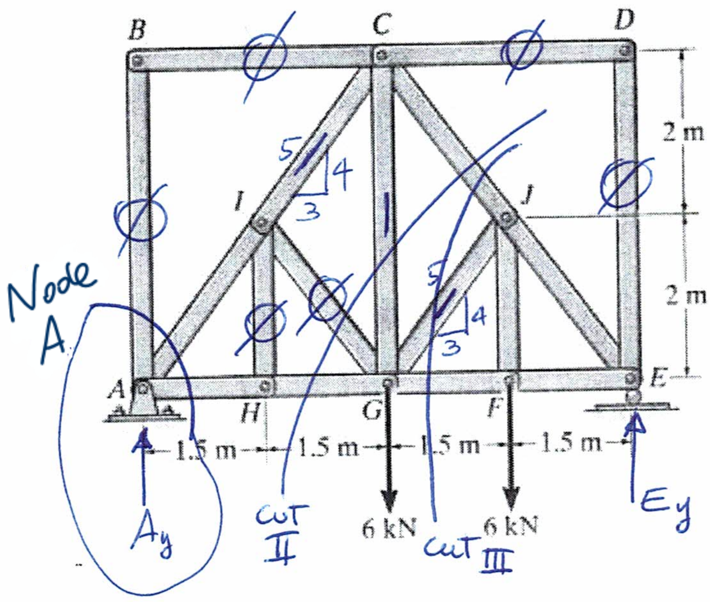
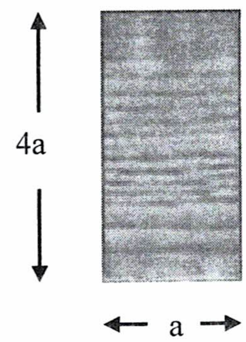
Question #1 [10 points]





1 – List all zero force members. **[2 point]**

Zero force members are:	AB , BC , IH , IG , CD , DE

2 - Determine the force in members **IC**, **GJ**, and **CG** of the truss and state if these members are in tension or compression.

IC= 5.625 **kN in** C	**GJ=** 3.75 **kN in** C	**CG=** 9.00 **kN in** T

[4 point]

3 – Assuming that the force in member **GF** is 5.625 kN in tension, calculate the minimum dimension for member **GF** knowing the cross section is rectangular as shown above. The maximum tensile strength for the wood is 12 MPa; the load factor is 2.0; and the side dimension ***a*** is only available in increments of 5 mm.

a= 15.3 mm	**Chosen cross section =** 20 **X** 80

[2 point]

4 – Assuming the member **AH**, having cross- sectional area is equal to 15x60 mm^2, to be subjected to a service load of 3.5 kN in tension, calculate its elongation. For the calculations assume the Young's modulus to be equal to 12 x 10^3 MPa.

Elongation = 0.486 **mm**	

[2 point]

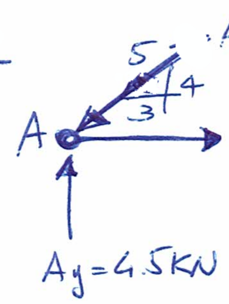
2) Reaction forces

@ A $\circlearrowleft$ $\Sigma M_A = -6\cdot 3 - 6\cdot 4.5 + E_y\cdot 6 = 0 \rightarrow E_y = 7.5$ KN

@ E $\circlearrowleft$ $\Sigma M_E = 0 = 6\cdot 1.5 + 6\cdot 3 - A_y\cdot 6 = 0 \rightarrow A_y = 4.5$ KN

verify that $\Sigma F_y = 0 = 7.5 - 6 - 6 + 4.5 = 0$ ✓

Node A



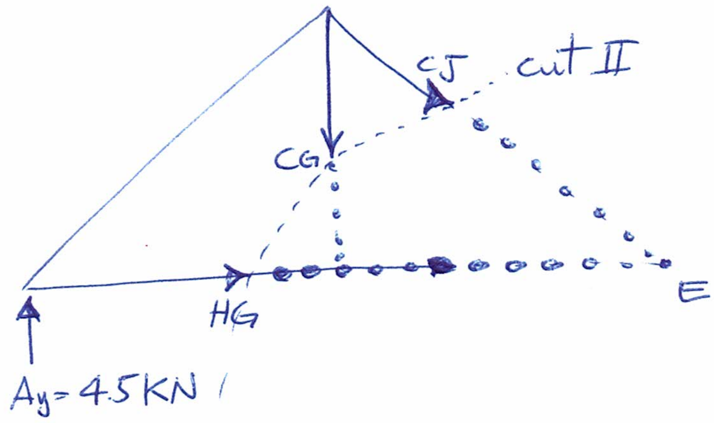
$\therefore AI = CI$

$\frac{4}{5} AI = AI_y = A_y$

$\Downarrow$

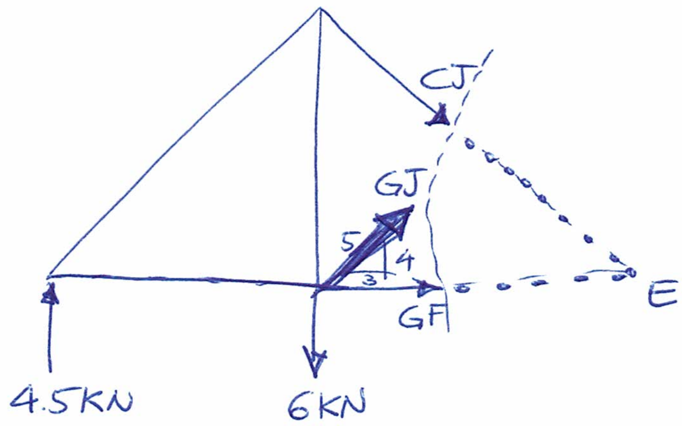
$AI = \frac{5}{4}\cdot 4.5 = 5.625$ KN (C)

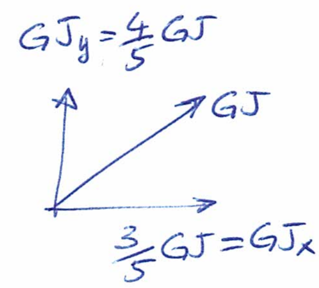
Cut II



$$@\ E \circlearrowleft^{+} \quad \Sigma M_E = 0 = -4.5 \cdot 6 + CG \cdot 3 = 0 \Rightarrow \underline{\underline{CG = 9\,KN\,(T)}}$$

Cut III





$$@\ E \circlearrowleft^{+} \quad \Sigma M_E = 0 = -4.5 \cdot 6 - GJ_y \cdot 3 + 6 \cdot 3 \Rightarrow \underline{\underline{GJ}} = \frac{15}{4} = \underline{\underline{3.75\,KN\,(C)}}$$

(3)

$$Area = a \cdot 4a = 4a^2$$

$$\sigma_y = \frac{F \cdot LF}{Area} \rightarrow Area = \frac{F \cdot LF}{\sigma_y} \Rightarrow 4a^2 = \frac{5.625 \cdot 10^3 \cdot 2}{12}$$

$$a^2 = 234.375\ mm^2 \rightarrow \underline{\underline{a = 15.31\ mm}}$$

$$\rightarrow \underline{\underline{\text{Section } 20 \times 80}}$$

(4)

$$Area = 15 \cdot 60 = 900\ mm^2$$

$$L = 1.5\,m = 1500\ mm$$

$$\sigma = \frac{F}{Area} = \frac{3.5 \cdot 10^3}{900} = 3.889\ MPa$$

$$\sigma = E \cdot \frac{\Delta L}{L} \rightarrow \underline{\underline{\Delta L}} = \frac{\sigma \cdot L}{E} = \frac{3.889 \cdot 1500}{12 \cdot 10^3} = \underline{\underline{0.486\ mm}}$$

Question #3 [10 points]

1- Draw **NEATLY** the Shear and Bending Moment diagrams for the beam ABCDEF in the space provided below the beam. (Locate and indicate values at supports, loads, and local maxima and minima) **[2 point]**

2- Find the magnitude of the Maximum Bending moment.

Maximum Bending moment = 16.54 **kN m**

[2 point]

3- Find the location, distance measured from A, where the bending moment is maximum.

Distance from A = 1.25 **m**

[2 point]

5 - If the maximum bending moment is 15 kN m, for the given cross section below, calculate the value of the maximum stress due to the applied bending moment.

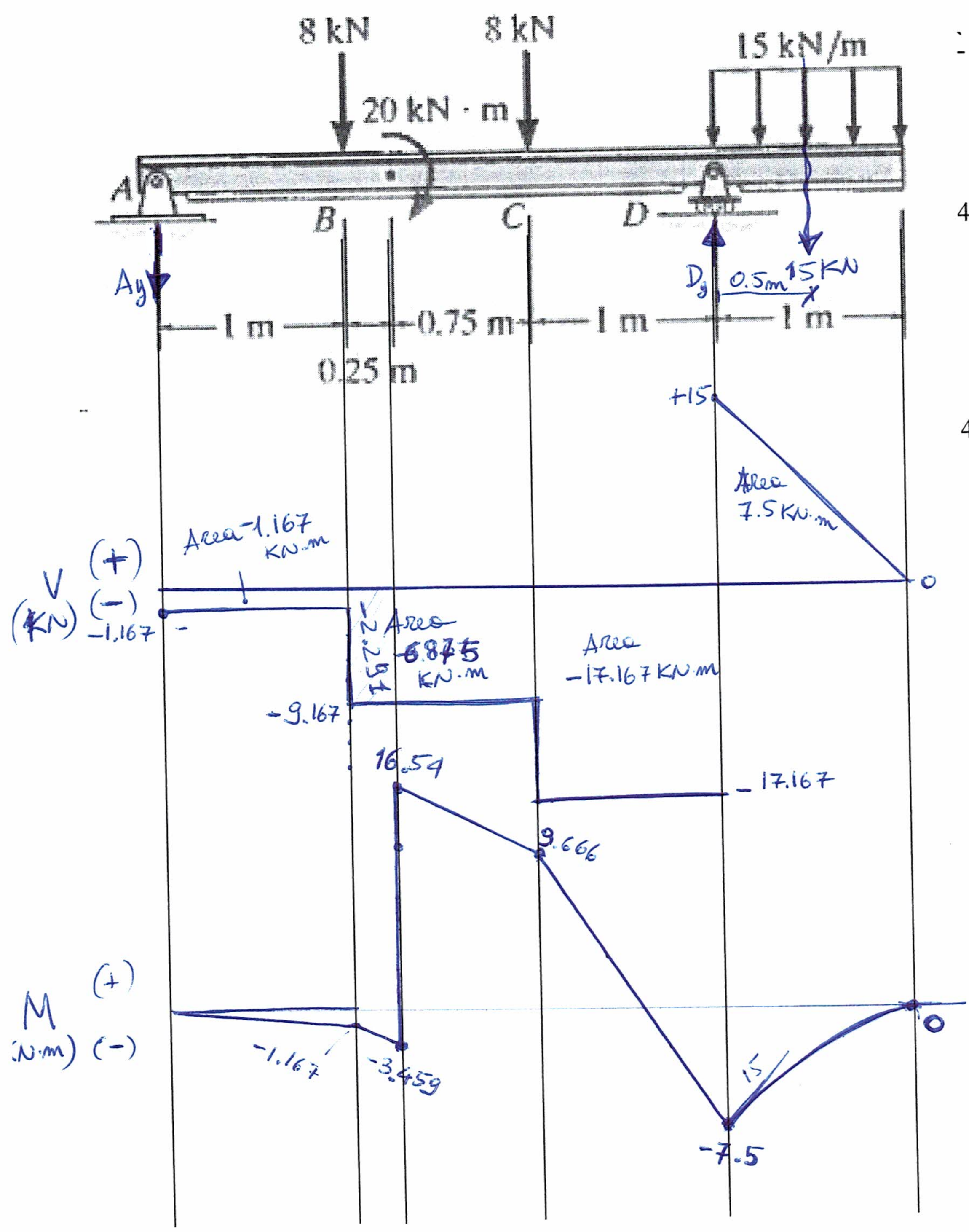
Maximum stress = 13.6 **MPa**

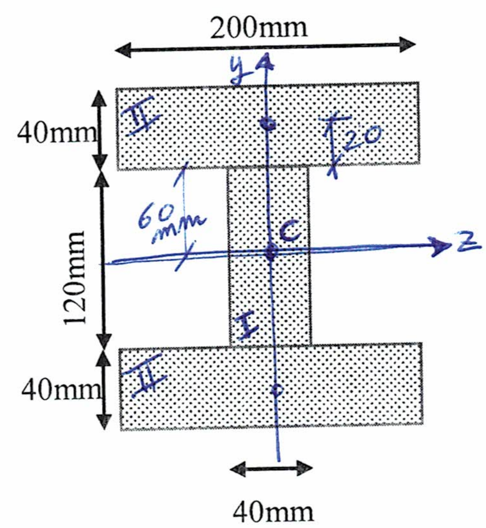
[2 point]

6 – If the yield stress for the material in the beam is 400 MPa, state if the beam is safe or not

The beam is SAFE

[2 point]





(1) @A $\circlearrowleft^{+}$ $M_A = 0 = -20 - 8\cdot 1 - 8\cdot 2 - 15\cdot 3.5 + D_y\cdot 3$

$$D_y = 32.167\ KN (\uparrow)$$

@D $\circlearrowleft$ $M_D = 0 = -15\cdot 0.5 + 8\cdot 1 + 8\cdot 2 - 20 + A_y\cdot 3$

$$A_y = 1.167\ KN (\downarrow)$$

Check: $+\uparrow \Sigma F_y = -1.167 - 8 - 8 + 32.167 - 15 = 0$ ✓

(5) $M_{z_{max}} = 15\ KN\cdot m$ $\qquad \sigma = \dfrac{M_{z_{max}} \cdot y_{max}}{I_z}$

$y_{max} = 100\ mm$

Part	I_z	$d_y(mm)$	$A(mm^2)$	d^2A	$I_z + d^2A\ (mm^4)$
I	$\frac{1}{12}\cdot 40\cdot 120^3$	⌀	4800	⌀	$5.76\cdot 10^6$
2x II	$\frac{1}{12}\ 200\cdot 40^3 = 1.067\cdot 10^6$	80	8000	$512\cdot 10^6$	$52.267\cdot 10^6 \times 2$

$I_z = 110.294\cdot 10^6 (mm^4)$

$$\sigma = \frac{15\cdot 10^6 \cdot 100}{110.294\cdot 10^6} = 13.6\ MPa$$

(6) $\sigma = 13.6\ MPa < 400\ MPa \Rightarrow$ Safe!