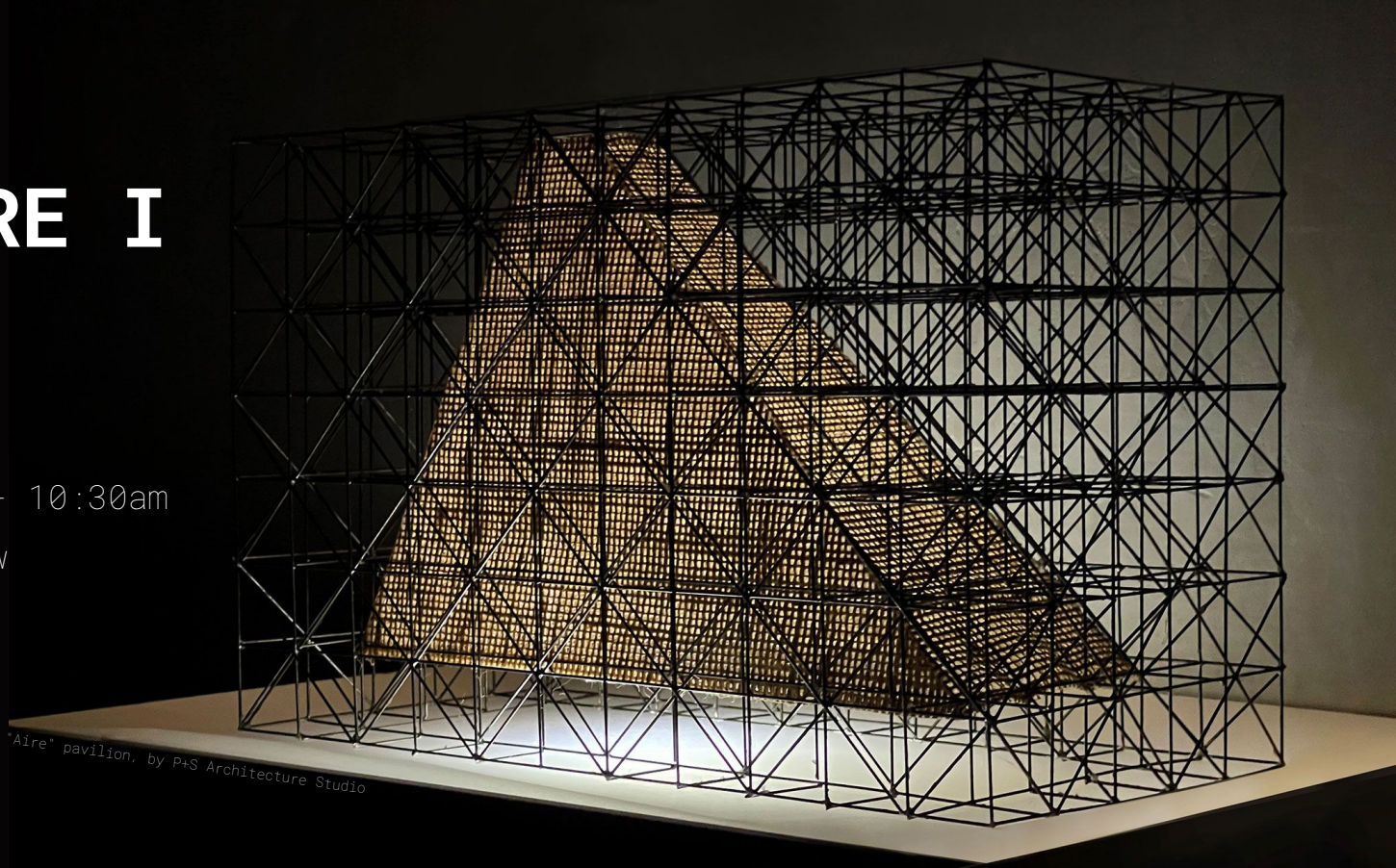
STRUCTURE I

ARCH-314

Friday(s): 9:30am - 10:30am

West Review



"Aire" pavilion, by P+S Architecture Studio

Today:

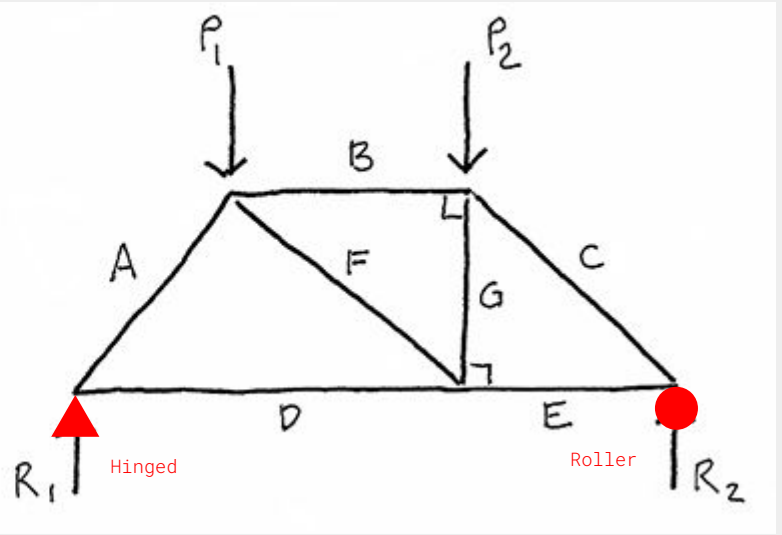
- Problem set No.7
- Preliminary Report Q&A

PROBLEM NO.7

Find the internal forces in members: A, B, C, D, E, F and G.

DATASET: 1 -2- -3-

Length B	12 FT
Length D	16 FT
Length E	10 FT
Length G	9 FT
Load P1	400 LBS
Load P2	250 LBS



PROBLEM NO.7

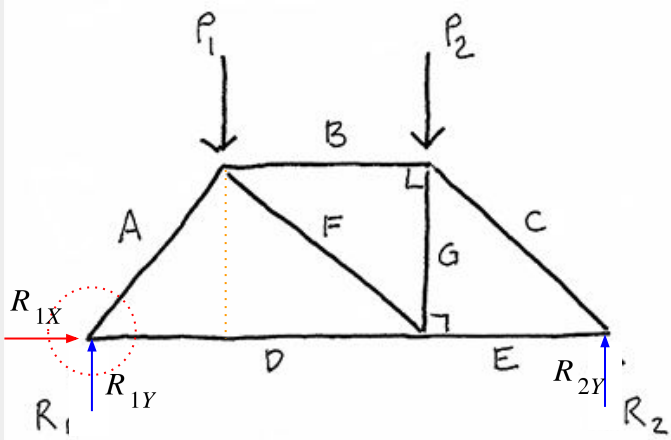
Question 2: **End reaction R2 (positive is upward)**

$$\sum_{M_{R1}} = 0$$

$$P_1 \times (D - B) + P_2 \times D - R_{2Y} \times (E + D) = 0$$

$$400 \times (16 - 22) + 250 \times 16 - R_{2Y} \times (10 + 16) = 0$$

$$R_{2Y} = 215.38 \; lbs$$



Find the internal forces in members: A, B, C, D, E, F and G.

DATASET: 1 -2- -3-

Length B	12 FT
Length D	16 FT
Length E	10 FT
Length G	9 FT
Load P1	400 LBS
Load P2	250 LBS

PROBLEM NO.7

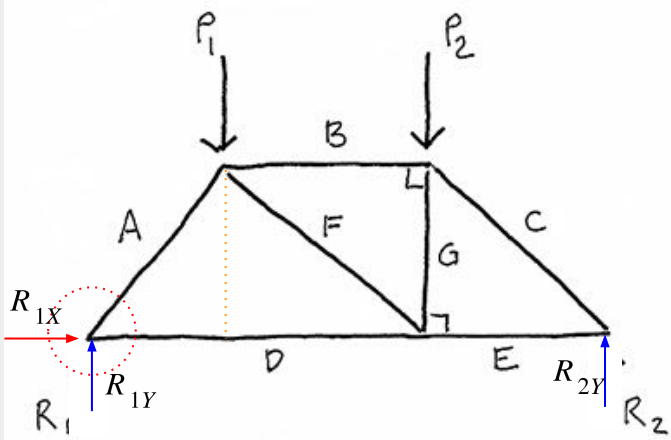
Question 1: **End reaction R1 (positive is upward)**

$$\sum_{F_Y} = 0$$

$$R_{1Y} - P_1 - P_2 + R_{2Y} = 0$$

$$R_{1Y} - 400 - 250 - 9 + 215.38 = 0$$

$$R_{1Y} = 434.61\ LBS$$



Find the internal forces in members: A, B, C, D, E, F and G.

DATASET: 1 -2- -3-

Length B	12 FT
Length D	16 FT
Length E	10 FT
Length G	9 FT
Load P1	400 LBS
Load P2	250 LBS

PROBLEM NO.7

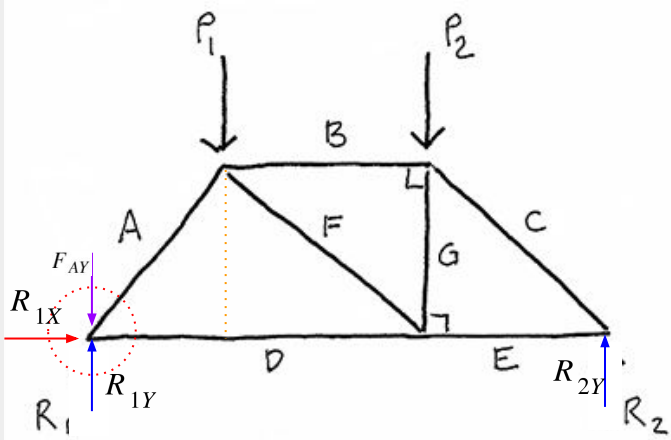
Question 4: **Vertical component of force in member A (absolute value)**

$$\sum F_Y = 0$$

$$-F_{AY} + R_{1Y} = 0$$

$$F_{AY} = R_{1Y}$$

$$F_{AY} = 434.61\ LBS$$



Find the internal forces in members: A, B, C, D, E, F and G.

DATASET: 1 -2- -3-

Length B	12 FT
Length D	16 FT
Length E	10 FT
Length G	9 FT
Load P1	400 LBS
Load P2	250 LBS

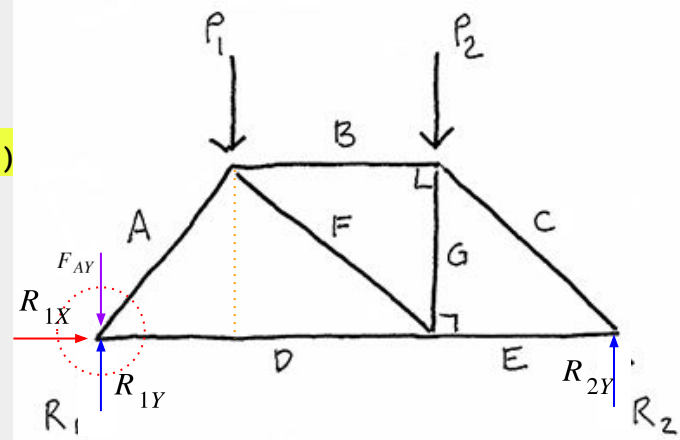
PROBLEM NO.7

Question 3: **Horizontal component of force in member A (absolute value)**

$$\tan\theta = \frac{F_{AY}}{F_{AX}} = \frac{G}{D-B}$$

$$\frac{434.61}{F_{AX}} = \frac{9}{4}$$

$$F_{AX} = 193.16$$



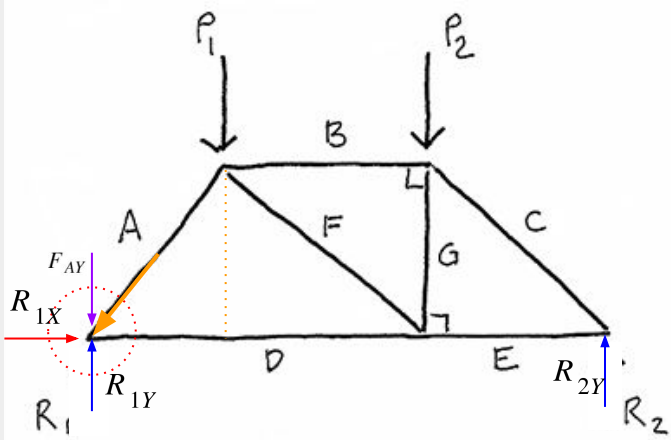
Find the internal forces in members: A, B, C, D, E, F and G.

DATASET: 1 -2- -3-

Length B	12 FT
Length D	16 FT
Length E	10 FT
Length G	9 FT
Load P1	400 LBS
Load P2	250 LBS

PROBLEM NO.7

Question 5: **Total axial force in member A (absolute value)**



Find the internal forces in members: A, B, C, D, E, F and G.

DATASET: 1 -2- -3-

Length B	12 FT
Length D	16 FT
Length E	10 FT
Length G	9 FT
Load P1	400 LBS
Load P2	250 LBS

$$F_A = \sqrt{F^2_{AX} + F^2_{AY}} = \sqrt{(193.16)^2 + (434.61)^2}$$

$$F_A = 475.6\ lbs$$

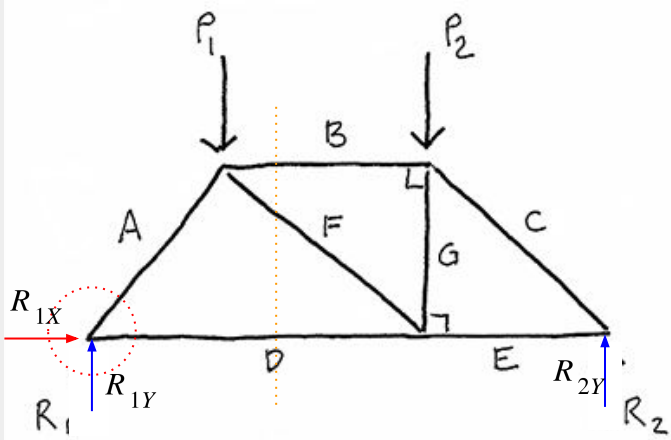
COMPRESSION

PROBLEM NO.7

Question 6: **Sign for member A (1 for tension or -1 for compression)**

$$F_A = 475.6\ lbs$$

COMPRESSION = -1



Find the internal forces in members: A, B, C, D, E, F and G.

DATASET: 1 -2- -3-

Length B	12 FT
Length D	16 FT
Length E	10 FT
Length G	9 FT
Load P1	400 LBS
Load P2	250 LBS

PROBLEM NO.7

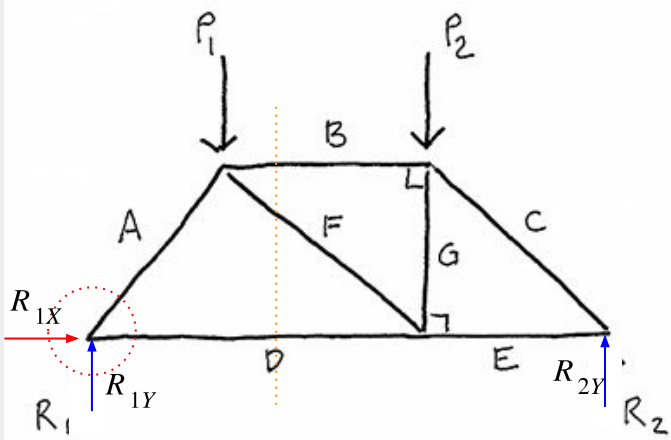
Question 7: **Total axial force in member B (absolute value)**

$$\sum M_J = 0$$

$$R_{1Y} \times D - P_2 \times B - F_B \times G = 0$$

$$434.61 \times 16 - 400 \times 12 - F_B \times 9 = 0$$

$$F_B = 239.3 \; lbs$$



Find the internal forces in members: A, B, C, D, E, F and G.

DATASET: 1 -2- -3-

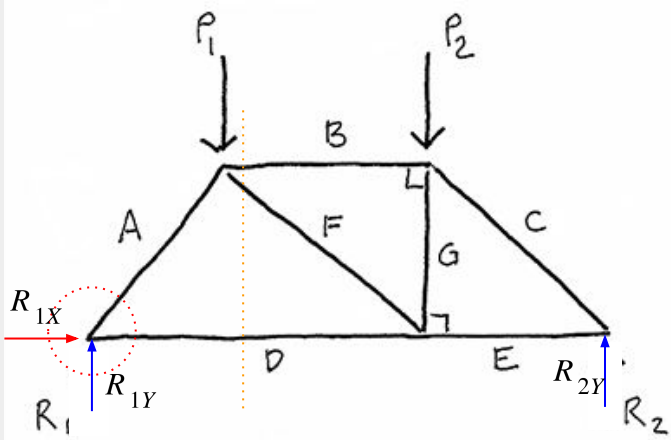
Length B	12 FT
Length D	16 FT
Length E	10 FT
Length G	9 FT
Load P1	400 LBS
Load P2	250 LBS

PROBLEM NO.7

Question 8: **Sign for member B (1 for tension or -1 for compression)**

$$F_B = 239.3\ lbs$$

COMPRESSION = -1



Find the internal forces in members: A, B, C, D, E, F and G.

DATASET: 1 -2- -3-

Length B	12 FT
Length D	16 FT
Length E	10 FT
Length G	9 FT
Load P1	400 LBS
Load P2	250 LBS

PROBLEM NO.6

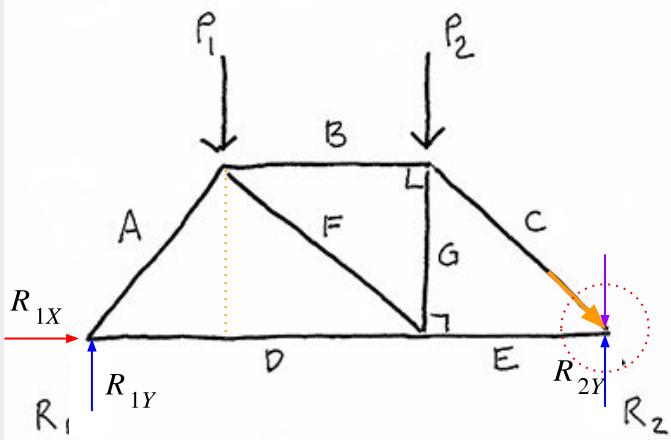
Question 10: **Vertical component of force in member C (absolute value)**

$$\sum_{F_Y} = 0$$

$$-F_{CY} + R_{2Y} = 0$$

$$F_{CY} = R_{2Y}$$

$$\boxed{F_{CY} = 215.38\ LBS}$$



Find the internal forces in members: A, B, C, D, E, F and G.

DATASET: 1 -2- -3-

Length B	12 FT
Length D	16 FT
Length E	10 FT
Length G	9 FT
Load P1	400 LBS
Load P2	250 LBS

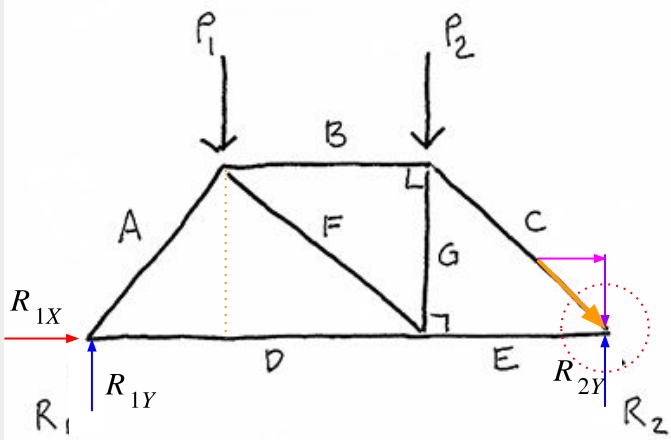
PROBLEM NO.7

Question 9: **Horizontal component of force in member C (absolute value)**

$$\tan\alpha = \frac{F_{CY}}{F_{CX}} = \frac{G}{E}$$

$$\frac{215.38}{F_{CX}} = \frac{9}{10}$$

$$F_{CX} = 239.31\ lbs$$



Find the internal forces in members: A, B, C, D, E, F and G.

DATASET: 1 -2- -3-

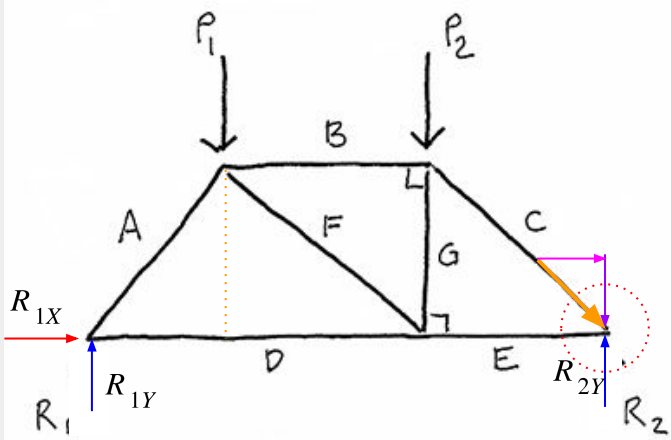
Length B	12 FT
Length D	16 FT
Length E	10 FT
Length G	9 FT
Load P1	400 LBS
Load P2	250 LBS

PROBLEM NO.7

Question 11: **Total axial force in member C (absolute value)**

$$F_C = \sqrt{F^2_{CX} + F^2_{CY}} = \sqrt{(239.31)^2 + (215.38)^2}$$

$$F_C = 321.96\ lbs$$



Find the internal forces in members: A, B, C, D, E, F and G.

DATASET: 1 -2- -3-

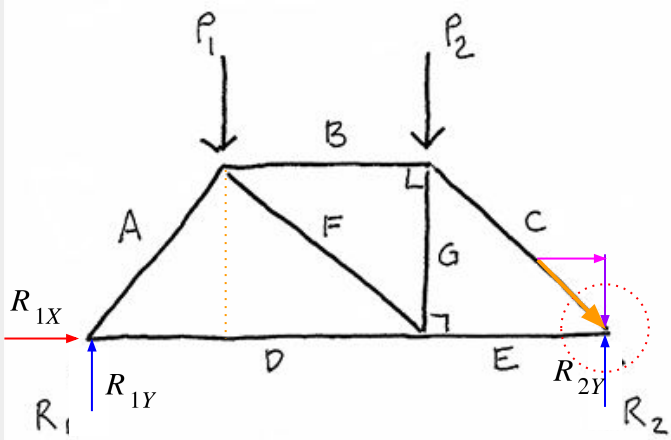
Length B	12 FT
Length D	16 FT
Length E	10 FT
Length G	9 FT
Load P1	400 LBS
Load P2	250 LBS

PROBLEM NO.7

Question 12: **Sign for member C (1 for tension or -1 for compression)**

$$F_C = 321.96\ lbs$$

COMPRESSION = -1



Find the internal forces in members: A, B, C, D, E, F and G.

DATASET: 1 -2- -3-

Length B	12 FT
Length D	16 FT
Length E	10 FT
Length G	9 FT
Load P1	400 LBS
Load P2	250 LBS

PROBLEM NO.7

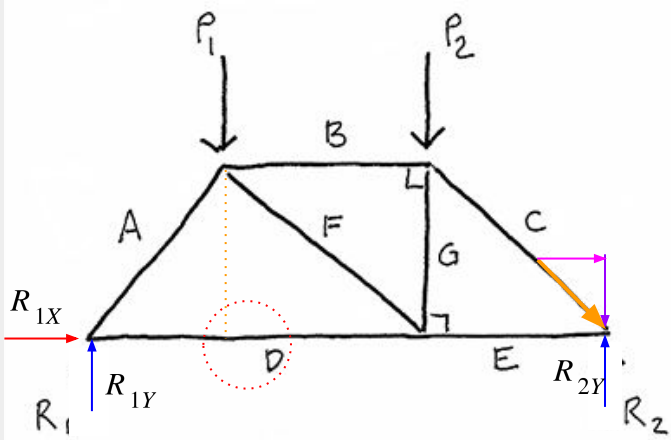
Question 13: **Total axial force in member D (absolute value)**

$$\sum F_X = 0$$

$$-F_{AX} + F_D = 0$$

$$F_{AX} = F_D$$

$$\boxed{F_D = 193.16\ LBS}$$



Find the internal forces in members: A, B, C, D, E, F and G.

DATASET: 1 -2- -3-

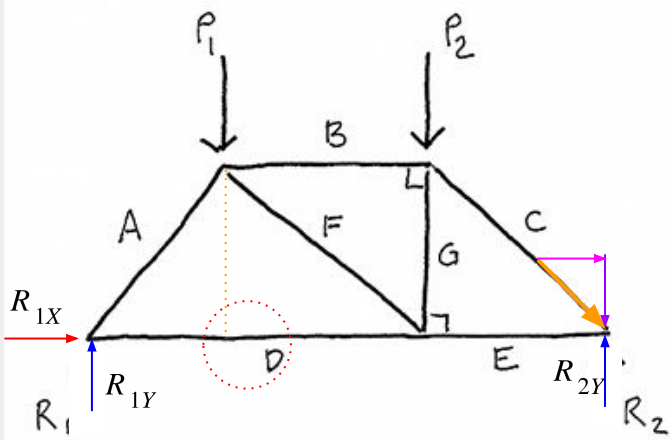
Length B	12 FT
Length D	16 FT
Length E	10 FT
Length G	9 FT
Load P1	400 LBS
Load P2	250 LBS

PROBLEM NO.7

Question 14: **Sign for member D (1 for tension or -1 for compression)**

$$F_D = 193.16\ LBS$$

TENSION = 1



Find the internal forces in members: A, B, C, D, E, F and G.

DATASET: 1 -2- -3-

Length B	12 FT
Length D	16 FT
Length E	10 FT
Length G	9 FT
Load P1	400 LBS
Load P2	250 LBS

PROBLEM NO.7

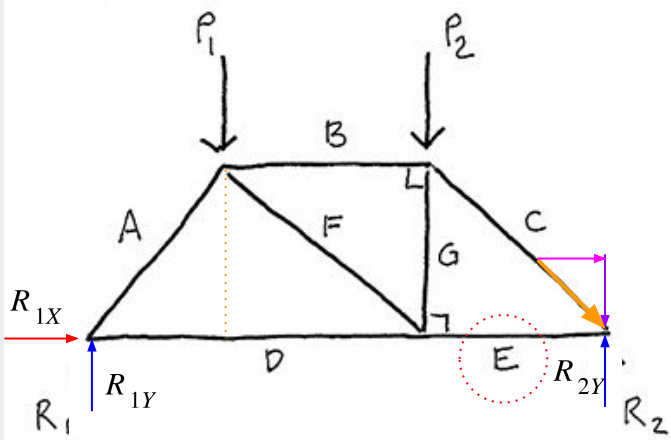
Question 15: **Total axial force in member E (absolute value)**

$$\sum F_X = 0$$

$$-F_{CX} + F_E = 0$$

$$F_{CX} = F_E$$

$$\boxed{F_E = 239.31 LBS}$$



Find the internal forces in members: A, B, C, D, E, F and G.

DATASET: 1 -2- -3-

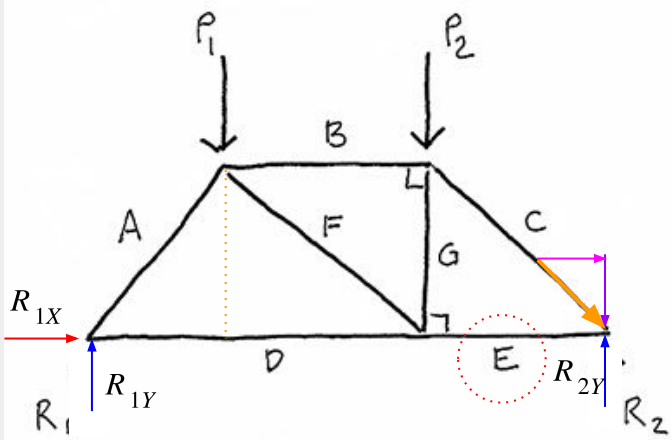
Length B	12 FT
Length D	16 FT
Length E	10 FT
Length G	9 FT
Load P1	400 LBS
Load P2	250 LBS

PROBLEM NO.7

Question 16: **Sign for member E (1 for tension or -1 for compression)**

$$F_E = 239.31 LBS$$

TENSION = 1



Find the internal forces in members: A, B, C, D, E, F and G.

DATASET: 1 -2- -3-

Length B	12 FT
Length D	16 FT
Length E	10 FT
Length G	9 FT
Load P1	400 LBS
Load P2	250 LBS

PROBLEM NO.7

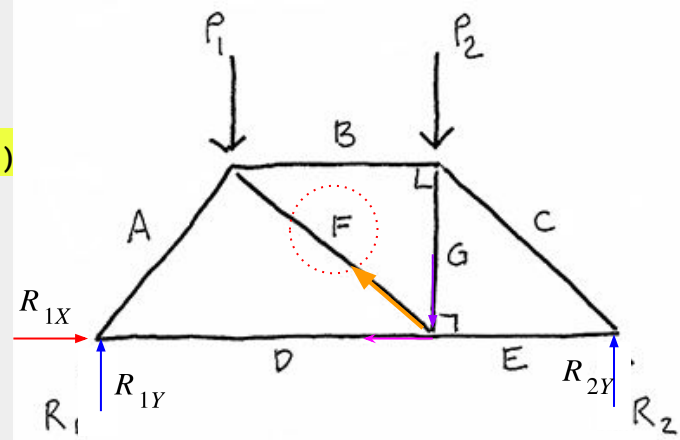
Question 17: **Horizontal component of force in member F (absolute value)**

$$\sum F_X = 0$$

$$F_{AX} - F_{CX} + F_{FX} = 0$$

$$-193.16 - 239.3 + F_{FX} = 0$$

$$F_{FX} = 46.14\ lbs$$



Find the internal forces in members: A, B, C, D, E, F and G.

DATASET: 1 -2- -3-

Length B	12 FT
Length D	16 FT
Length E	10 FT
Length G	9 FT
Load P1	400 LBS
Load P2	250 LBS

PROBLEM NO.7

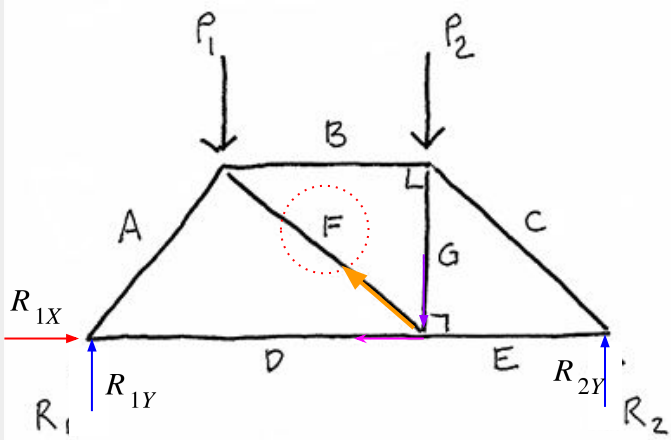
Question 18: **Vertical component of force in member F (absolute value)**

$$\sum_{FY} = 0$$

$$-F_{AY} - P_1 - F_{FY} = 0$$

$$-434.61 - 400 - F_{FY} = 0$$

$$F_{FY} = 34.61\ lbs$$



Find the internal forces in members: A, B, C, D, E, F and G.

DATASET: 1 -2- -3-

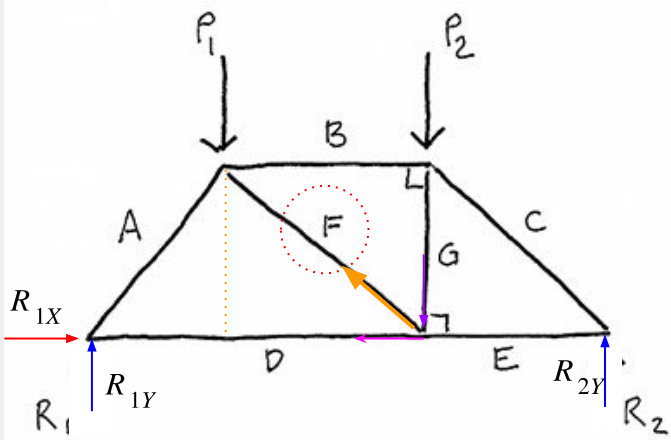
Length B	12 FT
Length D	16 FT
Length E	10 FT
Length G	9 FT
Load P1	400 LBS
Load P2	250 LBS

PROBLEM NO.7

Question 19: **Total axial force in member F (absolute value)**

$$F_F = \sqrt{F^2_{FX} + F^2_{FY}} = \sqrt{(46.14)^2 + (34.61)^2}$$

$$F_F = 57.68\ lbs$$



Find the internal forces in members: A, B, C, D, E, F and G.

DATASET: 1 -2- -3-

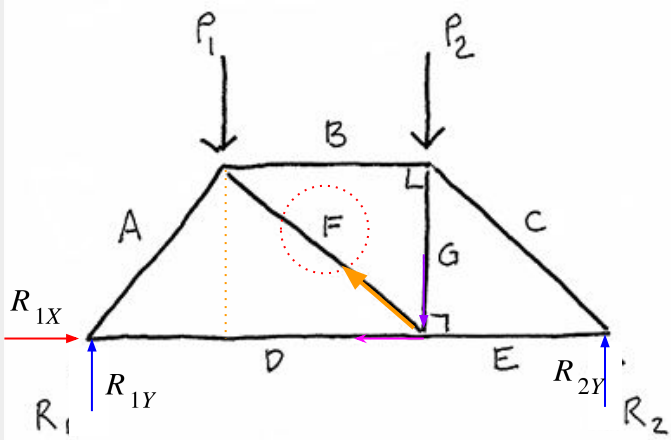
Length B	12 FT
Length D	16 FT
Length E	10 FT
Length G	9 FT
Load P1	400 LBS
Load P2	250 LBS

PROBLEM NO.7

Question 20: **Sign for member F (1 for tension or -1 for compression)**

$$F_F = 57.68\ lbs$$

TENSION = 1



Find the internal forces in members: A, B, C, D, E, F and G.

DATASET: 1 -2- -3-

Length B	12 FT
Length D	16 FT
Length E	10 FT
Length G	9 FT
Load P1	400 LBS
Load P2	250 LBS

PROBLEM NO.7

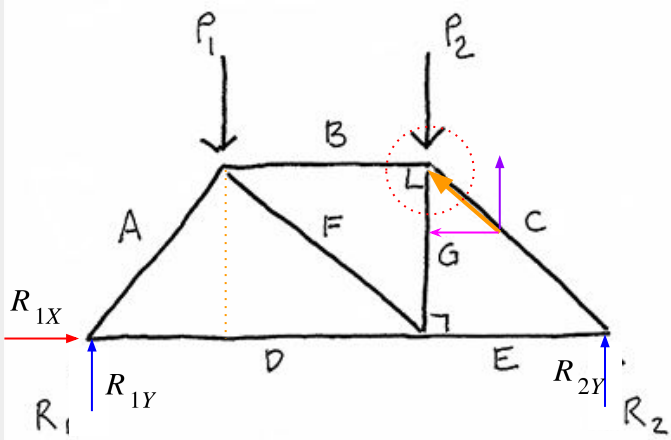
Question 21: **Total axial force in member G (absolute value)**

$$\sum_{FY} = 0$$

$$-P_2 + F_{CY} + F_G = 0$$

$$-250 - 215.38 - F_G = 0$$

$$F_G = 34.62\ lbs$$



Find the internal forces in members: A, B, C, D, E, F and G.

DATASET: 1 -2- -3-

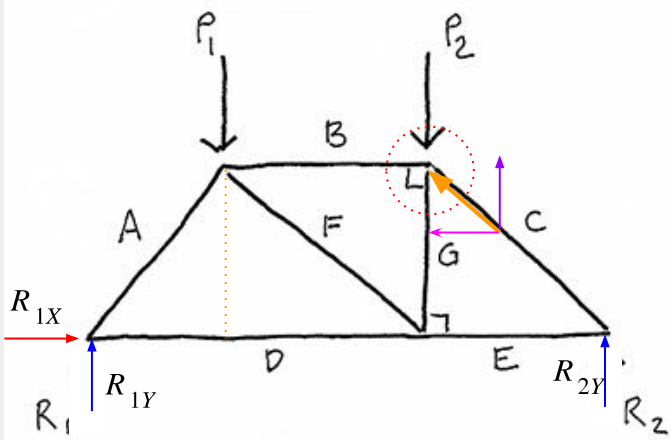
Length B	12 FT
Length D	16 FT
Length E	10 FT
Length G	9 FT
Load P1	400 LBS
Load P2	250 LBS

PROBLEM NO.7

Question 21: **Total axial force in member G (absolute value)**

$$F_G = 34.62\ lbs$$

COMPRESSION = -1



Find the internal forces in members: A, B, C, D, E, F and G.

DATASET: 1 -2- -3-

Length B	12 FT
Length D	16 FT
Length E	10 FT
Length G	9 FT
Load P1	400 LBS
Load P2	250 LBS

Preliminary Reports Due SUNDAY 11:59

PRELIMINARY REPORT (re-submit original)	40	
Explanation	5	
Illustrations: section (5), elevation (5), 3d view (5)	15	
Analysis: forces (5), sizing (5), weight estimate (5), load capacity (5)	20	
TESTING	**60**	
Bridge < 4 oz is 8 pts and holds at least 50 lbs is 8 pts (else pts scaled down)	16	
Correct materials – wood and glue – solid deck (no holes)	14	
Points awarded (out of 30) based on class rank using formula: [(4/weight OZ)*50 + (load in LBS/50)*9]	30	
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**	