CIE200 Statics – Fall 2013

FINAL EXAM

Closed Book, 180 Minutes

25-Jan-2014

All the following apply in this exam

- Every FBD needed for the solution of a problem should be clearly drawn.
- Points will be deducted for equilibrium equations that do not have a corresponding FBD or an incomplete/ incorrect FBD.
- Show all your calculations.
- Points will be deducted for answers that are not supported by proper calculations.
- Check that you have all 4 problems in this booklet.
- If you need extra space you can write on the back any sheet.
- Method A is the method of cuts and FBDs and Method B is the method of relations

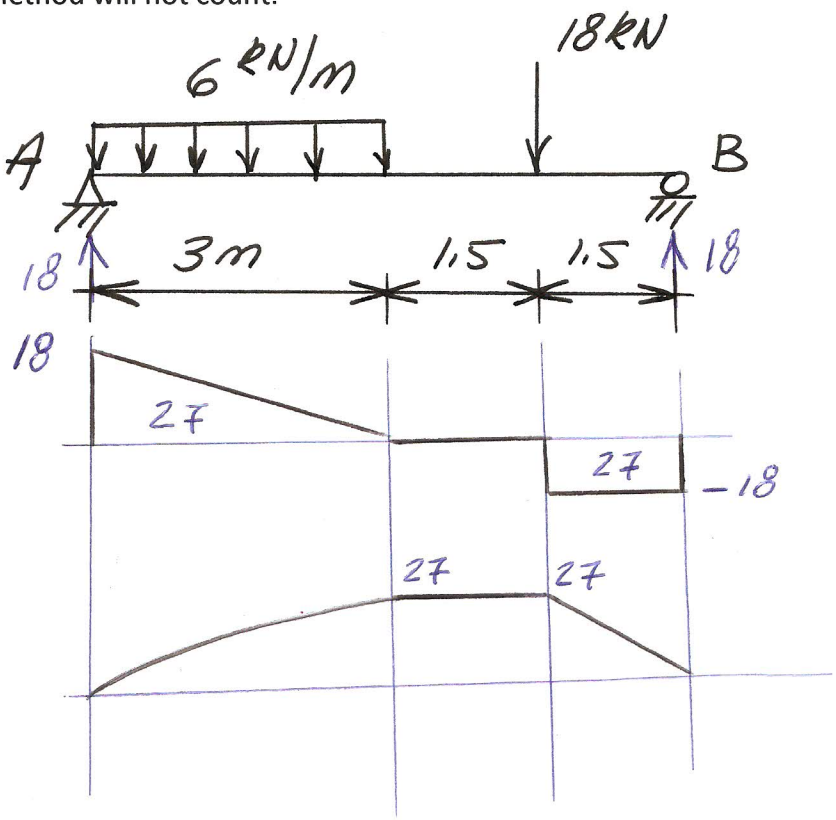
Name: M. TABBARA

ID Number: SOLUTION

Problem	1	2	3	4	5	6	7	8	
Score	____	____	____	____	____	____	____	____	____
Points	**10**	**10**	**10**	**10**	**10**	**15**	**20**	**15**	**100**

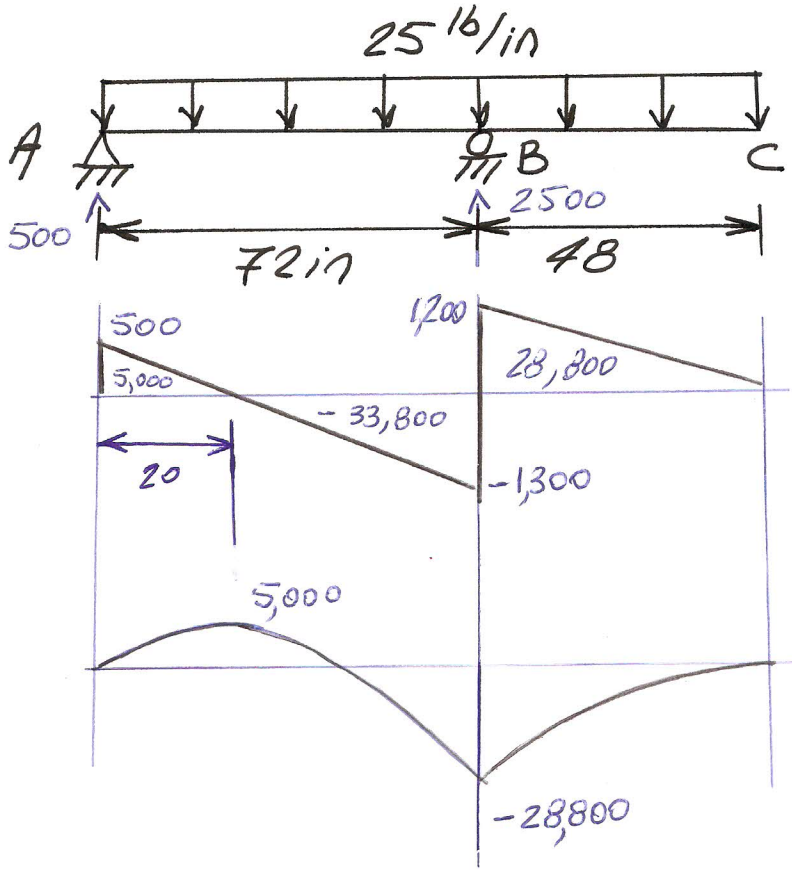
Problem 1

Beam AB is supported by a hinge at A and a roller at B. Draw shear and moment diagrams for AB using Method B; any other method will not count.



Problem 2

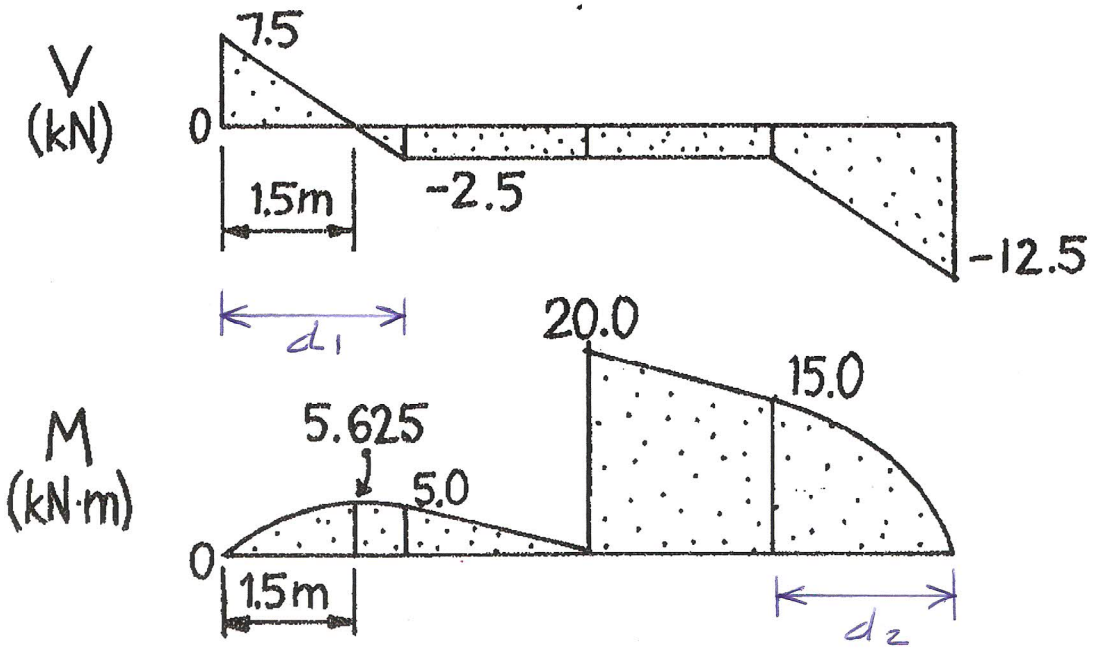
Beam AC is supported by a hinge at A and a roller at B. Draw shear and moment diagrams for AC using Method B; any other method will not count.

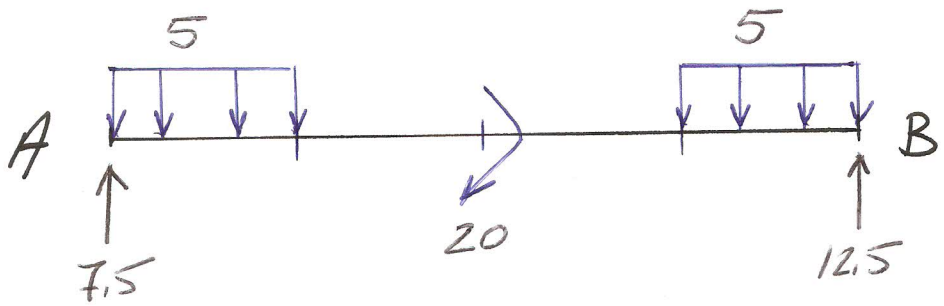


$\frac{500}{25} = 20$

Problem 3

The shear and moment diagrams for beam AB are shown below. Determine and draw the loading that acts on the beam.





$\frac{7.5+2.5}{2.0} = 5$

$\frac{12.5-2.5}{2.0} = 5$

$d_1 = 1.5 + \frac{2.5}{7.5} \times 1.5 = 2.0$

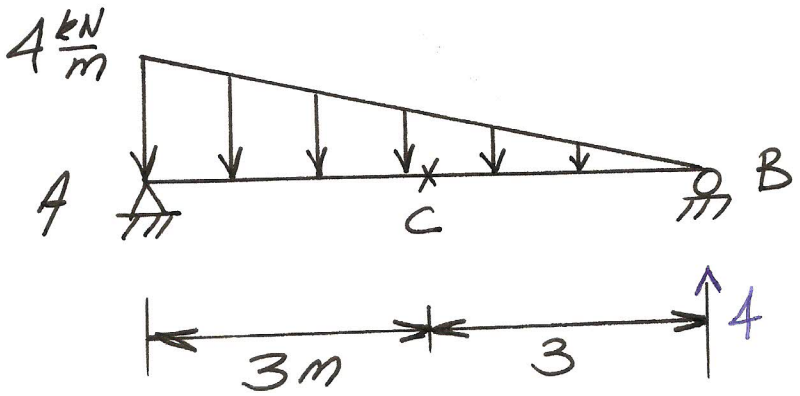
$\frac{1}{2}(2.5+12.5)\, d_2 = 15,\ d_2 = 2.0$

Problem 4

Beam AB is supported by a hinge at A and a roller at B. Determine the:

(a) Slope to the moment diagram at C

(b) Concavity of the moment diagram at C



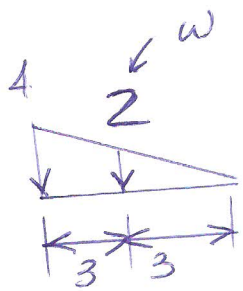
SLOPE

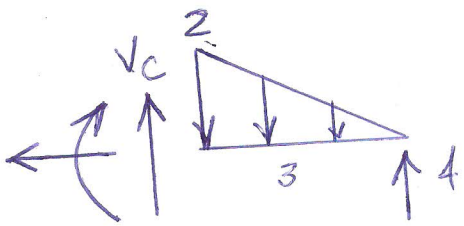
$\frac{dM}{dx} = V$

CONCAVITY

$\frac{d^2M}{dx^2} = \frac{dV}{dx} = -w$

AT C $V = ?$ $w = ?$





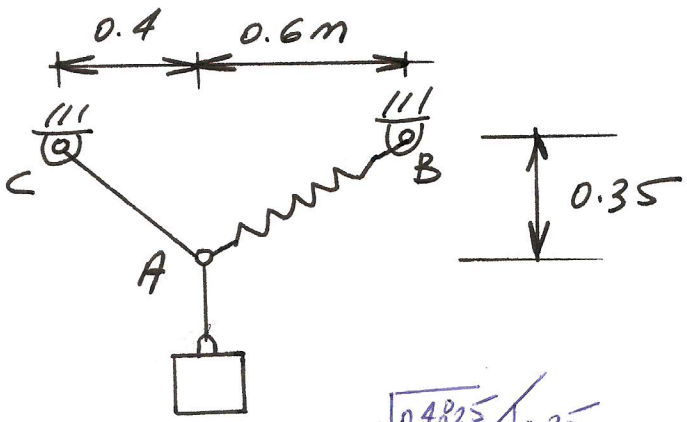
$\uparrow^+ \Sigma F_y = 0$: $V_C - \frac{1}{2} \times 2 \times 3 + 4 = 0$, $V_C = -1$

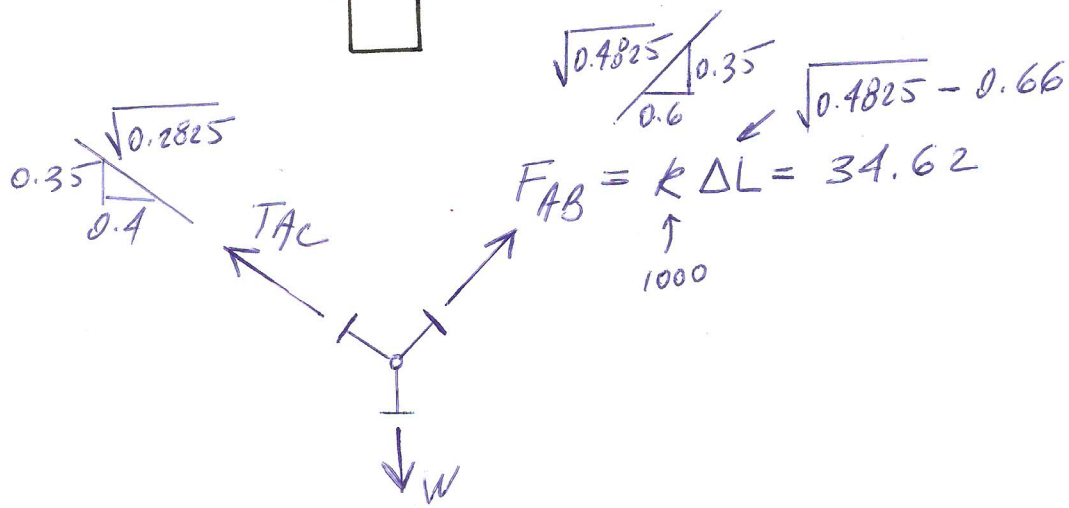
SLOPE = -1

CONCAVITY = -2

Problem 5

Cable AC and spring AB are connected at A. The original (unstretched) length of spring AB is 0.66 m and the spring constant k = 1000 N/m. Determine the weight of the block.





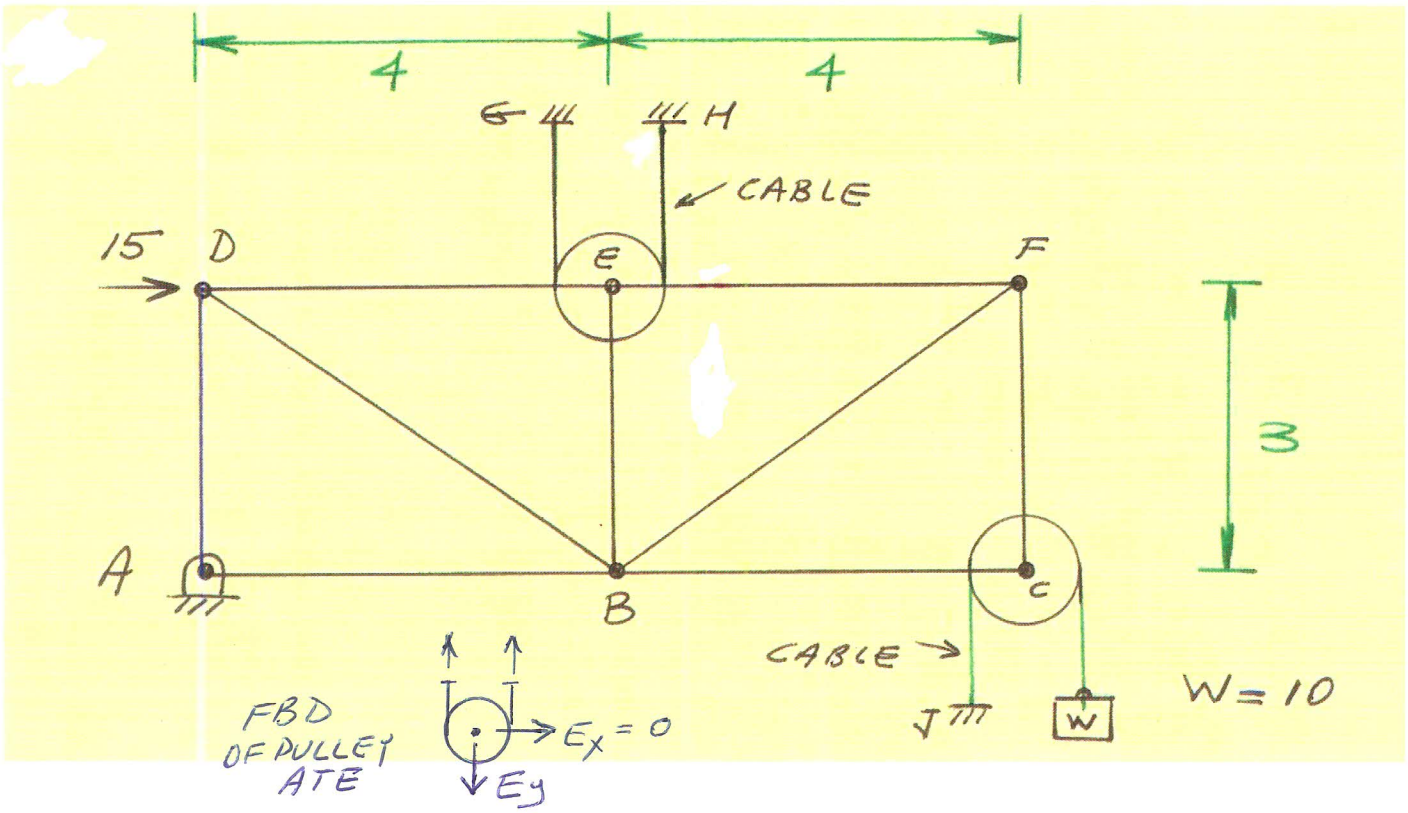
$$\overset{+}{\rightarrow} \Sigma F_x = 0: \quad \frac{0.4}{\sqrt{0.2825}} T_{AC} - \frac{0.6}{\sqrt{0.4825}} 34.62 = 0, \quad T_{AC} = 39.736$$

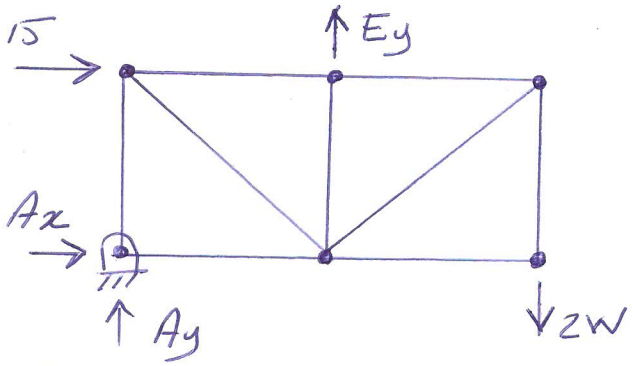
$$\overset{+}{\uparrow} \Sigma F_y = 0: \quad T_{AC} \frac{0.35}{\sqrt{0.2825}} - W = 0, \quad W = 43.61$$

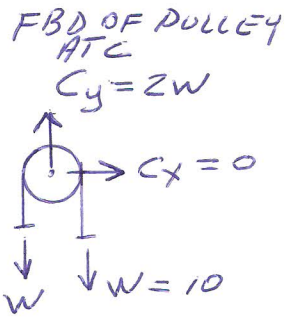
$$39.736 \qquad + 34.62 \frac{0.35}{\sqrt{0.4825}}$$

Problem 6

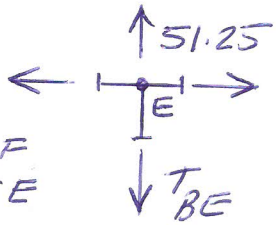
The truss shown below has a hinge at A, a pulley at E and a pulley at C. The radius of the pulley is 0.5 and the weight W = 10. Determine the axial force in member BE.







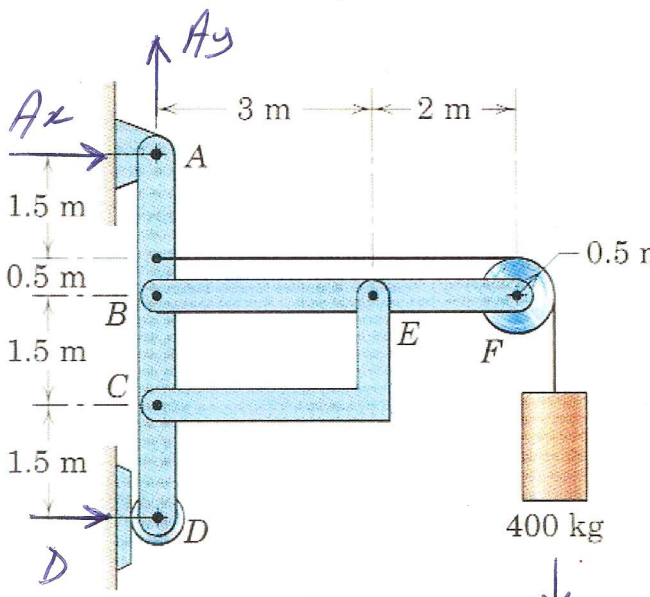
$$\circlearrowleft^{+} \Sigma M_A = 0 : -15(3) + E_y(4) - 20(8) = 0, \quad E_y = 51.25$$



$$\uparrow^{+} \Sigma F_y = 0 : -T_{BE} + 51.25 = 0, \quad T_{BE} = 51.25$$

Problem 7

Three members AD, BF and CE are connected by pins at B, C and E. Supports are a hinge at A and a roller at D. The radius of the pulley is 0.5 m and is connected by a pin at F. Determine all the forces that act on member AD and draw its updated FBD.



BASIC FBD

3,924

BASIC FBD

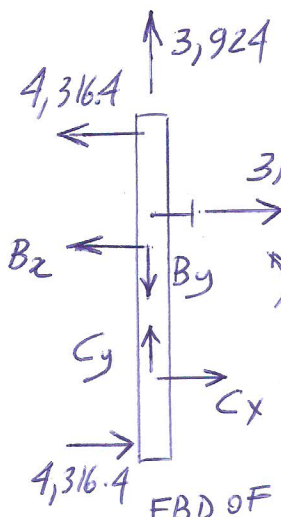
$\curvearrowleft^{+} \Sigma M_D = 0 : -A_x(5) - 3,924(5.5) = 0$

$A_x = -4,316.4$

$\rightarrow^{+} \Sigma F_x = 0 : D + A_x = 0, \quad D = 4,316.4$

$\uparrow^{+} \Sigma F_y = 0 : A_y - 3,924 = 0,$

$A_y = 3,924$



FBD OF AD

$\uparrow^{+} \Sigma F_y = 0 : -B_y + C_y + 3,924 = 0$

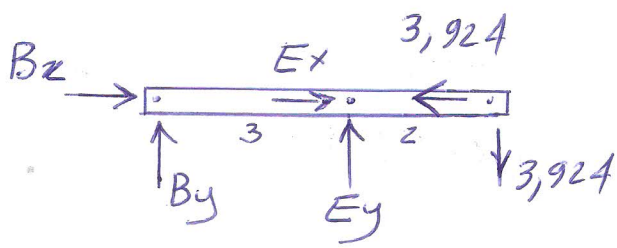
$C_y = -6,540$

$\curvearrowleft^{+} \Sigma M_C = 0 : B_x(1.5) + (4,316.4)(1.5) - 3,924(2) + 4,316.4(3.5) = 0$

$B_x = -9,156$

$\rightarrow^{+} \Sigma F_x = 0 : -B_x + C_x + 3,924 - 4,316.4 + 4,316.4 = 0$

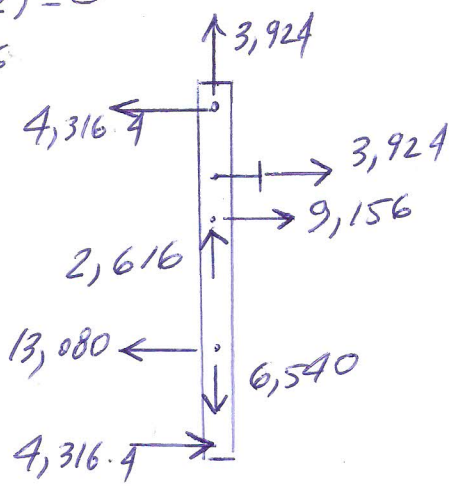
$C_x = -13,080$



FBD OF BF

$\curvearrowleft^{+} \Sigma M_E = 0 : -B_y(3) - 3,924(2) = 0$

$B_y = -2,616$



Problem 8

For the rectangular area shown below:

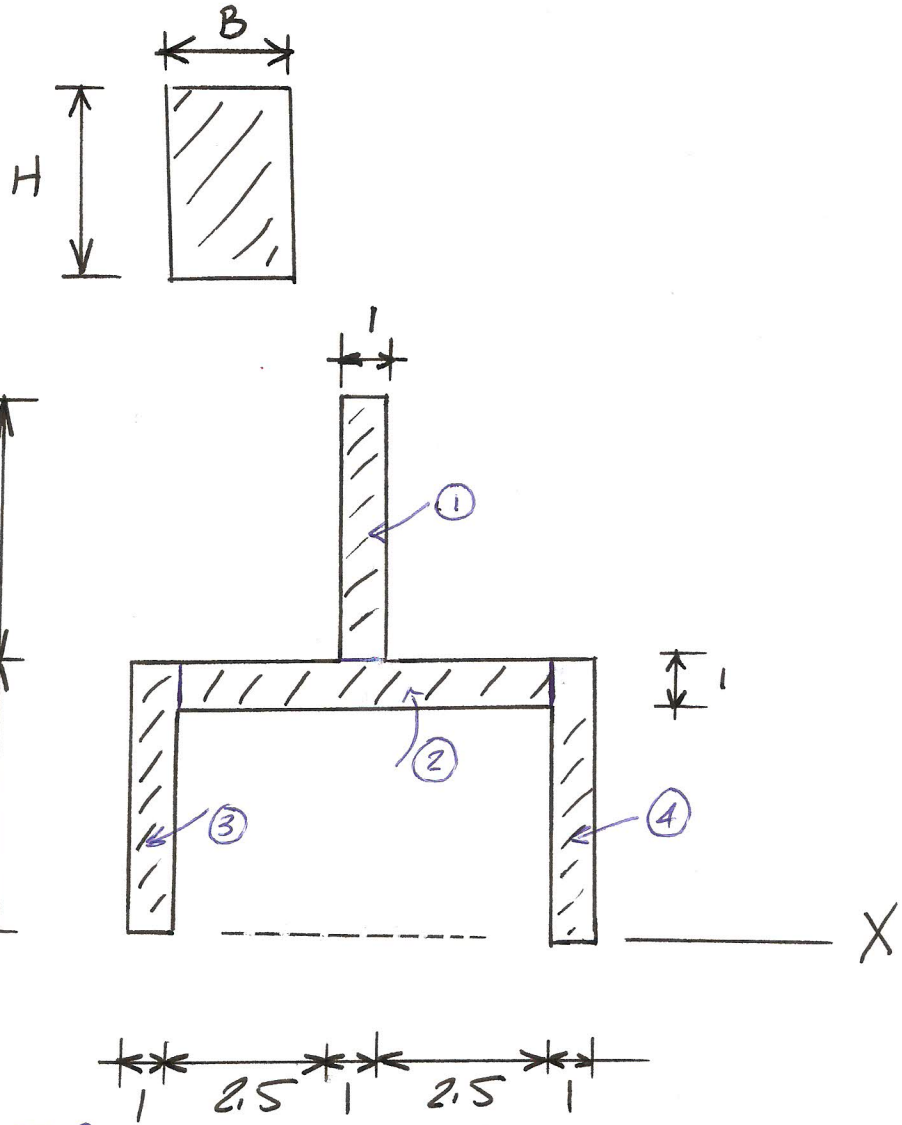
(a) The moment of inertia about the centroid = $BH^3/12$. Determine the moment of inertia about the base of the rectangle.

$$I_b = \frac{BH^3}{12} + Ad^2 \quad (A = BH,\ d = \tfrac{H}{2}) = \frac{BH^3}{3}$$

For the composite area shown below:

(b) Determine the coordinates of the centroid

(c) Determine the moment of inertia about the X-axis



	A_i	$\bar{y}_i$	$\bar{y}_i \cdot A_i$
1	6	9	54
2	6	5.5	33
3	6	3	18
4	6	3	18
	24		123

$$\bar{y} = \frac{123}{24} = 5.125$$

$$I_x = \tfrac{1}{3}(1)(6)^3 + \tfrac{1}{3}(1)(6)^3 + \tfrac{1}{12}(6)(1)^3 + 6(5.5)^2 + \tfrac{1}{12}(1)(6)^3 + 6(9)^2 = 830$$