CE-222 STRUCTURAL ANALYSIS I
DEPARTMENT OF CIVIL ENGINEERING
Midsem, February 29, 2020, 11am-1pm
Problems carry equal weightage

Problem 1
For the beam with internal hinge at ***B*** as shown in **Figure 1**, determine the **left rotation at *B*** and **vertical displacement at *B***. Consider only bending deformations. $E = 200$ GPa, $I = 5 \times 10^8 \text{mm}^4$

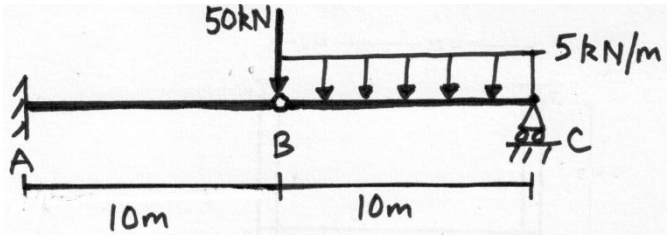

Fig. 1

Problem 2
For the frame in **Figure 2**, determine **the rotation and the horizontal displacement at support *C***. Consider only bending deformations. $E = 200$ GPa, $I = 5 \times 10^8 \text{mm}^4$

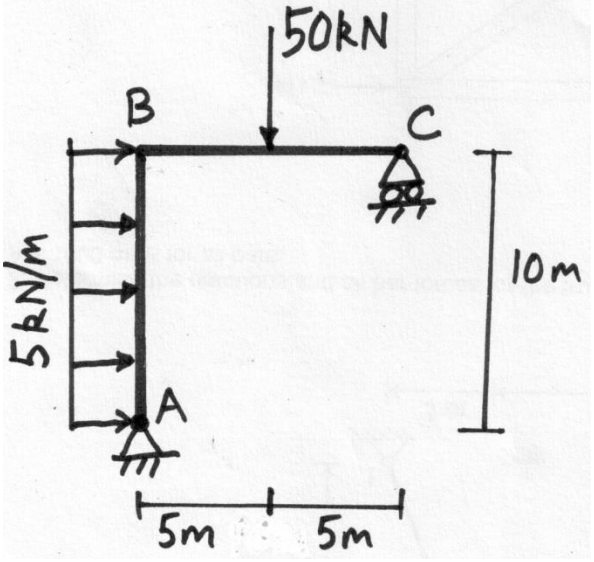

Figure 2

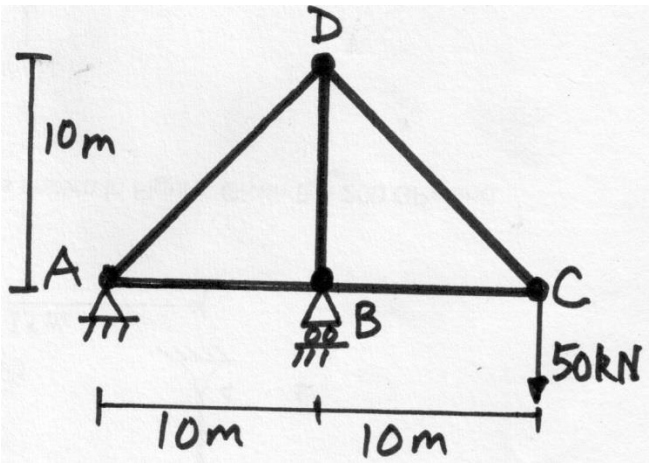

Figure 3

Problem 3
For the truss in **Figure 3**, determine the **horizontal displacement at joint *D***. Member ***AD*** is cooled to 10^0C below room temperature, and member ***BD*** is 10mm too long. Use $\alpha = \frac{10^{-4}}{\sqrt{2}}/C$; $E = 200$ GPa ; $A = 500$ mm^2

Problem 4
Find the **maximum shear at *D***, and the **maximum bending moment at *E*,** due to the traveling load train shown in **Figure 4.** There are 4 internal hinges as shown.

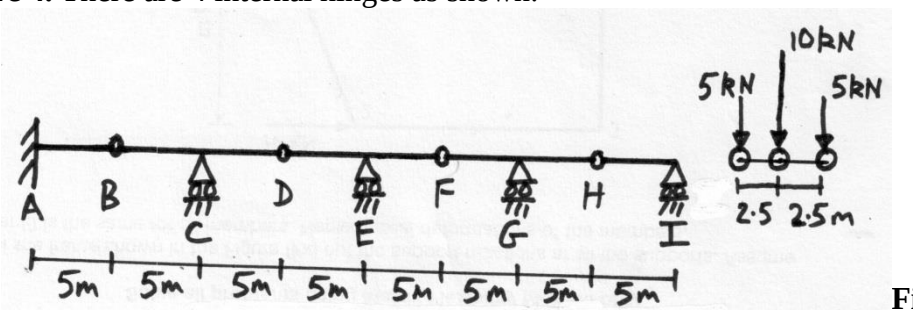

Figure 4

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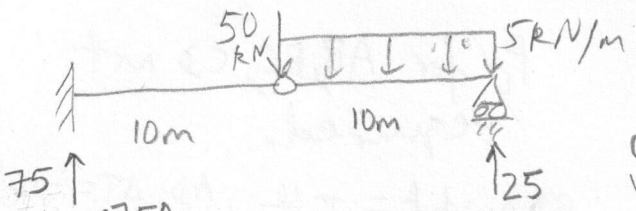
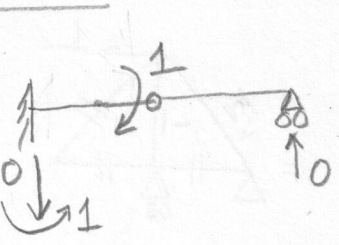
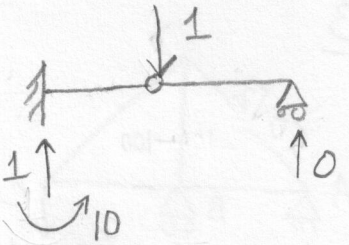
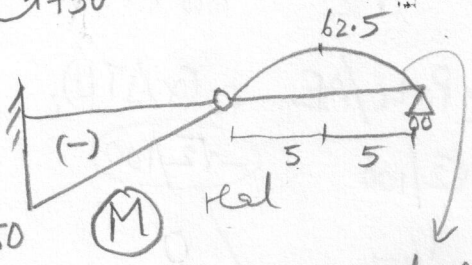
P1

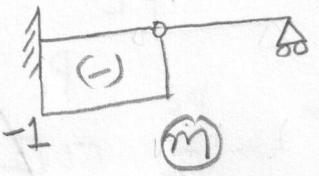


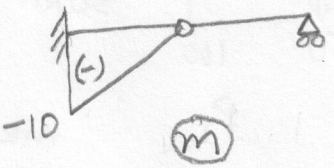


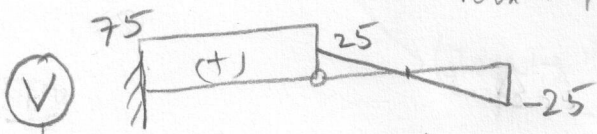




not required





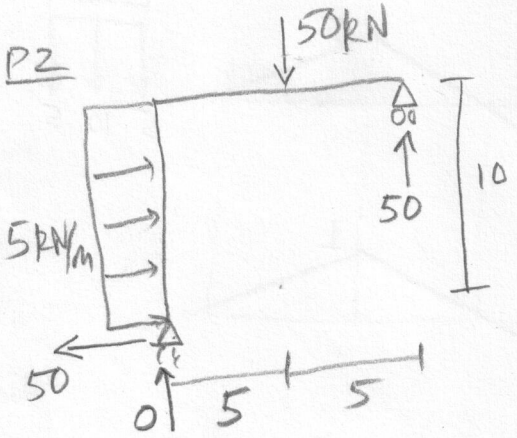


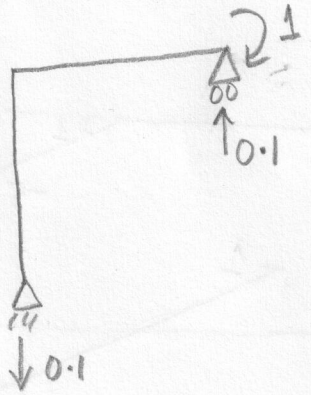
not required.

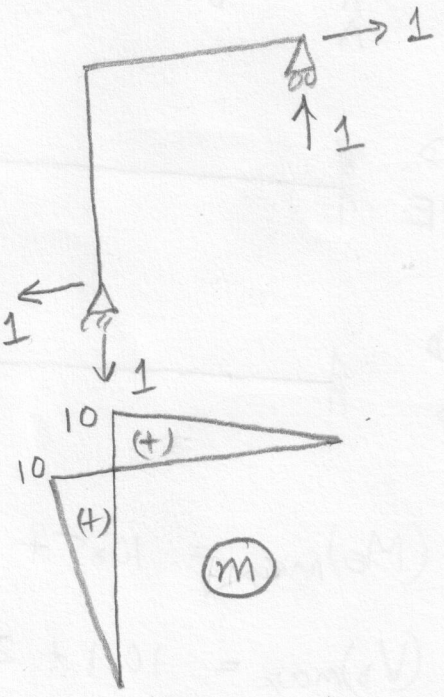
$$\theta_{B^-} = \frac{1}{2}(-750)(-1)(10)\frac{1}{EI} = \frac{3750}{EI} \quad ; \quad \Delta_{vB} = \frac{1}{3}(-750)(-10)(10)\frac{1}{EI} = \frac{25000}{EI}$$

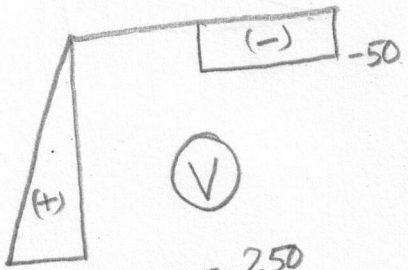
$$= \frac{3750}{(200E6)(5E-4)} = 0.0375 \text{ rad} \quad ; \quad \Delta_{vB} = \frac{25000}{(200E6)(5E-4)} = 0.25 \text{m}$$

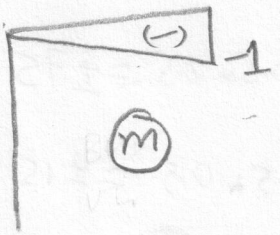
P2

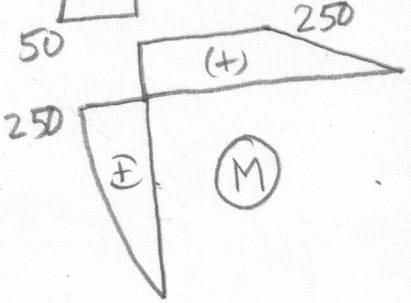












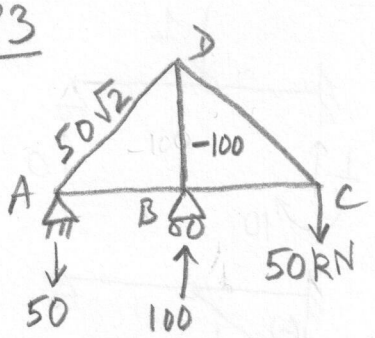
$$\theta_C = \left[\frac{1}{2}(250)(-0.5)(5) + \frac{1}{6}(250)(-2*0.5-1)(5)\right]\frac{1}{EI}$$

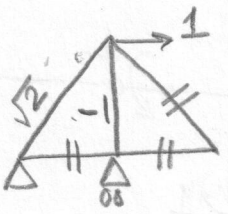
$$= -\frac{4375}{6EI} = -\frac{4375}{6(200E6)(5E-4)} = -7.29167 \times 10^{-3} \text{ rad}$$

$$\Delta_{HC} = \frac{1}{EI}\left(\frac{1}{2}(250)(10+5)(5) + \frac{1}{3}(250)(5)(5) + \frac{5}{12}(250)(10)(10)\right)$$

$$= \frac{21875}{EI} = -\frac{21875}{(200E6)(5E-4)} = 0.21875 \text{m}$$

P3





P_i

P_i for AB, BC, CD not required.

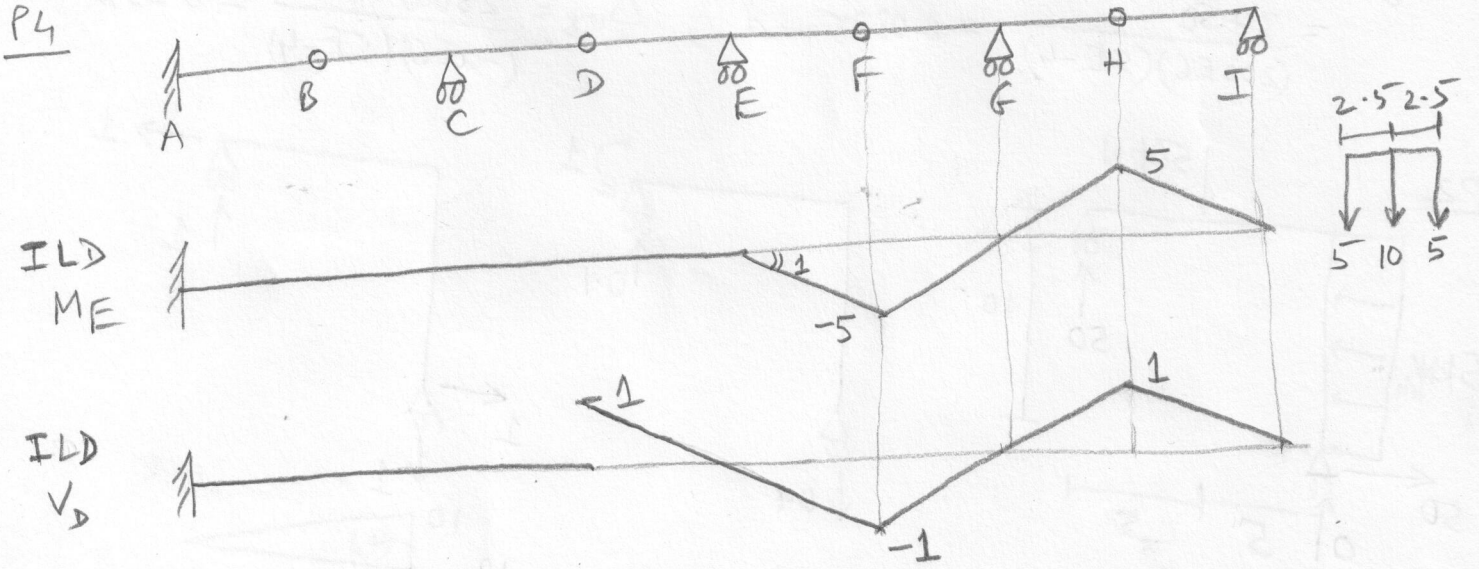
BD misfit $= +\frac{10}{1000}$, AD $\Delta T = -10°C$.

mem	p_i	P_i	$p_i P_i L_i/AE$	$p_i(\alpha \Delta T L)_i$	$p_i * (\text{misfit})_i$
AD	$\sqrt{2}$	$50\sqrt{2}$	$\sqrt{2}/100$	$-\sqrt{2}/100$	0
BD	-1	-100	$1/100$	0	$(-1)\left(\frac{10}{1000}\right)$

$(\sqrt{2})\left(\frac{10^{-4}}{\sqrt{2}}.(-10).10\sqrt{2}\right)$

$$\Delta_{DH} = \frac{\sqrt{2}}{100} + \frac{1}{100} - \frac{\sqrt{2}}{100} - \frac{10}{1000} = 0$$

P4



$$(M_E)_{max} = 10*5 + 2*5*2.5 = \pm 75 \text{ Nm}$$

$$(V_D)_{max} = 10*1 + 2*5*0.5 = \pm 15 \text{ N}$$