DEPARTMENT OF CIVIL ENGINEERING, IIT BOMBAY

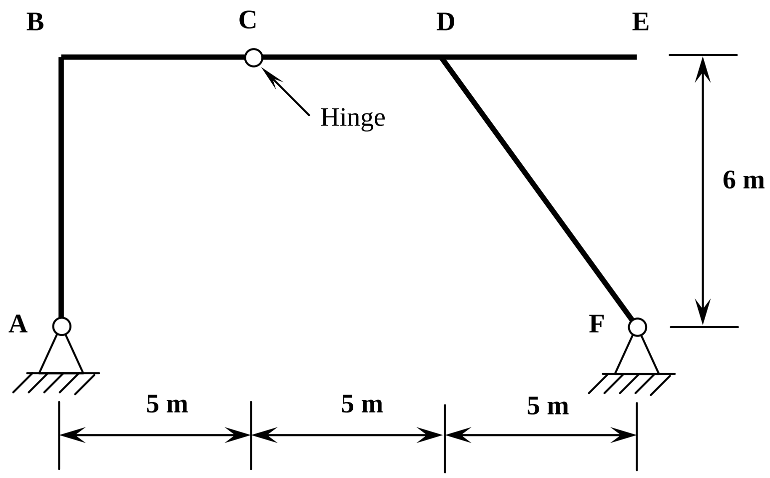
CE-222 STRUCTURAL MECHANICS I

Midsem 21/2/11

Problem 1

Consider the structure in **Fig. 1**. Draw influence lines for all reactions at supports, and for shear at the hinge, when a load moves from ***B*** to ***E***.

Fig. 1



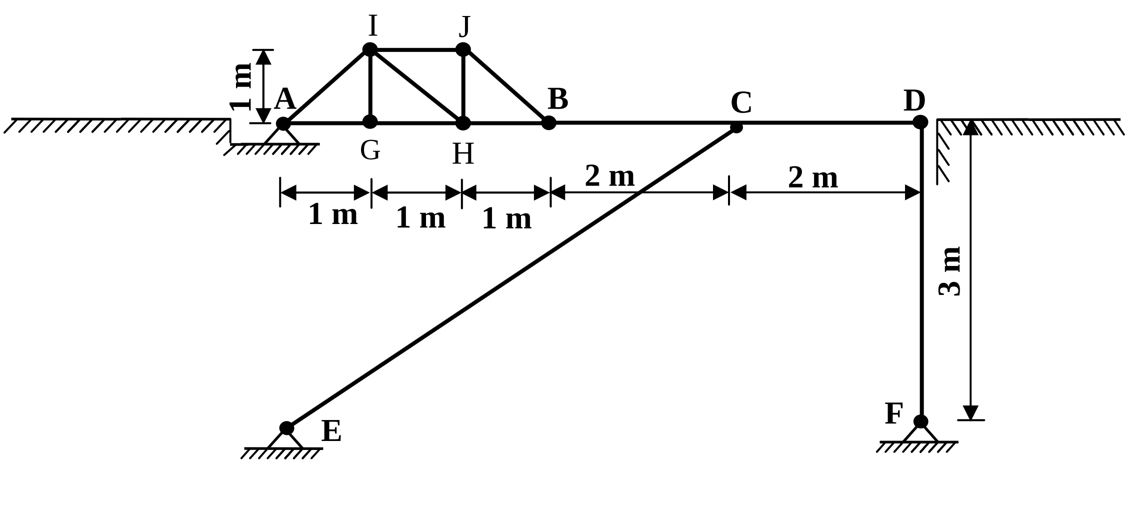
Problem 2

The truss-beam bridge structure shown in **Fig. 2** comprises truss ***AGHBJI*** and three members ***BCD***, ***DF***, and ***CE***. The truss is connected to member ***BCD***. Members ***BCD*** and ***CE*** are connected by a pin/hinge at ***C***. Members ***BCD*** and ***DF*** are connected by a pin/hinge at ***D***. Misfit errors exist in the truss members. Members ***AG*** and ***HB*** are 5mm longer, member ***GH*** is 2mm shorter, members ***AI*** and ***JB*** are 7mm shorter, and member ***IJ*** is 10mm longer. Also, member ***IJ*** is 120^{o}F above ambient temperature, and members ***IG***, ***JH***, ***IH*** are 60^{o}F below ambient temperature, with α=0.6E−5/ ^{o}F. Find:

(i) the rotation at point ***C*** in member ***BCD*** .

(ii) the rotation at point ***C*** in member ***CE*** .

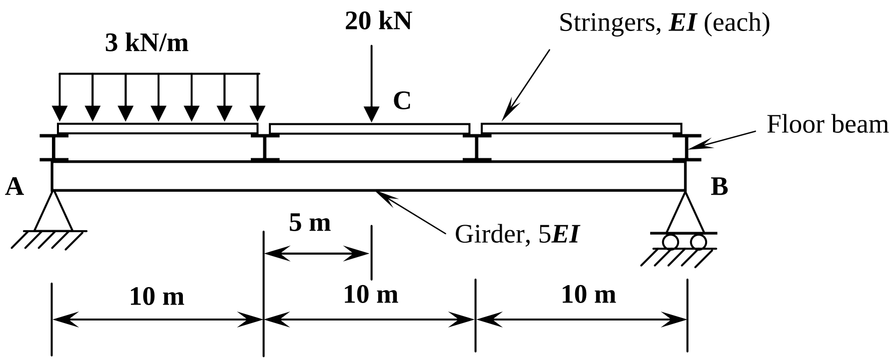
Fig. 2



Problem 3

The system shown in **Fig. 3** comprises stringers, floor beams, and a girder, with loading and properties as shown. Assume stringers are simply supported between floor beam support points. Find the vertical deflection at the midpoint ***C*** of the middle stringer. Neglect shear deformations.

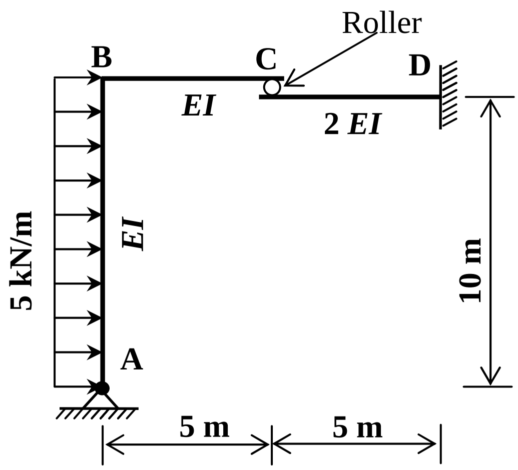
Fig. 3



Problem 4

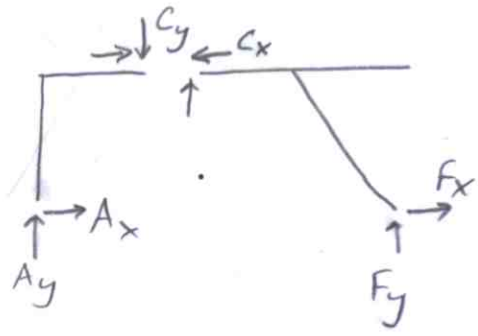
For the system shown in **Fig. 4,** find the rotation and horizontal deflection of point ***B***. Neglect axial and shear deformations.

Fig. 4

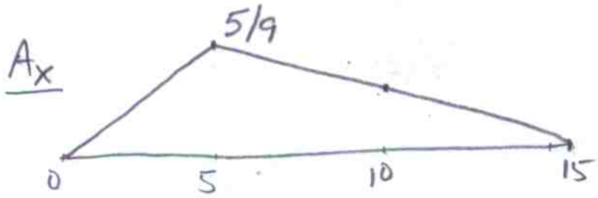


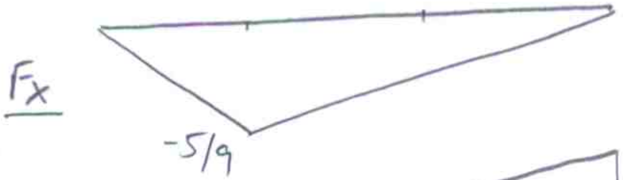
1. Use equilibrium approach.

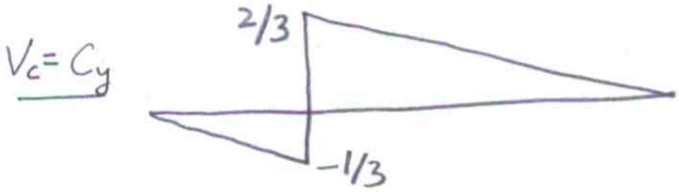
	A_x	A_y	F_x	F_y	C_y
$x=0$	0	1	0	0	0
$x=5^-$	5/9	2/3	−5/9	1/3	−1/3
$x=5^+$	5/9	2/3	−5/9	1/3	2/3
$x=10$	5/18	1/3	−5/18	2/3	1/3
$x=15$	0	0	0	1	0



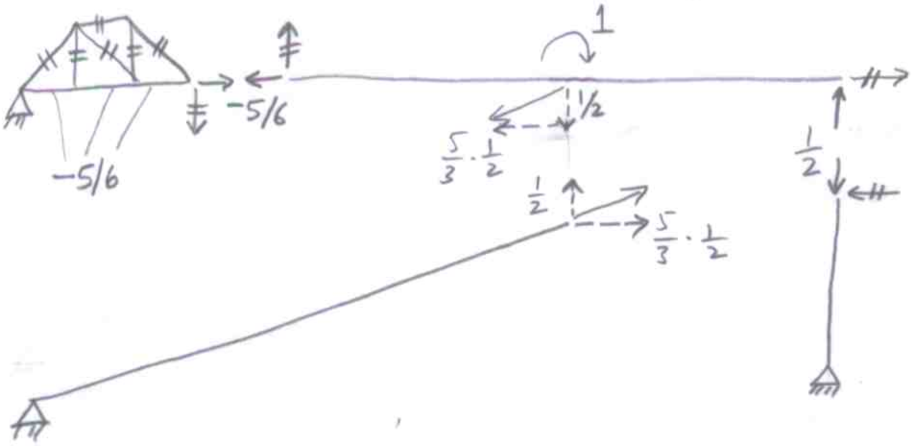
$\underline{x=5}$: $A_x = \frac{5}{6} A_y$







2.

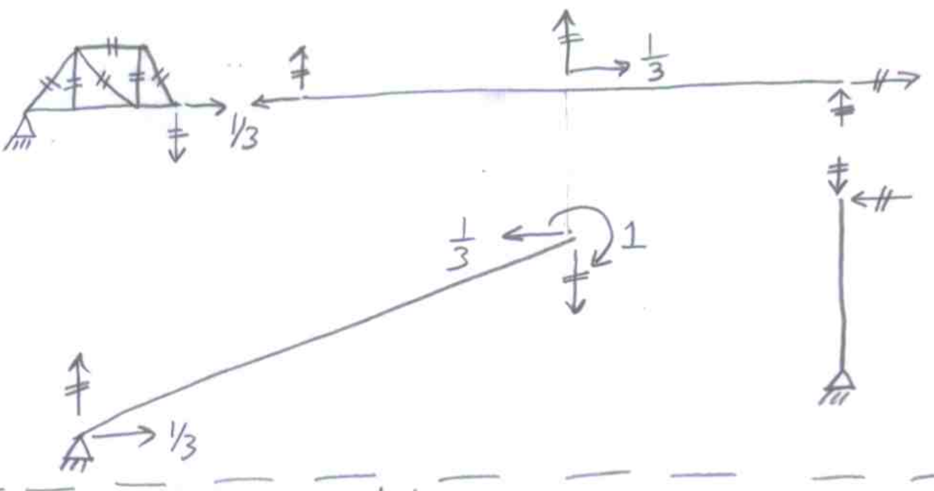


For rotation of BCD at C, apply $M_c = 1$ as shown.

Virtual work gives,

$$1\,\mathrm{Nm} \cdot \theta_c = -\frac{5}{6}\,\mathrm{N} \cdot (5+5-2)\,\mathrm{mm}$$

$$\Rightarrow \theta_c = 6.67\,\mathrm{E}{-3}\ \mathrm{rad.}$$



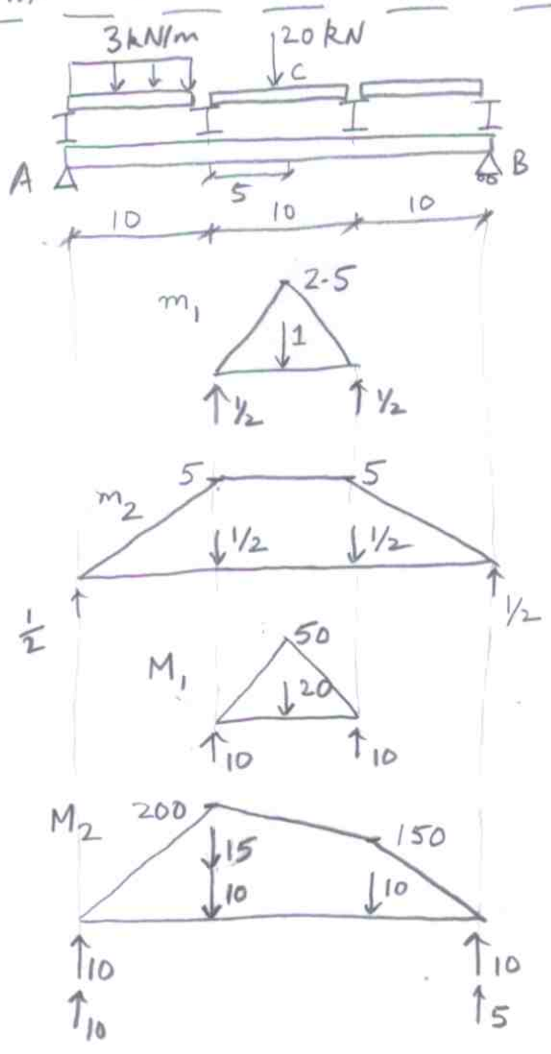
For rotation of CE at C, apply $M_c = 1$ as shown.

Virtual work gives,

$$1\,\mathrm{Nm} \cdot \theta_c = \frac{1}{3}\,\mathrm{N}\,(5+5-2)\,\mathrm{mm}$$

$$\theta_c = 2.67\,\mathrm{E}{-3}\ \mathrm{rad}$$

3.



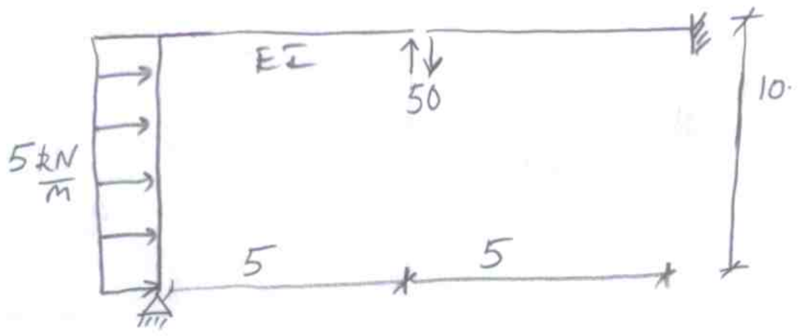
$$1 \cdot \Delta_{cv} = \int_0^{10} m_1 \frac{M_1}{EI}\,dx + \int_0^{30} m_2 \frac{M_2}{5EI}\,dx$$

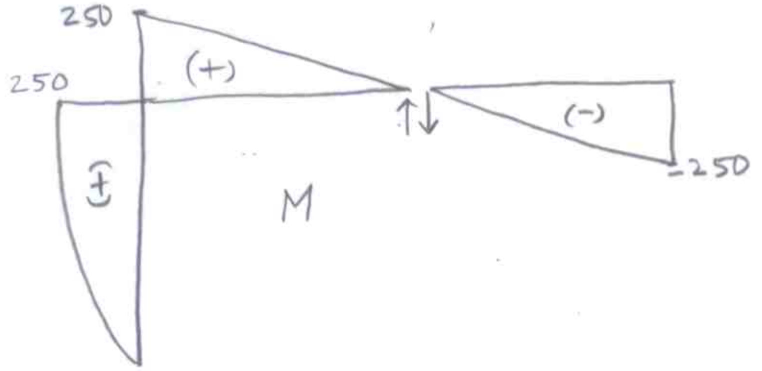
$$= \frac{1}{EI}\,\frac{1}{3}(50)(2.5)(10)$$

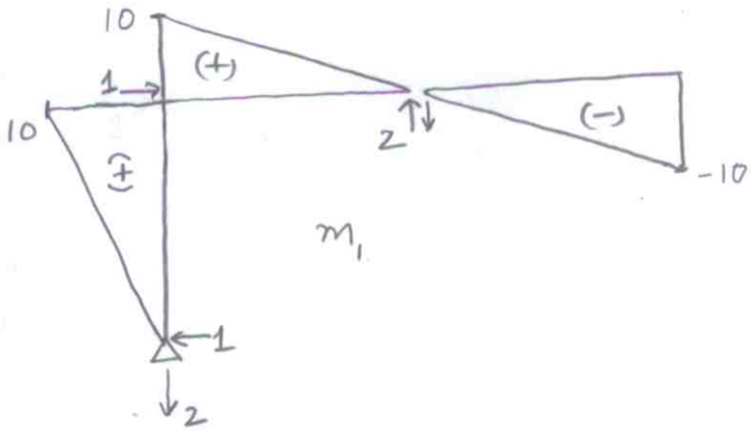
$$+ \frac{1}{5EI}\left\{\frac{1}{3}(10)\left[(200)(5) + (150)(5)\right] + \frac{1}{2}(5)(200+150)(10)\right\}$$

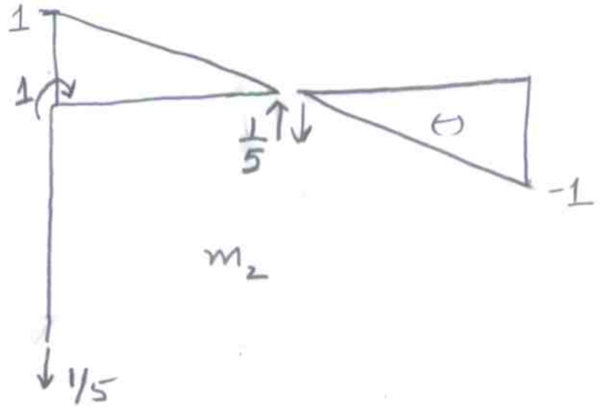
$$\Delta_{cv} = \frac{10000}{3EI}$$

4









For Δ_{BH} apply unit horizontal load at B

$$1 \cdot \Delta_{BH} = \int m_1 \frac{M}{EI}\, dx$$

$$\Delta_{BH} = \frac{1}{3}(250)(10)(5)\frac{1}{2EI} + \frac{1}{3}(250)(10)(5)\cdot\frac{1}{EI} + \frac{5}{12}(10)(250)(10)\cdot\frac{1}{EI}$$

$$\Delta_{BH} = \frac{50000}{3}\frac{1}{EI}$$ ◄

For θ_B apply unit moment at B

$$\theta_B = \frac{1}{3}(250)(1)(5)\cdot\frac{1}{2EI} + \frac{1}{3}(250)(1)(5)\cdot\frac{1}{EI}$$

$$\theta_B = 625\,\frac{1}{EI}$$ ◄