FINAL, Closed Book, 120 Minutes, Friday 27-Jan-2012

Write your full name, ID number, and circle the section that you are registered in.

Name: _____ ID: _____ Section: **10 AM** **11 AM** **1 PM**

Problem 1	Problem 2	Problem 3	Problem 4	Problem 5	Problem 6	Score
/ 20 Points	/ 20 Points	/ 15 Points	/ 15 Points	/ 15 Points	/ 15 Points	/ 100

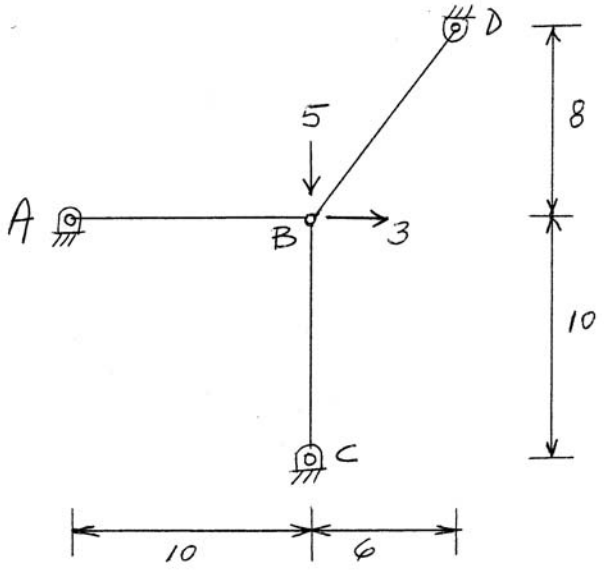
Make sure that you are aware of all the following

- Show all your calculations, points will be deducted for answers that are not supported by proper calculations.
- Use the Virtual Work Method to determine all displacement; using any other method will not count.
- Use the specified Virtual structure; using any other virtual structure will not count.
- If the Virtual structure is not specified, choose your own Virtual structure.
- Ignore shear deformations unless stated otherwise in the problem.
- All members have the same E , G, I, J and A, unless stated otherwise in the problem.
- Use the specified redundant; using any other redundant will not count.
- If a redundant is not specified, choose your own redundant.
- Use matrix algebra to solve simultaneous equations. Any other method will not count.
- Take advantage of the information provided on the test sheets.

TRUSS PROBLEM

For the truss shown in the figure, determine the **horizontal reaction at D** and the **horizontal displacement at B**.

Use E = 1 and A = 10



Problem 1 (20 points)

Solve the truss problem given above by using only the Stiffness method. Any other method will not count. Use the structural model given below; points will be deducted for using any other model.

Joints are:	Joint 1 is A	Joint 2 is B	Joint 3 is C	Joint 4 is D

Elements are:	Element 1 is AB	Element 2 is BC	Element 3 is BD

$$\begin{bmatrix} 1.36 & 0.48 \\ 0.48 & 1.64 \end{bmatrix} \begin{bmatrix} d_3 \\ d_4 \end{bmatrix} = \begin{bmatrix} 3 \\ -5 \end{bmatrix} \qquad \begin{bmatrix} d_3 \\ d_4 \end{bmatrix} = \frac{1}{2} \begin{bmatrix} 1.64 & -0.48 \\ -0.48 & 1.36 \end{bmatrix} \begin{bmatrix} 3 \\ -5 \end{bmatrix} = \begin{bmatrix} 3.66 \\ -4.12 \end{bmatrix}$$

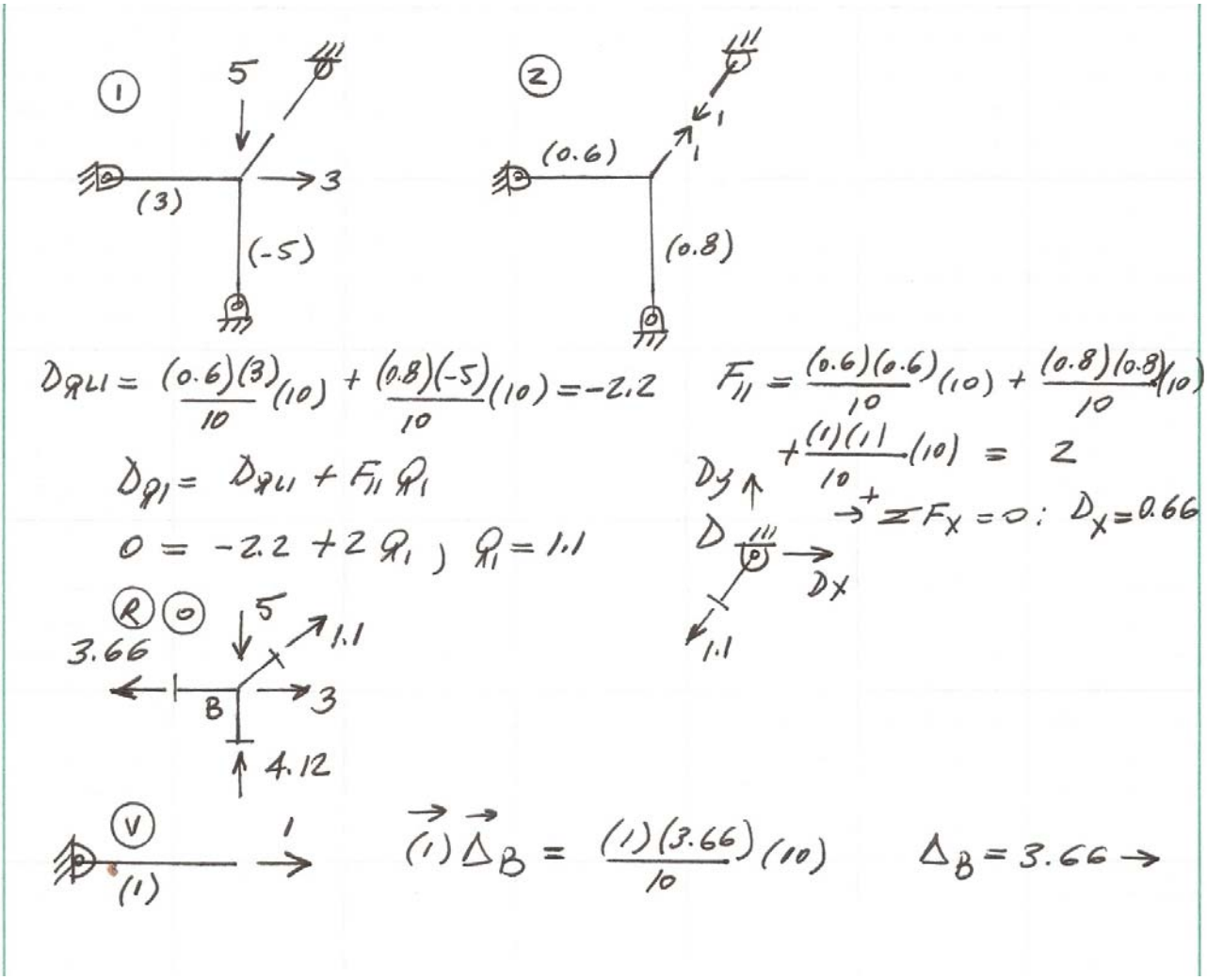
$\Delta_B = d_3$, $\Delta_B = 3.66 \rightarrow$

$R_7 = K_{73} d_3 + K_{74} d_4 = 0.66$ ($K_{73} = -0.36$, $K_{74} = -0.48$)

$D_x = R_7$, $D_x = 0.66 \rightarrow$

Problem 2 (20 points)

Solve the truss problem given on Page 2 by using the Flexibility method with Q_1 = axial force in BD.



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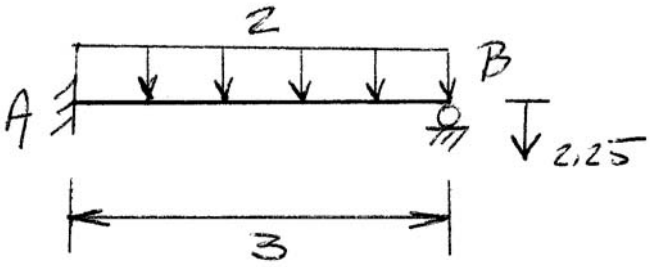
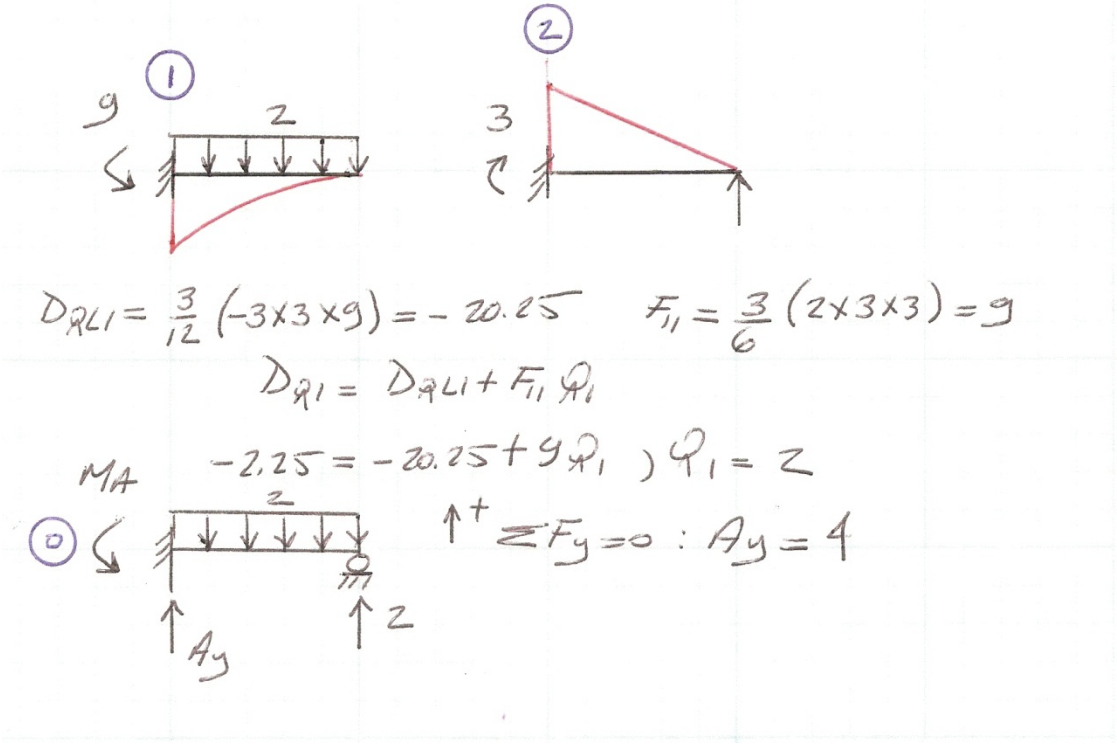
Problem 3 (15 points)

For the beam shown in the figure, determine the vertical reaction at A. In addition to the applied distributed load = 2, there is a support movement at B = 2.25 down.



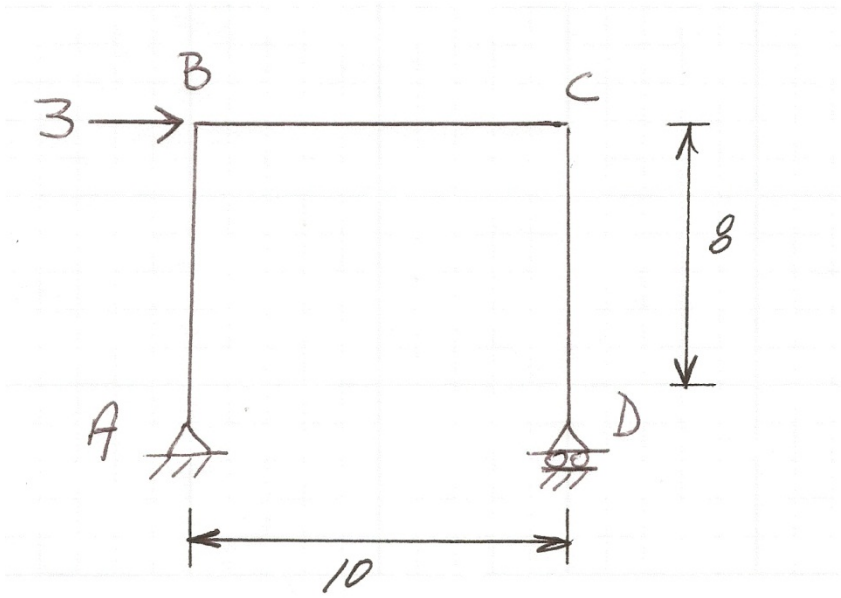
Use E = 1 and I = 1

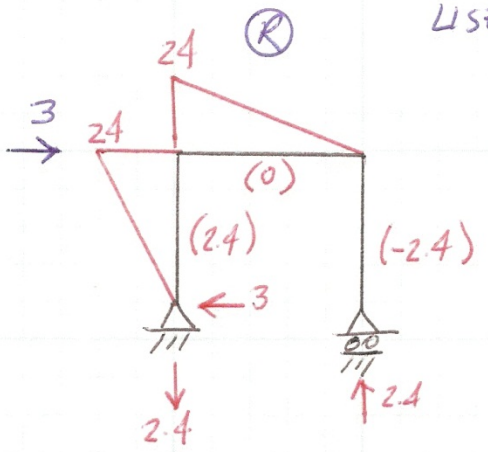


Problem 4 (15 points)

For the frame shown in the figure the supports are a hinge at A and roller at D. Determine the horizontal displacement at B.

Use E = 1, A = 3, and I = 288





USE (V) = (R)

$$(1)\ \Delta_B = \frac{8}{6EI}(2\times 8\times 24) + \frac{10}{6EI}(2\times 8\times 24) + \frac{(0.8)(24)}{EA}(8) + \frac{(-0.8)(-24)}{EA}(8)$$

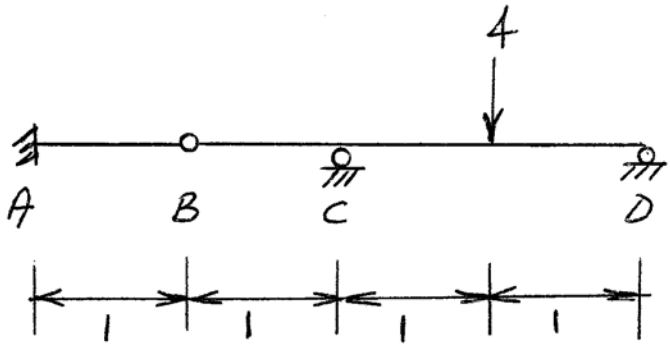
$E = 1,\ A = 3,\ I = 288$

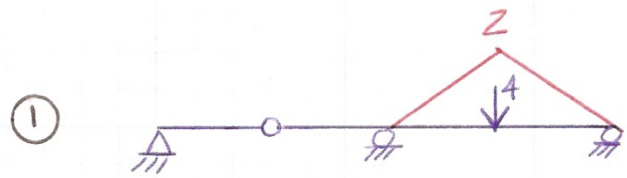
$$\Delta_B = 14.24 \rightarrow$$

Problem 5 (15 points)

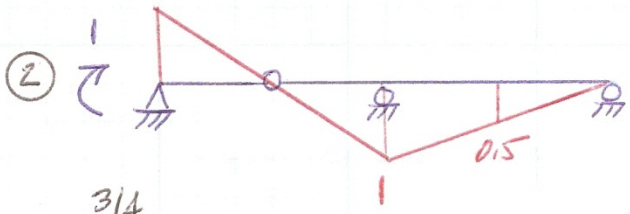
Two members AB and BD are connected by a pin at B. The supports are a fixity at A, rollers at C and D. Determine the vertical reaction at A. Use the Flexibility method with Q_1 = moment at A.

Use E = 1, and I = 1.





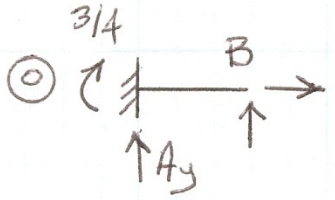
$$D_{Q1} = \frac{1}{6}(-2\times0.5\times2 - 1\times2) + \frac{1}{6}(-2\times0.5\times2) = -1$$



$$F_{11} = \frac{2}{6}(2\times1\times1 + 2\times1\times1 - 1\times1 - 1\times1) = \frac{4}{3}$$

$$D_{Q1} = D_{Q1} + F_{11}Q_1$$

$$0 = -1 + \frac{4}{3}Q_1 \;\Rightarrow\; Q_1 = \frac{3}{4}$$



$$\overset{+}{\circlearrowleft} \Sigma M_B = 0 : A_y = -3/4 \qquad A_y = 0.75 \downarrow$$

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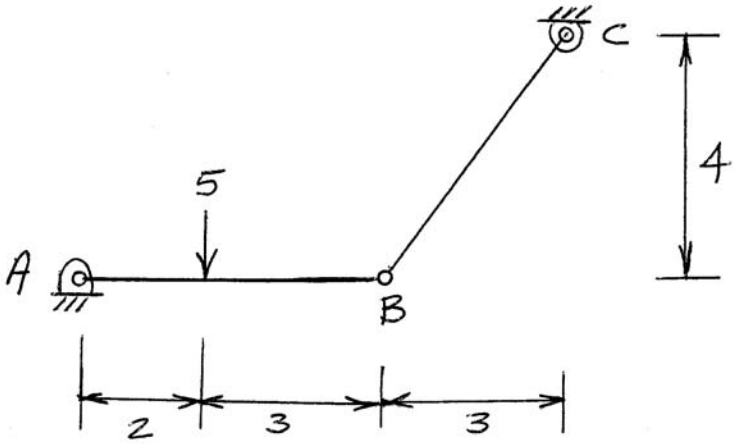
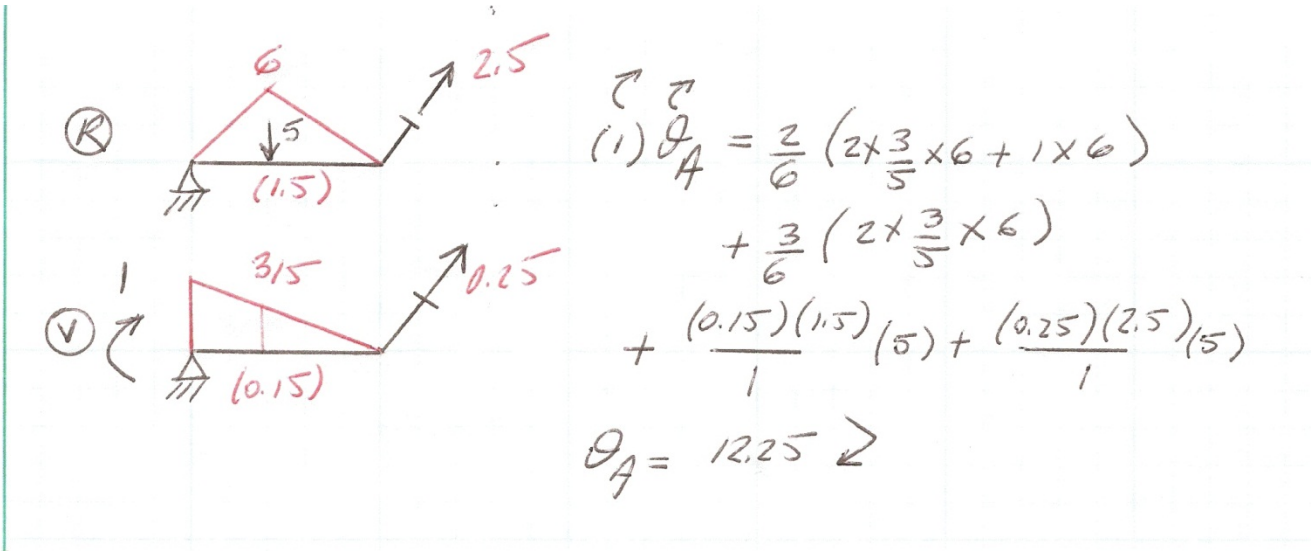
Problem 6 (15 points)

Two members AB and BC are connected by a pin at B. The supports are hinges at A and C. Determine the rotation at A. Use Virtual structure same as the Real structure.

Use E = 1, A = 1, and I = 1





$$(1)\ \theta_A = \frac{2}{6}\left(2\times\frac{3}{5}\times 6 + 1\times 6\right) + \frac{3}{6}\left(2\times\frac{3}{5}\times 6\right) + \frac{(0.15)(1.5)}{1}(5) + \frac{(0.25)(2.5)}{1}(5)$$

$$\theta_A = 12.25 \curvearrowright$$