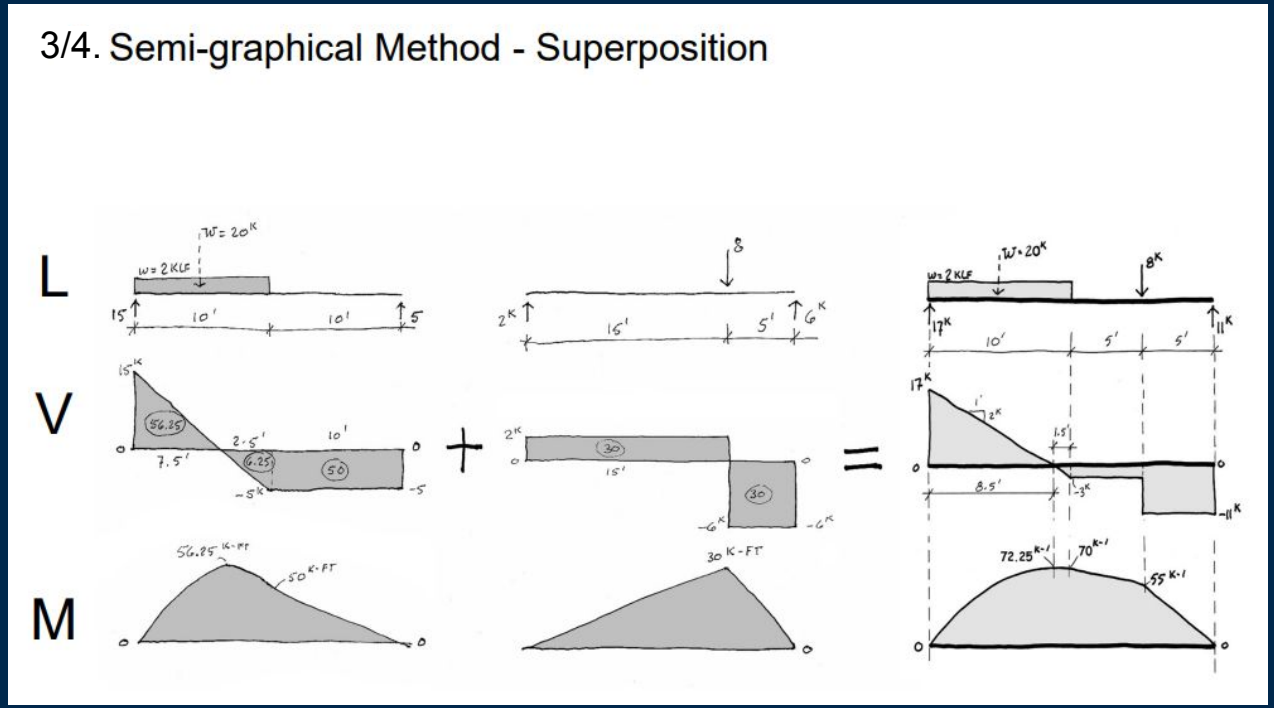

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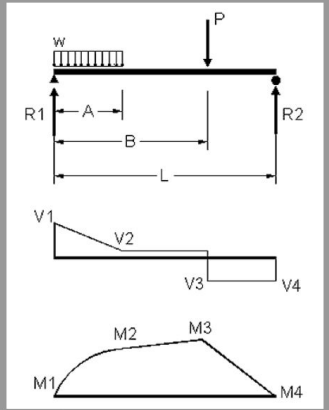
HW #12: Shear and Moment Diagrams

12. Shear and Moment Diagrams

Calculate end reactions and construct the shear & moment diagrams for the loading shown.



DATASET: 1 -2- -3-

Total Span L	32 FT
Length A	14 FT
Length B	21 FT
Uniform Load on Length A (w)	270 PLF
Point Load (P)	1350 LBS

Your answer was correct.
You scored 5 points.

#	Question	Your Response	Correct Answer	Score
1	Left Reaction (R1) (+ is upward; - is downward)	3417.19 LBS	3417.19 LBS	5
2	Right Reaction (R2) (+ is upward; - is downward)	1712.81 LBS	1712.81 LBS	5
3	Peak Shear value at R1 (V1) (use + or - sign)	3417.19 LBS	3417.19 LBS	5
4	Moment value at R1 (M1)	0 FT-LBS	0 FT-LBS	5
5	Shear value at A distance from R1 (V2) (use + or - sign)	-362.81 LBS	-362.812 LBS	5
6	Moment value at A dist. from R1 (M2 tension on bottom is +)	21380.7 FT-LBS	21380.6 FT-LBS	5
7	Peak Shear value at B distance from R1 (V3) (use + or - sign)	-1712.81 LBS	-1712.81 LBS	5
8	Moment value at B dist. from R1 (M3 tension on bottom is +)	18841.1 FT-LBS	18840.9 FT-LBS	5
9	Peak Shear value at R2 (V4) (use + or - sign)	-1712 LBS	-1712.81 LBS	5
10	Moment value at R2 (M4)	0 FT-LBS	0 FT-LBS	5
11	Maximum Moment (tension on bottom is +)	21624.5 FT-LBS	21624.4 FT-LBS	5
12	Distance from Left to Max. Moment in (decimal)	12.65 FT	12.66 FT	5

Current Score: 60 / 60

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HW #12: Shear and Moment Diagrams

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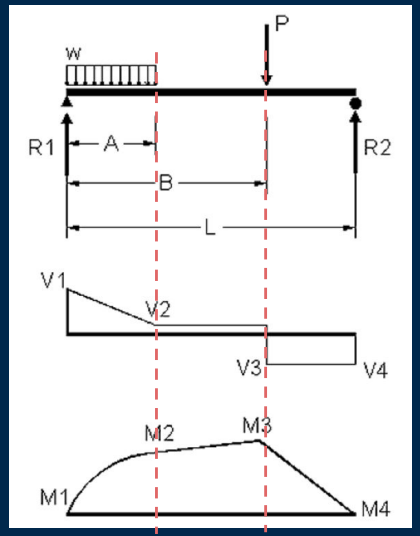

1-2. End reactions (R1 and R2)

$W = w \times A$

$= 270(14')$

$W = 3{,}780$ LBS

$\Sigma M_{R1} = 0 = W\left(\frac{A}{2}\right) + P(B) - R_2(L)$

$= 3{,}780\left(\frac{14}{2}\right) + 1350(21) - R_2(32)$

$32R_2 = 54{,}810$

$R_2 = 1712.81$ LBS ← Answer to #2

$\Sigma M_V = 0 = R_1 + R_2 - W - P$

$= R_1 + 1712.81 - 3{,}780 - 1350$

$R_1 = 3{,}417.19$ LBS ← Answer to #1

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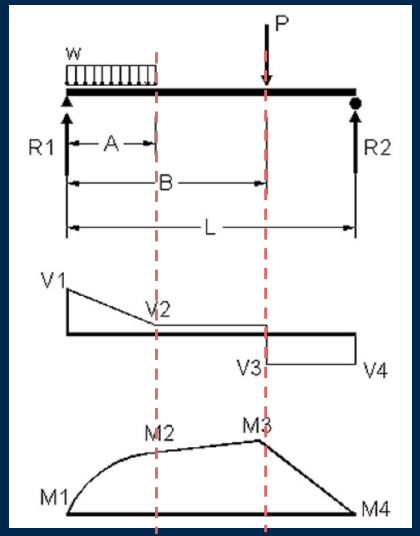

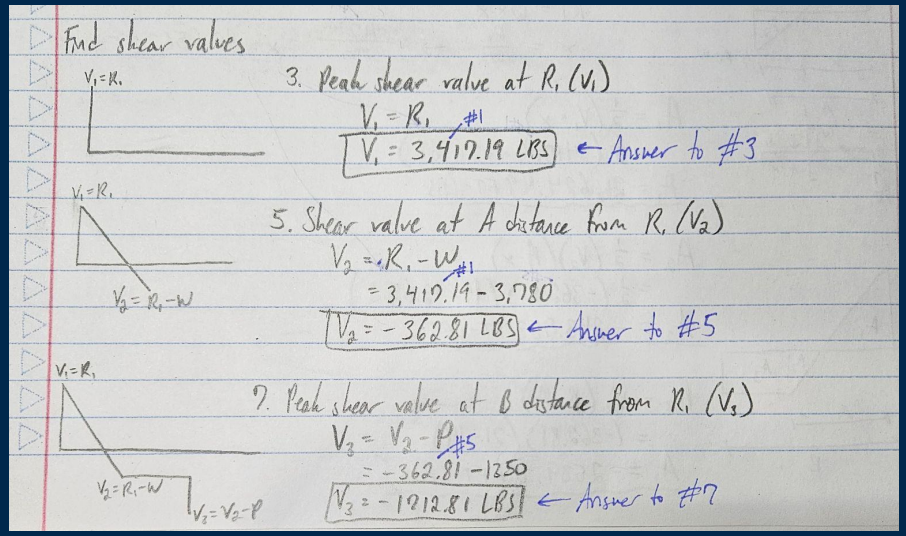

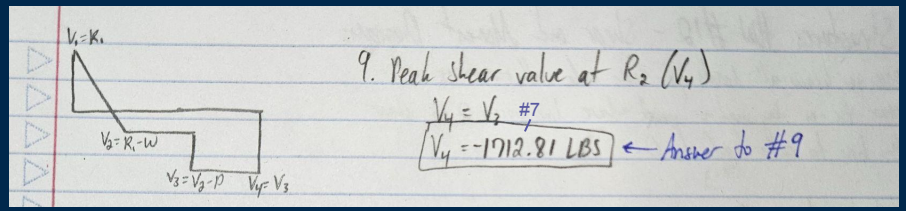

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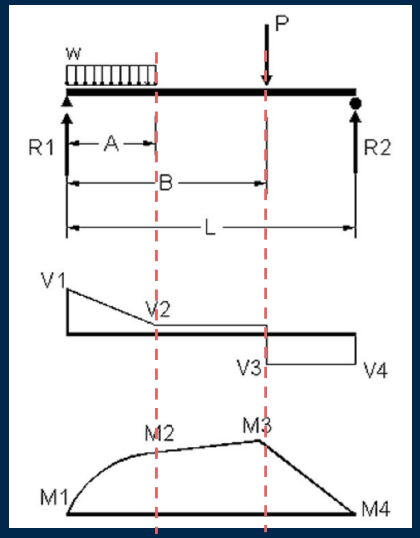

Find moment values

* Moments at end reactions = 0 ($\Sigma M = 0$)

4. Moment value at R_1 (M_1)

$M_1 = 0$ FT-LBS ← Answer to #4

10. Moment value at R_2 (M_4)

$M_4 = 0$ FT-LBS ← Answer to #10

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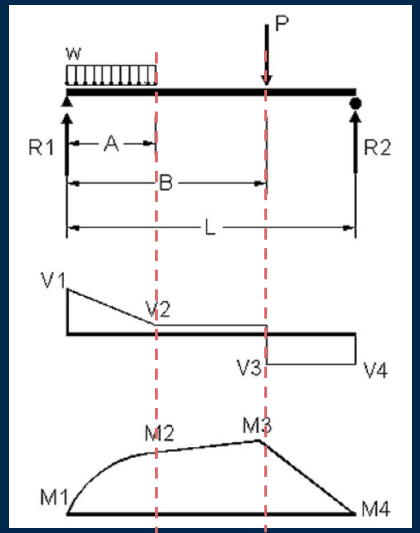

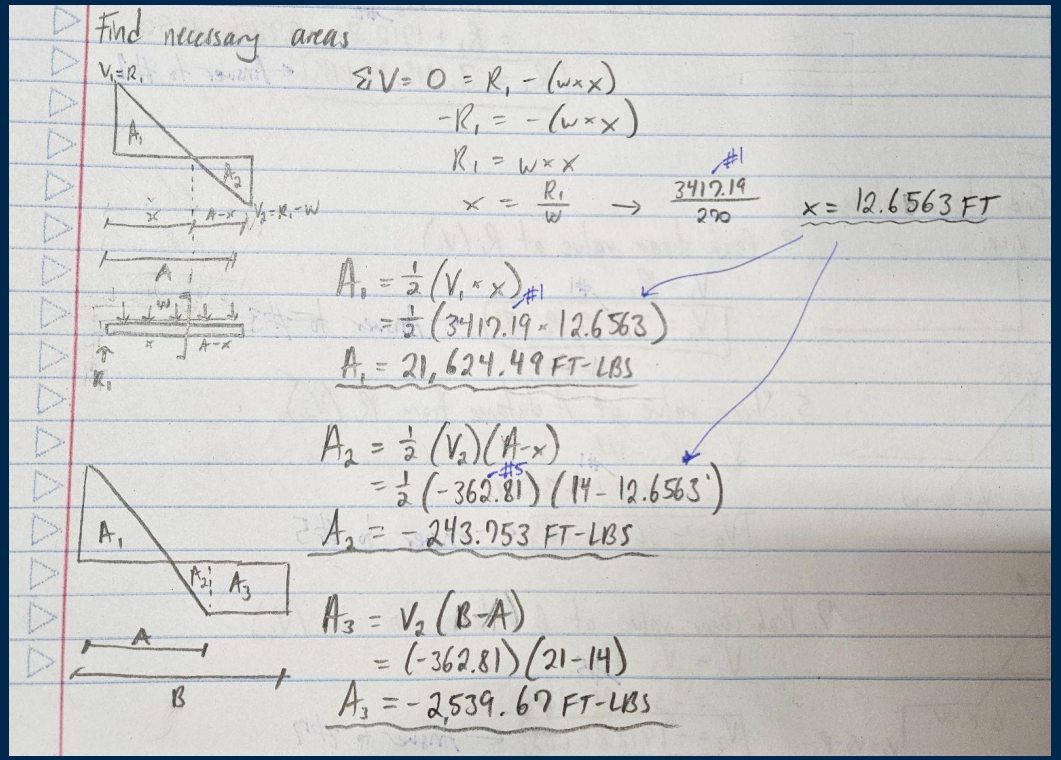

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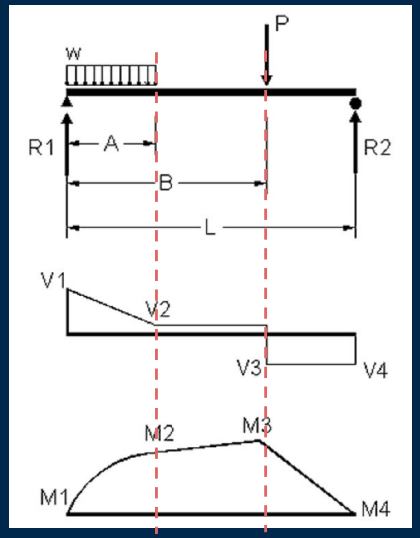

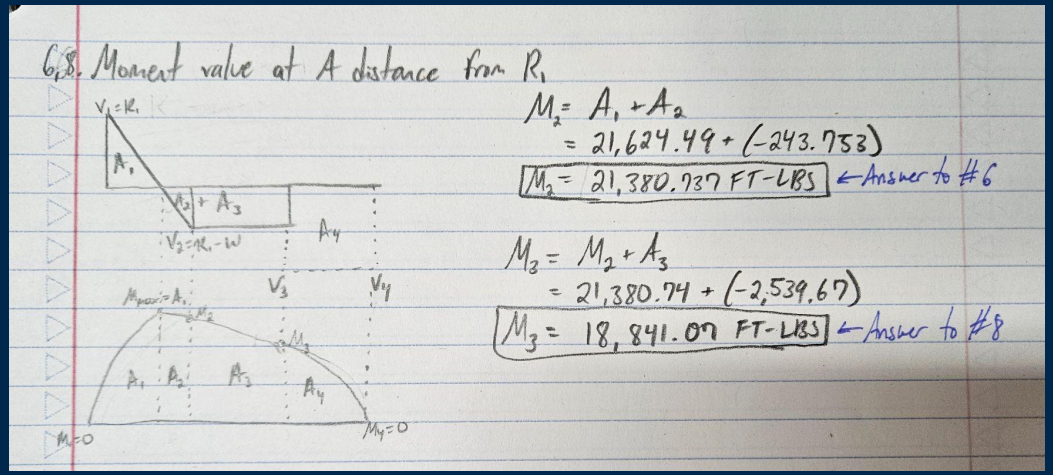

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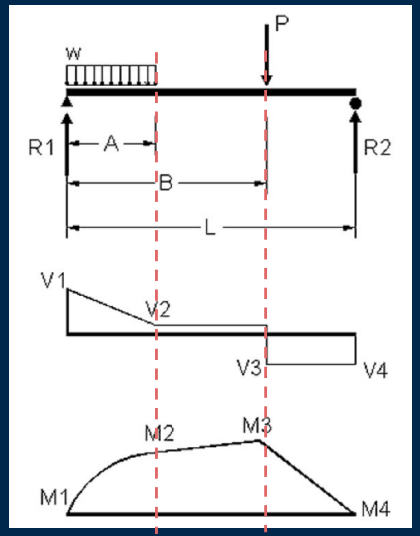


11. Maximum Moment

$M_{max} = A_1$

* point at which shear diagram intersects *

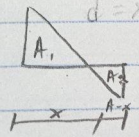
$M_{max} = 21,624.49$ FT-LBS ← Answer to #11

12. Distance from left to Max Moment

$d = x$

$d = x$

$x = 12.6563$ FT ← Answer to #12



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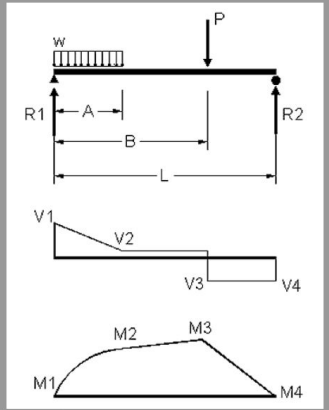

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LAB!

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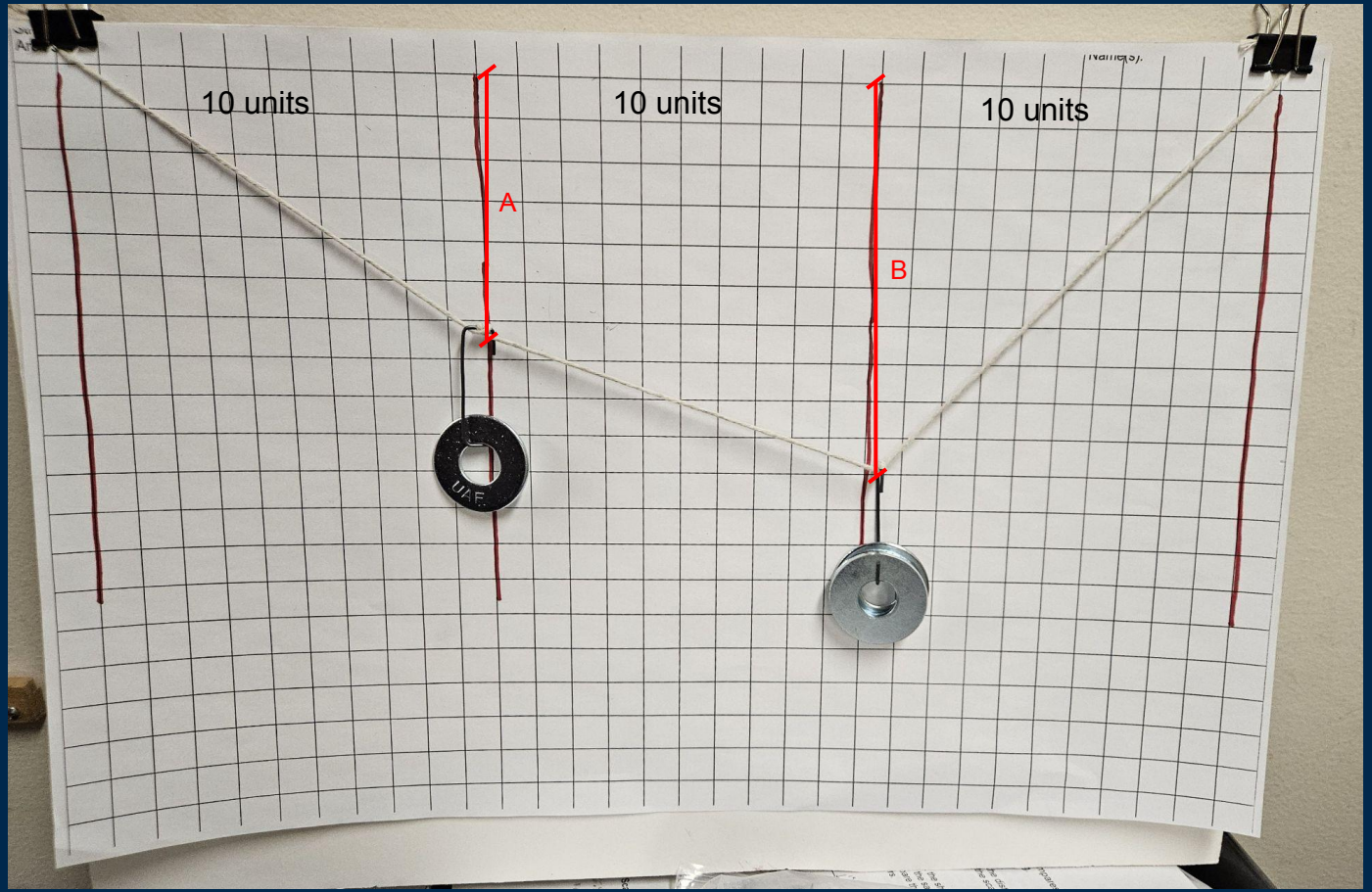

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