CE-222 STRUCTURAL MECHANICS I

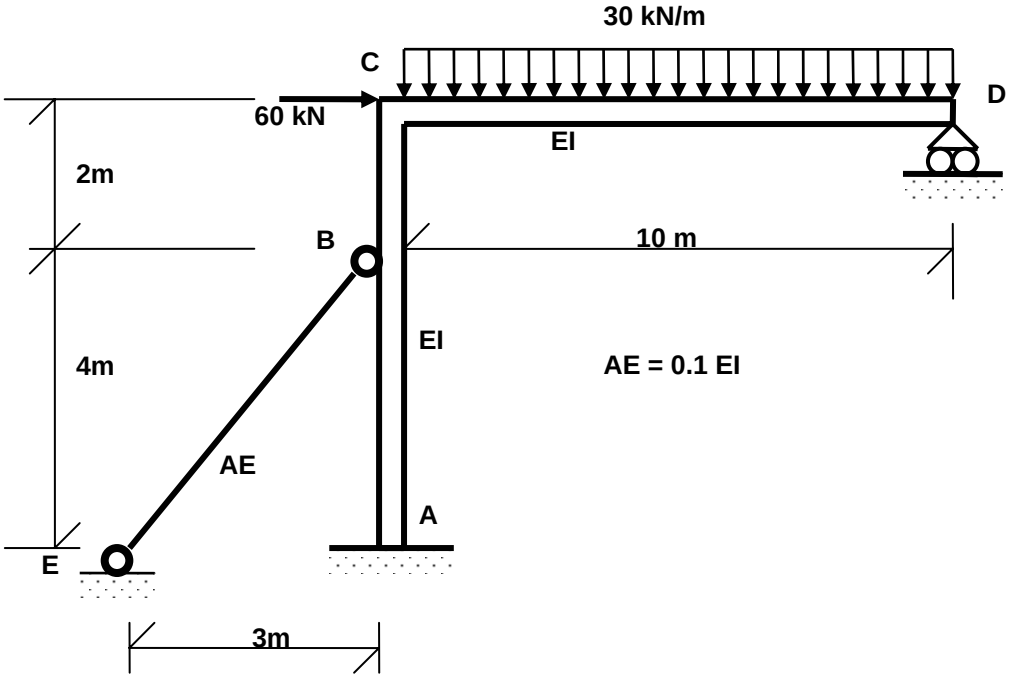
DEPARTMENT OF CIVIL ENGINEERING

Tutorial Assignment # 11: Statically Indeterminate Structures

Indeterminacy of Degree Two

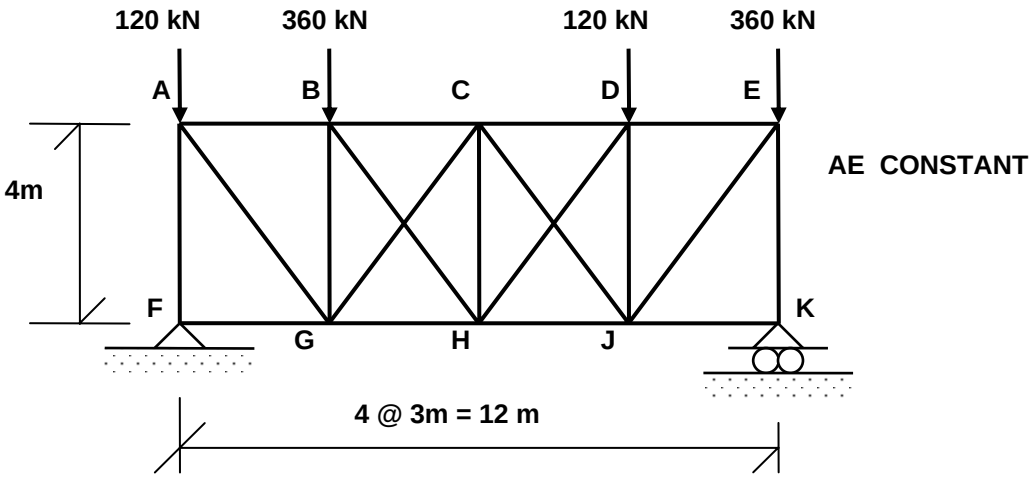
Problem # 1

Draw the **Shear Force and Bending Moment Diagrams** for the following system and calculate the force in truss member. Sketch the **Qualitative Deflected Shape**.

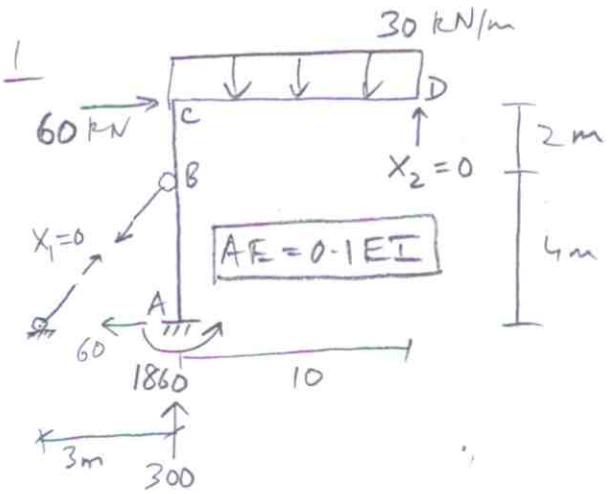


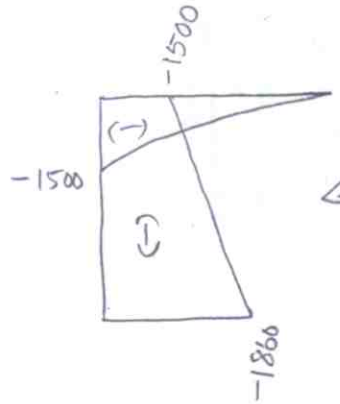
Problem # 2

For the truss system shown below, find the member forces.

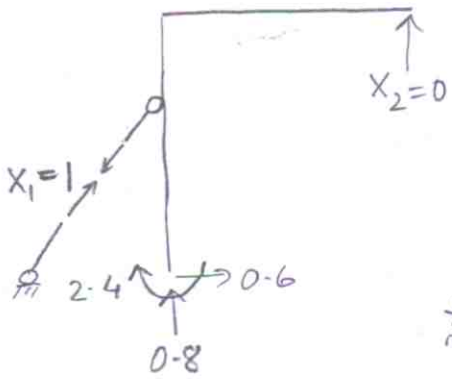


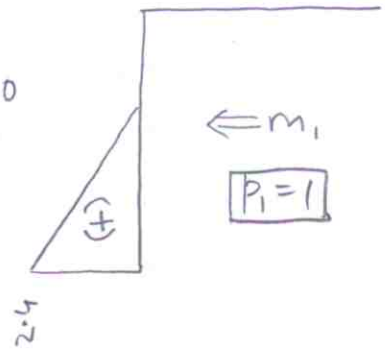
1



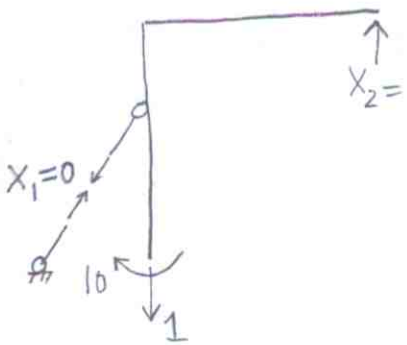


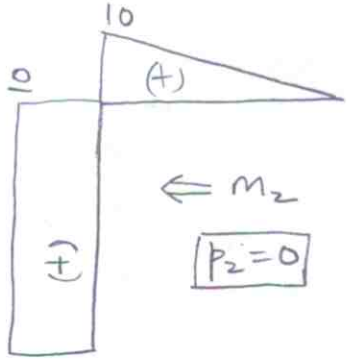
$\Leftarrow M$ $\quad P=0$





$$\Delta_{10} = \frac{1}{6}(2\cdot4)(-2*1860-1620)(4)\cdot\frac{1}{EI}$$
$$= -8544/EI$$
$$f_{11} = \frac{1}{3}(2\cdot4)(2\cdot4)(4)\cdot\frac{1}{EI} + \frac{(1)^2(5)}{AE \to 0\cdot1EI}$$
$$= 57\cdot68/EI$$
$$f_{12} = \frac{1}{2}(10)(2\cdot4)(4)\cdot\frac{1}{EI} = 48/EI$$

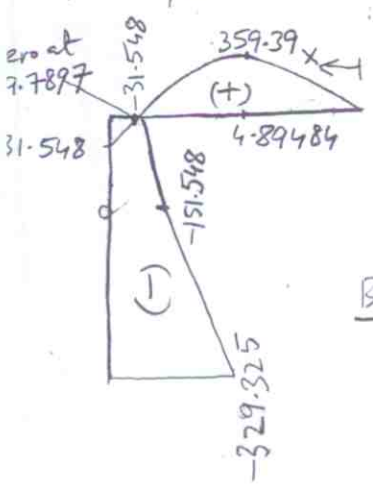




$$\Delta_{20} = \frac{1}{EI}\left[-\int_0^{10}(x)(15x^2)\,dx - \frac{1}{2}(10)(1860+1500)(6)\right]$$
$$= -138300/EI$$
$$f_{22} = \left[(10)(10)(6) + \frac{1}{3}(10)(10)(10)\right]\cdot\frac{1}{EI}$$
$$= 2800/3EI$$

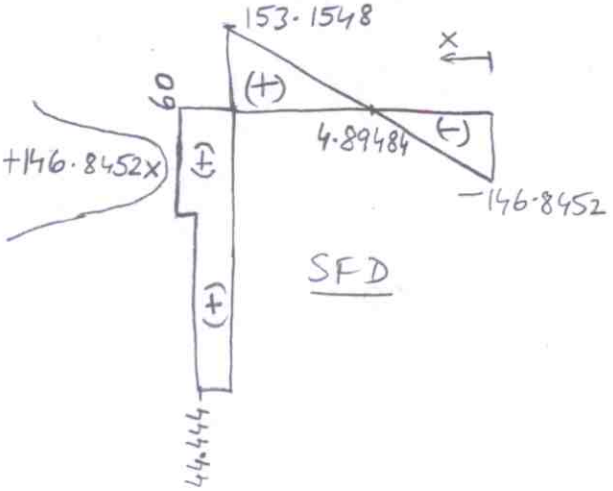
$$\begin{Bmatrix} -8544 \\ -138300 \end{Bmatrix} + \begin{bmatrix} 57\cdot68 & 48 \\ 48 & \frac{2800}{3} \end{bmatrix}\begin{Bmatrix} X_1 \\ X_2 \end{Bmatrix} = \begin{Bmatrix} 0 \\ 0 \end{Bmatrix} \Rightarrow \begin{Bmatrix} X_1 \\ X_2 \end{Bmatrix} = \frac{3}{154592}\begin{bmatrix} \frac{2800}{3} & -48 \\ -48 & 57\cdot68 \end{bmatrix}\begin{Bmatrix} 8544 \\ 138300 \end{Bmatrix}$$

$T = X_1 = 25\cdot9263$, $X_2 = 146\cdot8452 = R_D$

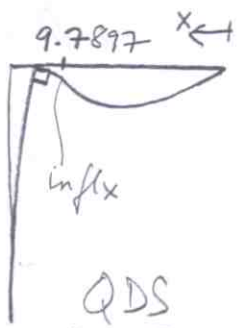


BMD

For DC,
$M = -15x^2 + 146\cdot8452x$

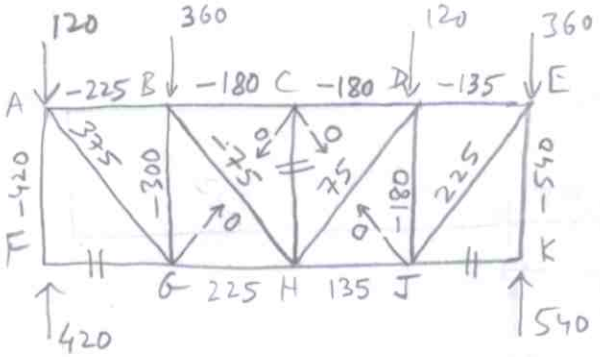


SFD



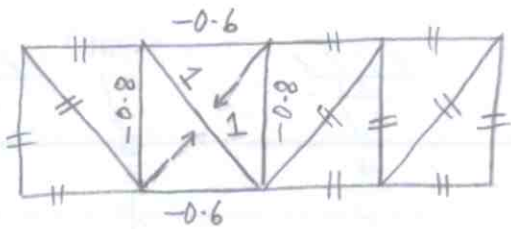
QDS

P2



(a)

$X_1 = 1$



(b)

mem	P_i	p_{i1}	p_{i2}	L_i	$P_i p_{i1} L_i$	$P_i p_{i2} L_i$	$p_{i1}^2 L_i$	$p_{i2}^2 L_i$	$p_{i1} p_{i2} L_i$
BC	-180	-0.6	0	3	324	0	1.08	0	0
CD	-180	0	-0.6	3	0	324	0	1.08	0
GH	225	-0.6	0	3	-405	0	1.08	0	0
HJ	135	0	-0.6	3	0	-243	0	1.08	0
BG	-300	-0.8	0	4	960	0	2.56	0	0
CH	0	-0.8	-0.8	4	0	0	2.56	2.56	2.56
DJ	-180	0	-0.8	4	0	576	0	2.56	0
BH	-75	1	0	5	-375	0	5	0	0
DH	75	0	1	5	0	375	0	5	0
CG	0	1	0	5	0	0	5	0	0
CJ	0	0	1	5	0	0	0	5	0

$504 = \Delta_{10}$ $1032 = \Delta_{20}$ $17.28 = f_{11}$ $17.28 = f_{22}$ $2.56 = f_{12} = f_{21}$

$$\frac{1}{AE}\begin{Bmatrix} 504 \\ 1032 \end{Bmatrix} + \frac{1}{AE}\begin{bmatrix} 17.28 & 2.56 \\ 2.56 & 17.28 \end{bmatrix}\begin{Bmatrix} X_1 \\ X_2 \end{Bmatrix} = 0$$

$$\begin{Bmatrix} X_1 \\ X_2 \end{Bmatrix} = -\frac{1}{292.0448}\begin{bmatrix} 17.28 & -2.56 \\ -2.56 & 17.28 \end{bmatrix}\begin{Bmatrix} 504 \\ 1032 \end{Bmatrix} = -\begin{Bmatrix} 20.7749 \\ 56.6445 \end{Bmatrix} = \begin{Bmatrix} GC \\ CJ \end{Bmatrix}$$

(b) is as shown ↑

$BC = -180 + (-0.6)(-20.7749) = -167.535$
$GH = 225 + (-0.6)(-20.7749) = 237.465$
$BG = -300 + (-0.8)(-20.7749) = -283.38$

$BH = -75 + (-20.7749)$
$= -95.7749$
$DH = 75 + (-56.6445)$
$= 18.3555$

$CD = -180 + (-0.6)(-56.6445) = -146.013$
$HJ = 135 + (-0.6)(-56.6445) = 168.987$
$DJ = -180 + (-0.8)(-56.6445) = -134.684$
$CH = (-0.8)(-20.7749 - 56.6445) = 61.936$