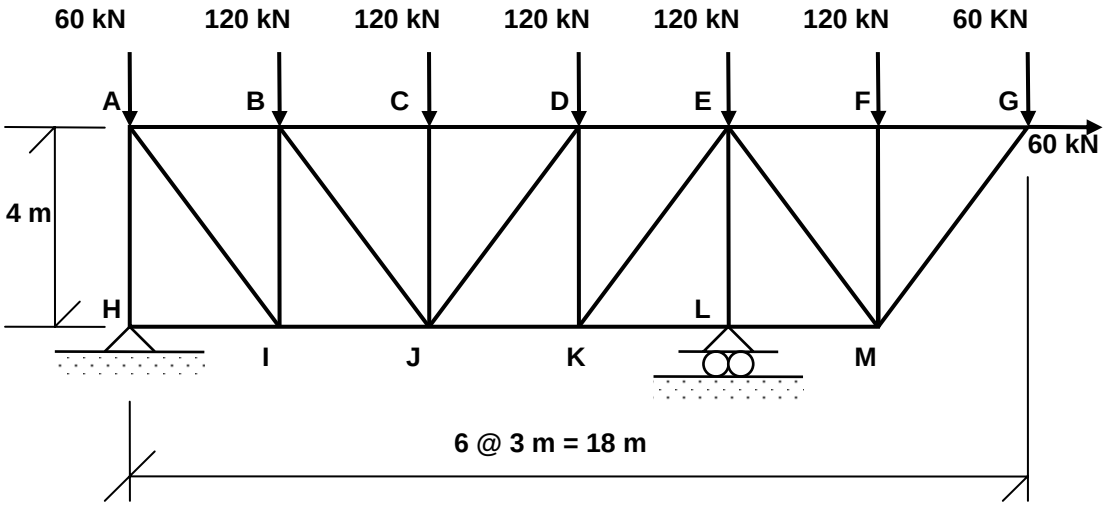
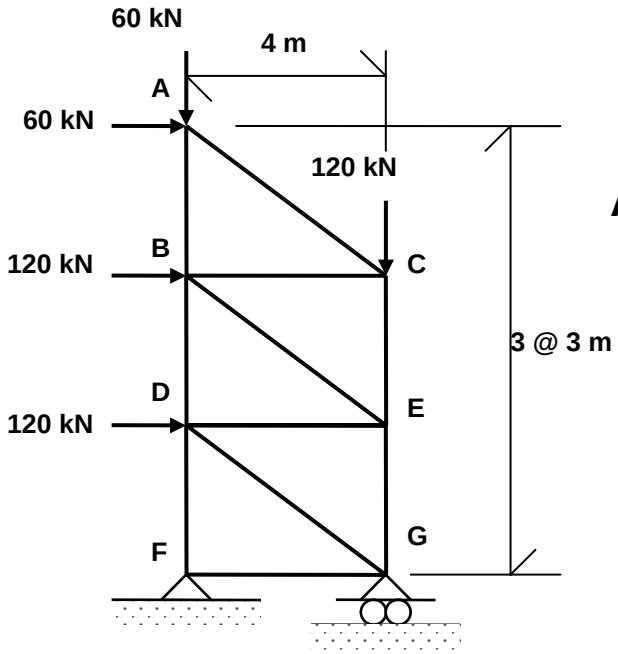
CE-222 STRUCTURAL MECHANICS I
DEPARTMENT OF CIVIL ENGINEERING
Tutorial Assignment # 5: Displacement of Truss Joints

Calculate the **Horizontal Displacement of Joint G** and **Vertical Displacement of Joint J** for the first truss system shown below.

Calculate the **Horizontal and Vertical Displacements of Joint A** for the second truss system shown below.

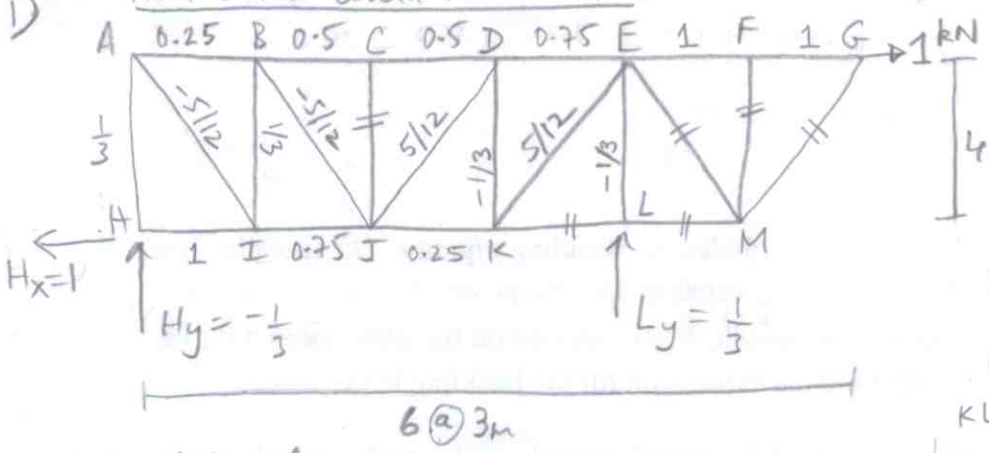




AE CONSTANT

CE222 TUTORIAL #5

1) Horizontal unit load at G:



$H_y = -\frac{(1)(4)}{12} = -1/3$

$L_y = \frac{1}{3}$

$MG = 0$

$EF = FG = 1$

$CJ = FM = 0$

$KL = LM = \frac{(1)(0)}{4} = 0$

$EM = 0$

$FL = -L_y = -\frac{1}{3}$

$DE = \frac{(1)(4) - (\frac{1}{3})(3)}{4} = 0.75$

$KE = (\frac{1}{3})(\frac{5}{4}) = \frac{5}{12}$

$DK = -(\frac{5}{12})(\frac{4}{5}) = -\frac{1}{3}$

$JD = (\frac{1}{3})(\frac{5}{4}) = \frac{5}{12}$

$CD = BC = 0.75 - (\frac{5}{12})(\frac{3}{5}) = 0.5$

$JK = (\frac{5}{12})(\frac{3}{5}) = 0.25$

$BJ = -JD = -\frac{5}{12}$

$BI = (\frac{5}{12})(\frac{4}{5}) = \frac{1}{3}$

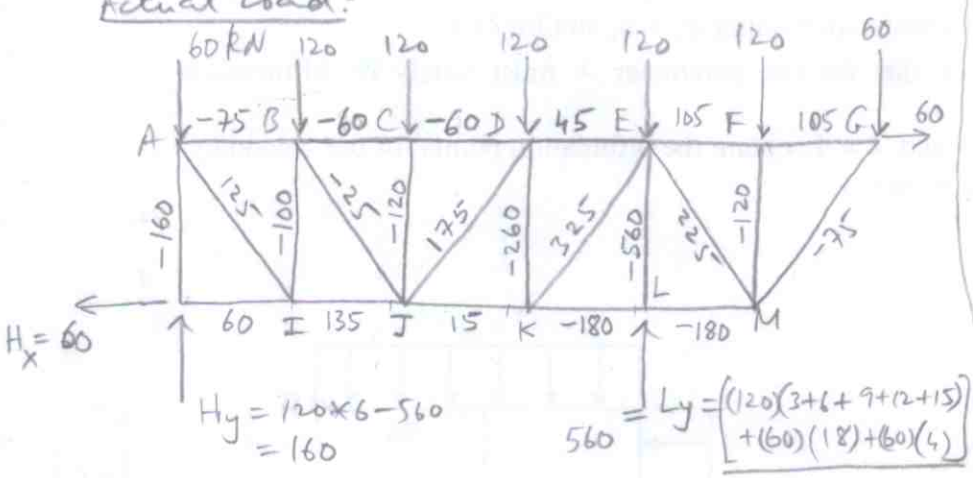
$AI = -(\frac{1}{3})(\frac{5}{4}) = -\frac{5}{12}$

$IJ = 1 - 0.5 + (\frac{5}{12})(\frac{3}{5}) = 0.75$

$HI = H_x = 1$

$AB = (5/12)(3/5) = 0.25$

Actual Load:



$EF = FG = \frac{(60)(3+4)}{(4)} = 105$

$MG = -(60)(\frac{5}{4}) = -75$

$KL = LM = -\frac{[(120)(3) + (60)(6)]}{(4)} = -180$

$EM = (180 + 60 - 105)(\frac{5}{3}) = 225$

$AI = (160 - 60) \times \frac{5}{4} = 125$

$AB = -(125)(\frac{3}{5}) = -75$

$BJ = (160 - 60 - 120)(\frac{5}{4}) = -25$

$JD = -(160 - 60 - 120 - 120)(\frac{5}{4}) = 175$

$KE = -(160 - 60 - 3*120)(\frac{5}{4}) = 325$

$IJ = (125)(\frac{3}{5}) + 60 = 135$

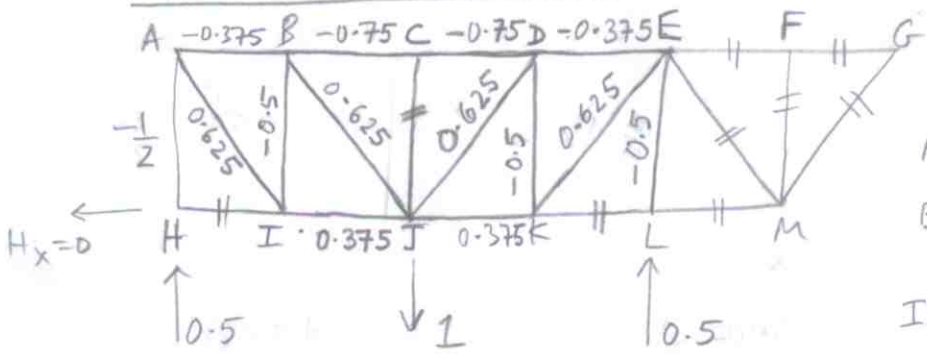
$CD = BC = -75 + (25)(\frac{3}{5}) = -60$

$JK = 135 - (25)(\frac{3}{5}) - (175)(\frac{3}{5}) = 15$

$DE = 60 - 15 = 45$

$IB = -(125)(\frac{4}{5}) = -100$; $DK = -(325)(\frac{4}{5}) = -260$

Vertical unit load at J:



$AI = KE = \left(\frac{1}{2}\right)\left(\frac{5}{4}\right) = 0.625$

$AB = DE = -(0.625)\left(\frac{3}{5}\right) = -0.375$

$BI = DK = -(0.625)\left(\frac{4}{5}\right) = -0.5$

$IJ = JK = (0.625)\left(\frac{3}{5}\right) = 0.375$

$BJ = JD = (0.5)\left(\frac{5}{4}\right) = 0.625$

$BC = CD = -0.375 - 0.625\left(\frac{3}{5}\right) = -0.75$

$AH = EL = -0.5$

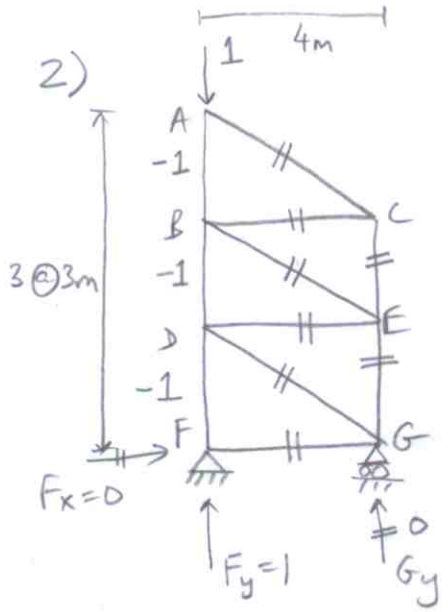
The part EFGML (overhang) is unloaded, hence carries no internal forces, i.e redundant. Hence the remaining part ABCDELKJIH is symmetric in loading, structure, and boundary conditions, hence symmetric in member forces.

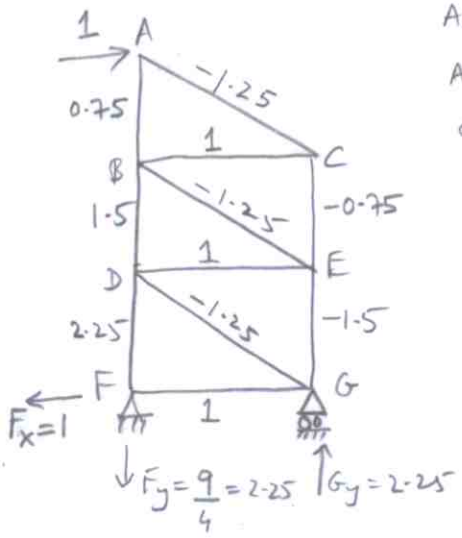
Mem	P_I	P_{II}	P_{real}	L_i	$P_I P_{real} L_i$	$P_{II} P_{real} L_i$
AB	0.25	-0.375	-75	3	-56.25	84.375
BC	0.50	-0.75	-60	3	-90	135
CD	0.50	-0.75	-60	3	-90	135
DE	0.75	-0.375	45	3	101.25	-50.625
EF	1.0	0.0	105	3	315	0.0
FG	1.0	0.0	105	3	315	0.0
HI	1.0	0.0	60	3	180	0.0
IJ	0.75	0.375	135	3	303.75	151.875
JK	0.25	0.375	15	3	11.25	16.875
AH	1/3	-0.5	-160	4	-213.33	320
AI	-5/12	0.625	125	5	-260.417	390.625
BI	1/3	-0.5	-100	4	-133.33	200
BJ	-5/12	0.625	-25	5	52.083	-78.125
CJ	0.0	0.0	-120	4	0.0	0.0
DJ	5/12	0.625	175	5	364.583	546.875
DK	-1/3	-0.5	-260	4	346.67	520
EK	5/12	0.625	325	5	677.083	1015.625
EL	-1/3	-0.5	-560	4	746.67	1120
					2570.0093	4507.5

$$\Delta_{GH} = \frac{2570}{AE}$$

$$\Delta_{JV} = \frac{4507.5}{AE}$$

2)





$AC = -(1)\left(\frac{5}{4}\right) = -1.25$

$AB = (1.25)\left(\frac{3}{5}\right) = 0.75$

$CE = -AB = -0.75$

$BC = (1.25)\left(\frac{4}{5}\right) = 1$

$FG = F_x = 1$

$FD = F_y = 2.25$

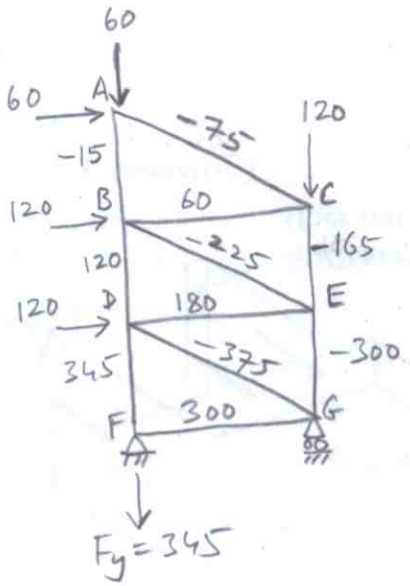
$DG = -(1)\left(\frac{5}{4}\right) = -1.25$

$DE = (1.25)\left(\frac{4}{5}\right) = 1$

$BE = (-1)\left(\frac{5}{4}\right) = -1.25$

$EG = -0.75 - (1.25)\left(\frac{3}{5}\right) = -1.5$

$BD = -EG = 1.5$



$AC = -60\left(\frac{5}{4}\right) = -75$

$AB = 75\left(\frac{3}{5}\right) - 60 = -15$

$CE = -(120+60) + 15 = -165$

$BC = 60$; $DE = 60+120 = 180$; $FG = 60+120+120 = 300$

$BE = -(120+60)\left(\frac{5}{4}\right) = -225$

$DG = -(120+180)\left(\frac{5}{4}\right) = -375$

$BD = (225)\left(\frac{3}{5}\right) - 15 = 120$

$EG = -(60+120+120) = -300$

$DF = (375)\left(\frac{3}{5}\right) + 120 = 345$

$F_y = [60\times 9 + (120)(6+3) - (60)(4)]/4 = 345 = DF$ → checks out

$F_x = 60+120+120 = 300 = FG$ → checks out.

$G_y = 345+60+120 = 525 = -EG - (DG)\left(\frac{3}{5}\right)$ → jt. G equil checks out.

$G_x = 300 - 375\left(\frac{4}{5}\right) = 0$ → jt G. equil checks out.

Member	P_v	P_H	P_{real}	L_i	$P_v P_{real}/L_i$	$P_H P_{real}/L_i$
AB	-1	0.75	-15	3	45	-33.75
BD	-1	1.5	120	3	-360	540
DF	-1	2.25	345	3	-1035	2328.75
CE	0	-0.75	-165	3	0	371.25
EG	0	-1.5	-300	3	0	1350
AC	0	-1.25	-75	5	0	468.75
BC	0	1.0	60	4	0	240
BE	0	-1.25	-225	5	0	1406.25
DE	0	1.0	180	4	0	720
DG	0	-1.25	-375	5	0	2343.75
FG	0	1.0	300	4	0	1200
					-1350	10935

$\Delta_{AV} = 1350/AE$ ↑

$\Delta_{AH} = 10935/AE$ →