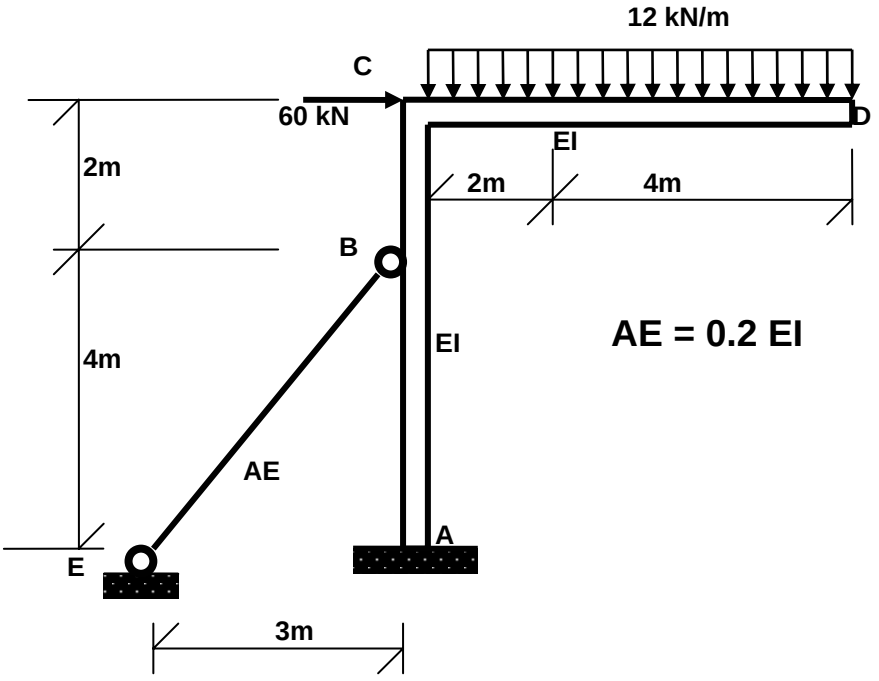
CE-222 STRUCTURAL MECHANICS I

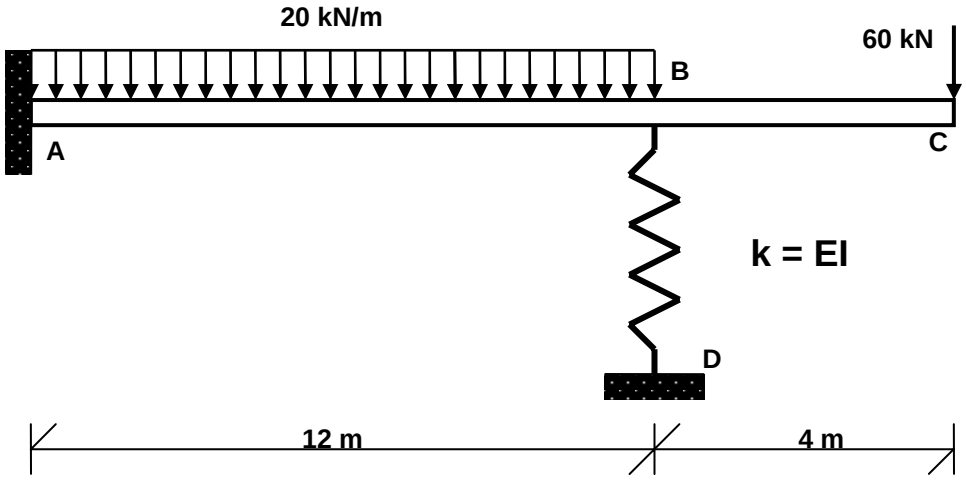
DEPARTMENT OF CIVIL ENGINEERING

Tutorial Assignemnt # 10: Statically Indeterminate Structures

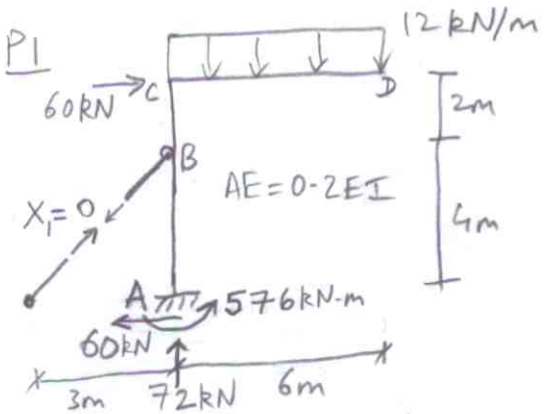
Indeterminacy of Degree One

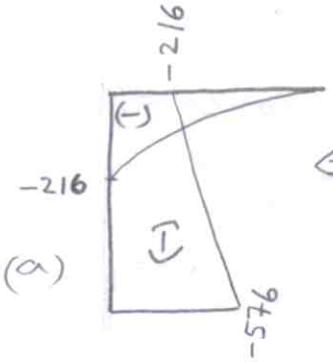
Draw the **Shear Force and Bending Moment Diagrams** for the following systems. Sketch the **Qualitative Deflected Shapes**. Flexural rigidity of all members is equal to EI. **Equivalence of EI, AE and k is in numerical values for Force units in kN and distance in 'm'**. Use method of consistent deformations and standard notations and signs.



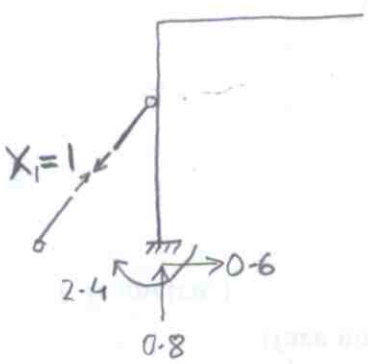


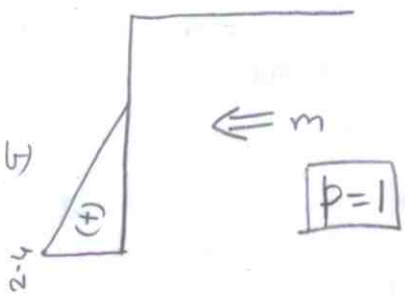
P1





$P = 0$





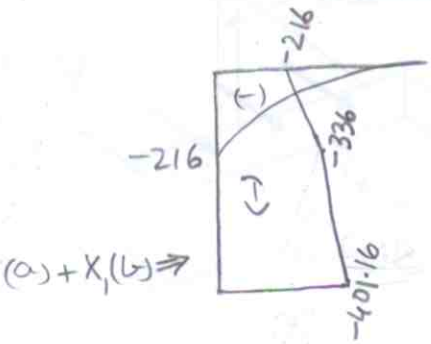
$P = 1$

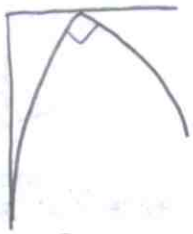
$$\Delta_{10} = \frac{1}{6}(2\cdot4)(-2\times576 - 336)(4)\cdot\frac{1}{EI}$$
$$= -2380\cdot8/EI$$

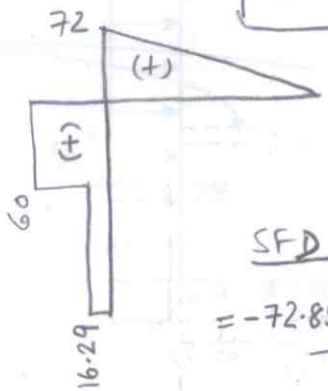
$$f_{11} = \frac{1}{3}(2\cdot4)(2\cdot4)(4)\cdot\frac{1}{EI} + \frac{5}{AE}$$
($\frac{5}{AE} \rightarrow 0\cdot2EI$)

$$\Delta_{10} + f_{11}X_1 = 0$$

$$X_1 = \frac{2380\cdot8}{32\cdot68\,EI} = 72\cdot852 \text{ kN}$$

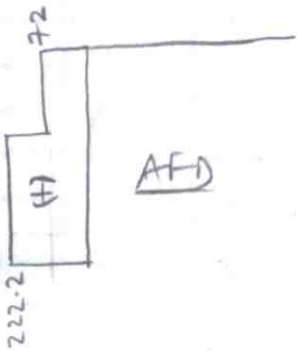




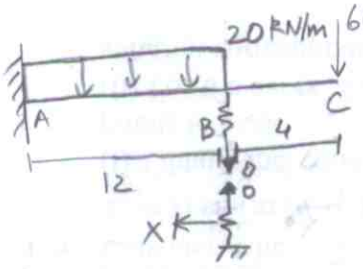


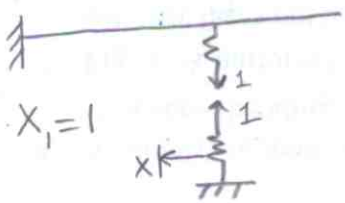
SFD

$= -72\cdot852(0\cdot6) + 60$



P2





$M = -60(x+4) - 20\left(\frac{x^2}{2}\right)$ in BA

$P = 0$

x measure leftward from B.

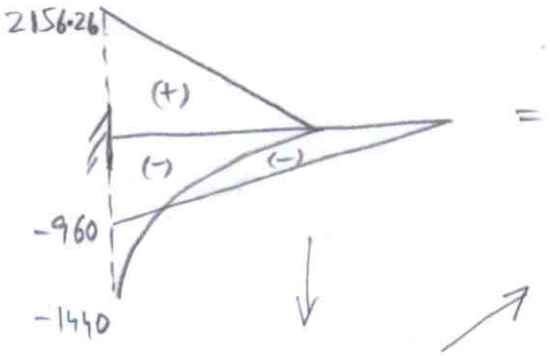
$m = -1(x)$ in BA

$P = 1$

$$\Delta_{10} = \int_0^{12} m\frac{M}{EI}dx = \frac{1}{EI}\left[(60)\left(\frac{12^3}{3}\right) + (240)\left(\frac{12^2}{2}\right) + 10\left(\frac{12^4}{4}\right)\right]$$
$$= 103680/EI$$

$$f_{11} = \int_0^{12}\frac{m^2}{EI} + \frac{P^2L}{AE\,EI} = \left(\frac{12^3}{3} + 1\right)\cdot\frac{1}{EI} = \frac{577}{EI}$$

$$\Delta_{10} + f_{11}X_1 = 0 \Rightarrow X_1 = -179\cdot688 \text{ kN}$$



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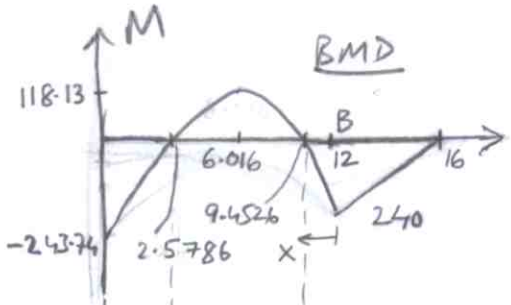
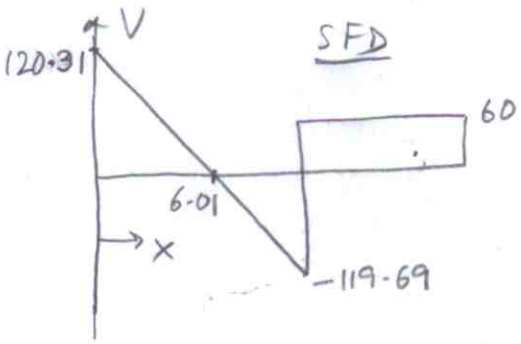
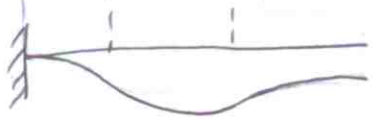


$M = -60(x+4) - 10x^2 + 179.688x$

$= -10x^2 + 119.688x - 240$.

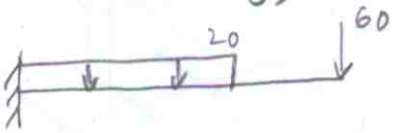
$x = 2.5374,\ 9.4214$. (mark $(12-x)$ on plot)





QDS

Another way,



M = same as before.

$m = x$ (-ve of before)

$\Delta_{10} = \int_0^{12} m \frac{M}{EI}$ = -ve of before

$= -103680/EI$.

$f_{11} = \int_0^{12} \frac{m^2}{EI} dx = \frac{12^3}{3} \cdot \frac{1}{EI}$

$\Delta_{10} + f_{11} X_1 = \Delta_1$

$\Delta_1 = -\frac{X_1}{k} = -\frac{X_1}{EI}$

$\Rightarrow -\frac{103680}{EI} + \frac{12^3}{3} \cdot \frac{1}{EI} \cdot X_1 = -\frac{X_1}{EI}$

$X_1 = 179.688\ (\uparrow)$ at B

$\Rightarrow \boxed{X_1 = 179.688\ (C)}$ in spring

↓ same as before.