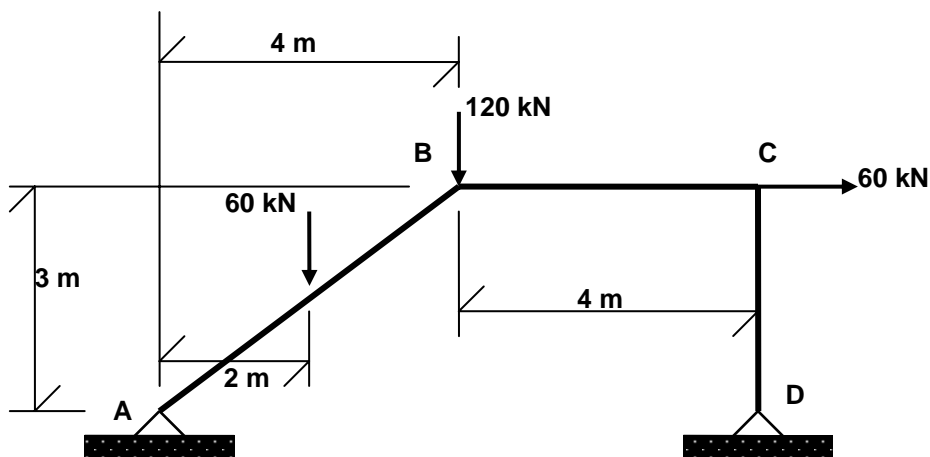
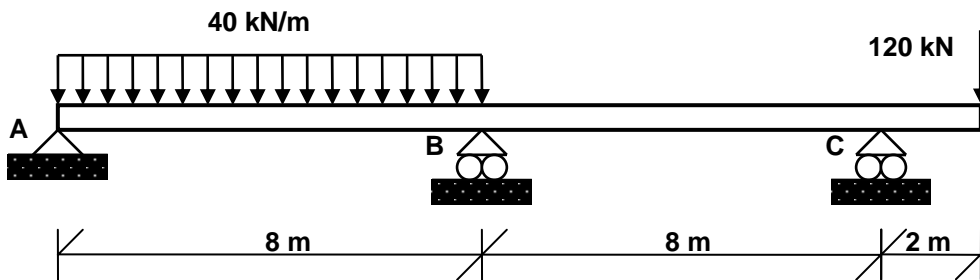
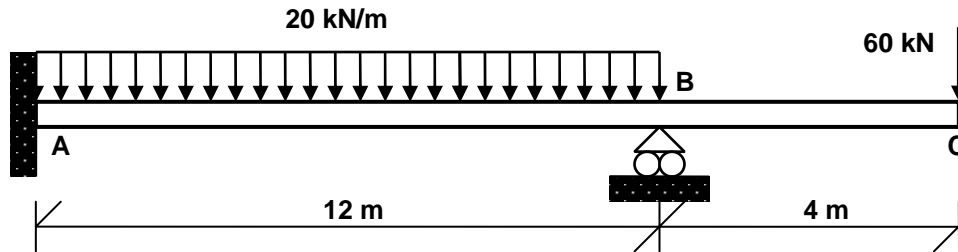


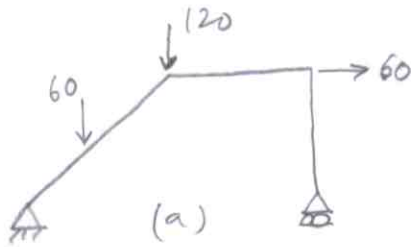
CE-222 STRUCTURAL MECHANICS I
DEPARTMENT OF CIVIL ENGINEERING

Tutorial Assignment # 8: Statically Indeterminate Simple Beams and Frames - External Indeterminacy of Degree One

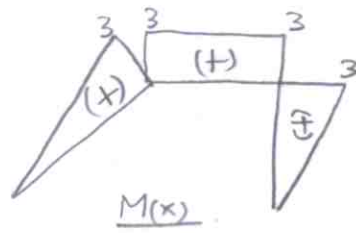
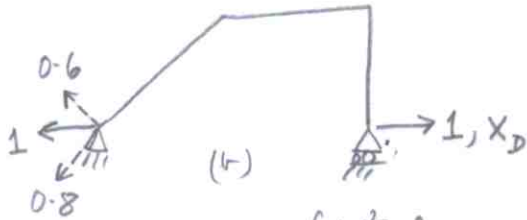
Draw the **Shear Force and Bending Moment Diagrams** for the following systems. Sketch the **Qualitative Deflected Shapes**. Flexural rigidity of all members is equal to EI . Neglect axial deformations. Use method of consistent deformations and standard notations and signs.



③



From tute 6, soln. $\Delta_{D0} = \frac{4515}{EI} \times 10^3$, EI in Nm^2

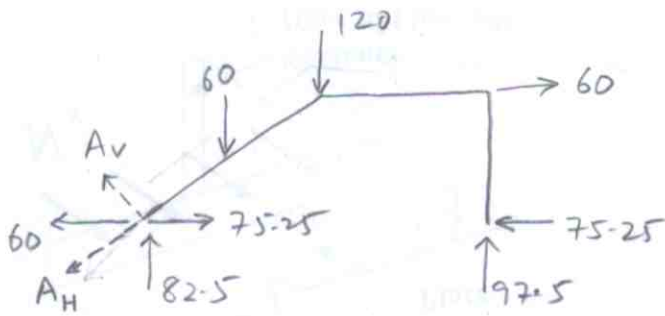


← From tute 6 soln.
(Real & virtual load is same)

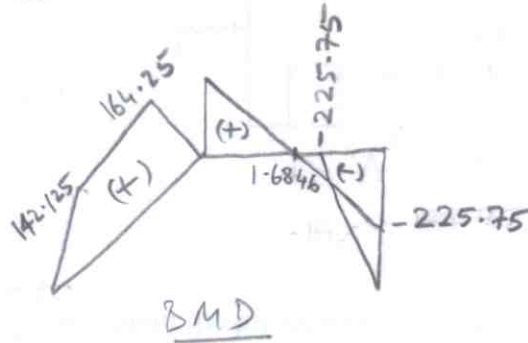
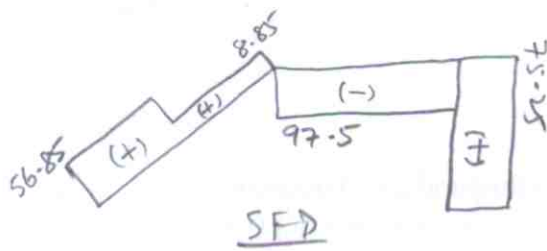
$$f_{DD} = \int \frac{M^2}{EI} dx = \frac{1}{EI} \left(\frac{1}{3} (3)(3)(5) + (3)(3)(4) + \frac{1}{3} (3)(3)(3) \right) = \frac{60 \times 10^3}{EI}$$

$$0 = \Delta_D = \Delta_{D0} + f_{DD} X_D \Rightarrow X_D = R_D = -\frac{4515}{60} = -75.25 \text{ kN}$$

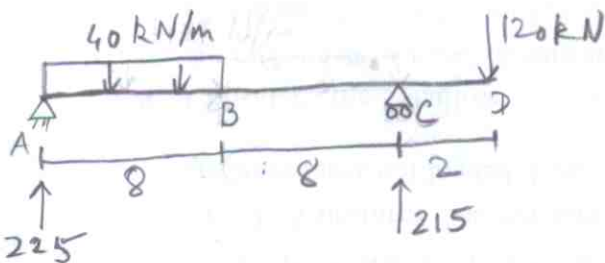
Thus we have, after superposing (a) + X_D * (b), (use Tute-6 soln.)



$$A_V = (60 - 75.25) \left(\frac{3}{5}\right) + (82.5) \left(\frac{4}{5}\right) = 56.85$$



②



$$M = 225x - 20x^2 \text{ in AB, } x(\rightarrow) \text{ from A}$$

$$= 120x \text{ in DC, } x(\leftarrow) \text{ from D}$$

$$= -240 + 95x \text{ in CB, } x(\leftarrow) \text{ from C.}$$

$$X_1 = R_B = 1$$

$$m = -0.5x \text{ in AB, } x(\rightarrow) \text{ from A}$$

$$= -0.5x \text{ in CB, } x(\leftarrow) \text{ from C}$$

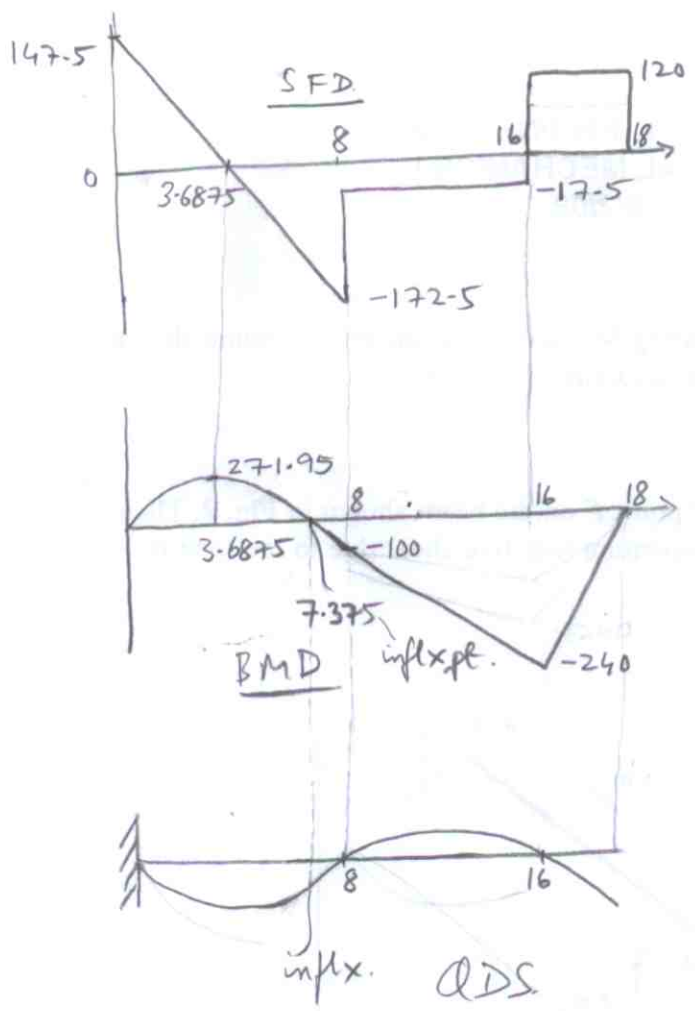
$$f_{11} = 2 \times (0.25) \left(\frac{8^3}{3}\right) = 85.333/EI$$

$$\Delta_{10} = \frac{1}{EI} \left[- \int_0^8 (225x - 20x^2 - 240 + 95x)(-0.5x) dx \right]$$

$$= \frac{1}{EI} \left[(160) \left(\frac{8^3}{3}\right) - (0) \left(\frac{8^4}{4}\right) - 120 \left(\frac{8^2}{2}\right) \right] = -\frac{13226.67}{EI}$$

$$\Rightarrow X_1 = 155 \text{ kN} = R_B$$

$$R_c = 215 - \left(\frac{1}{2}\right)(155) = 137.5$$



① Similar to P. 2, Tutorial 10 → put $k \rightarrow \infty$ there, i.e. rigid support in place of spring.