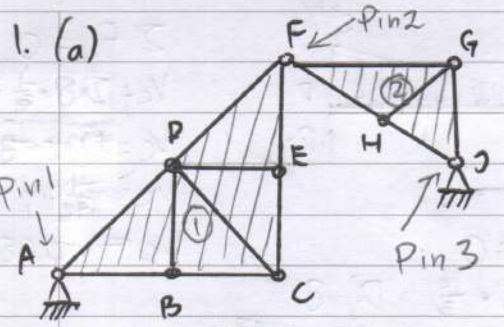
Louis Chandra

CV2011
2018/2019 Sem II

1. (a)

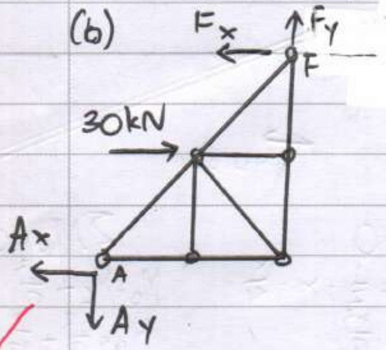


$n=2 \quad P=3$

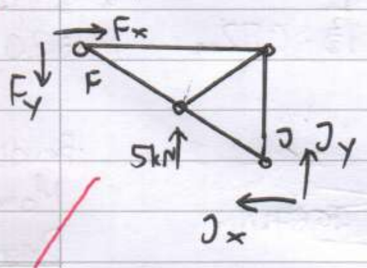
$\overline{DOF} = 3n - 3R - 2P - r$
$= 3 \cdot 2 - 2 \cdot 3$
$= 0$ //

Overall: Statically determinate
Stable Structure //
External: Simply-supported //

(b)



$\Sigma M_A = 0$
$F_x \cdot 6 + F_y \cdot 6 = 30 \cdot 3$
$F_x + F_y = 15$
$F_x = 15 - F_y$



$\Sigma M_J = 0$
$F_x \cdot 3 + 5 \cdot 2 = F_y \cdot 4$
$3(15 - F_y) + 10 = 4F_y$
$55 - 3F_y = 4F_y$
$7F_y = 55$
$F_y = \frac{55}{7}$ kN

$F_x = \frac{50}{7}$ kN

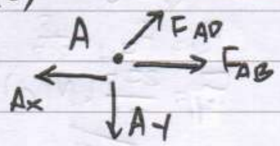
$\Sigma F_x = 0$
$A_x + F_x = 30$
$A_x = \frac{160}{7}$ kN $(\leftarrow)$ //

$\Sigma F_y = 0$
$A_y = F_y$
$A_y = \frac{55}{7}$ kN $(\downarrow)$ //

$\Sigma F_x = 0$
$J_x = F_x$
$J_x = \frac{50}{7}$ kN $(\leftarrow)$ //

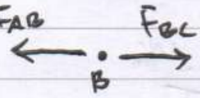
$\Sigma F_y = 0$
$J_y + 5 = F_y$
$J_y = \frac{20}{7}$ kN $(\uparrow)$ //

(c) BD and DE are zero force members

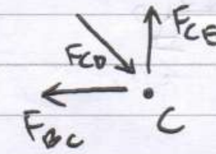


$\Sigma F_y = 0$
$F_{AD} \cdot \frac{1}{\sqrt{2}} = A_y$
$F_{AD} = \frac{55}{7}\sqrt{2}$ kN (T) //

$\Sigma F_x = 0$
$A_x = F_{AB} + F_{AD} \cdot \frac{1}{\sqrt{2}}$
$F_{AB} = \frac{160}{7} - \frac{55}{7} = 15$ kN (T) //

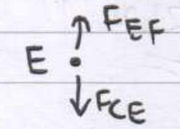


$F_{BC} = 15$ kN (T) //

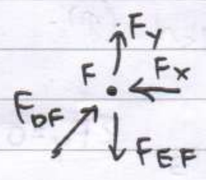


$\Sigma F_x = 0$
$F_{CD} \cdot \frac{1}{\sqrt{2}} = F_{BC}$
$F_{CD} = 15\sqrt{2}$ kN (C) //

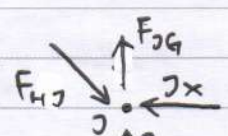
$\Sigma F_y = 0$
$F_{CE} = F_{CD} \cdot \frac{1}{\sqrt{2}}$
$F_{CE} = 15$ kN (T) //



$F_{EF} = 15$ kN (T) //

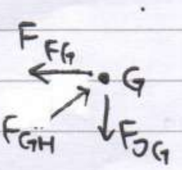


$\Sigma F_x = 0$
$F_{DF} \cdot \frac{1}{\sqrt{2}} = F_x$
$F_{DF} = \frac{50}{7}\sqrt{2}$ kN (C) //



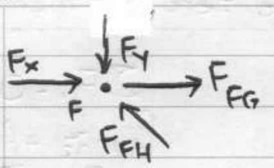
$\Sigma F_x = 0$
$F_{HJ} \cdot \frac{2}{2.5} = J_x$
$F_{HJ} = \frac{125}{14}$ kN (C) //

$\Sigma F_y = 0$
$F_{JG} + J_y = F_{HJ} \cdot \frac{1.5}{2.5}$
$F_{JG} = 2.5$ kN (T) //



$\Sigma F_y = 0$
$F_{GH} \cdot \frac{1.5}{2.5} = F_{JG}$
$F_{GH} = \frac{25}{6}$ kN (C) //

$\Sigma F_x = 0$
$F_{FG} = F_{GH} \cdot \frac{2}{2.5}$
$F_{FG} = 2$ kN (T) //

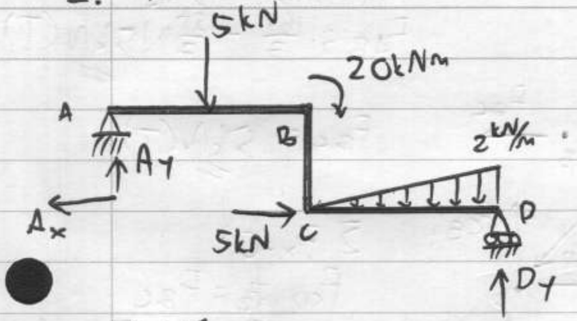


$\Sigma F_y = 0$

$F_y = F_{FH} \cdot \frac{1.5}{2.5}$

$F_{FH} = \frac{275}{21}\,kN\,(C)$

2. (a)



$\Sigma F_x = 0$

$A_x = 5kN \ (\leftarrow)$

$\Sigma M_A = 0$

$-5\cdot 4 - 20 + 5\cdot 4 - \frac{1}{2}\cdot 2\cdot 8 \cdot (8 + \frac{16}{3}) + 16D_y = 0$

$-20 - \frac{320}{3} + 16D_y = 0$

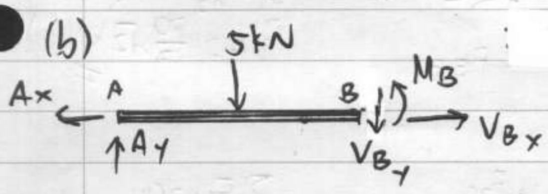
$D_y = \frac{95}{12} \approx 7.92kN \ (\uparrow)$

$\Sigma F_y = 0$

$A_y + D_y = 5 + \frac{1}{2}\cdot 2\cdot 8$

$A_y = \frac{61}{12} \approx 5.08kN \ (\uparrow)$

(b)



$\Sigma F_y = 0$

$A_y = 5 + V_{By}$

$V_{By} = -5 + \frac{61}{12} = \frac{1}{12}kN$

$V_{By} \approx 0.083\,kN$

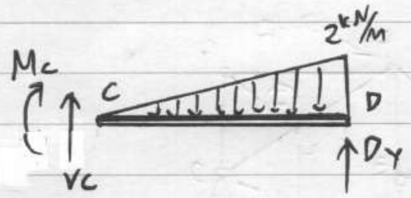
$\Sigma M_B = 0$

$A_y \cdot 8 = 5\cdot 4 + M_B$

$M_B = \frac{61}{12}\cdot 8 - 20$

$M_B = \frac{62}{3} \approx 20.67kNm$

$V_{Bx} = A_x = 5kN$



$\Sigma F_y = 0$

$V_C + D_Y = \frac{1}{2}\cdot 2\cdot 8$

$V_C = 8 - \frac{95}{12}$

$V_C = \frac{1}{12}kN$

$V_C \approx 0.083kN$

$\Sigma M_C = 0$

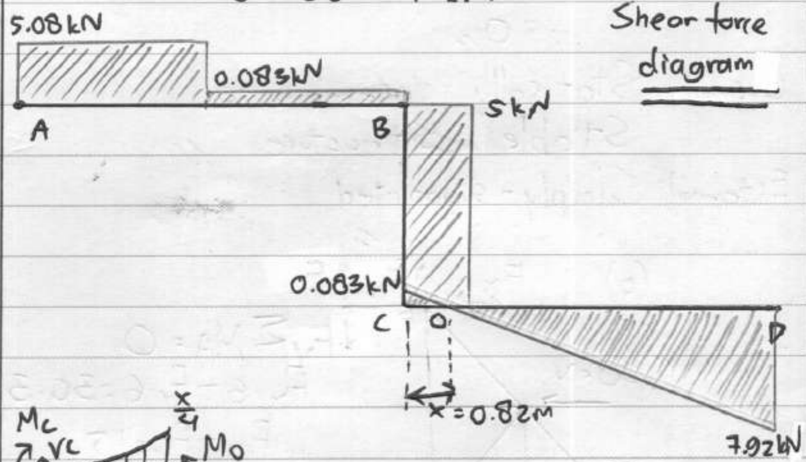
$M_C + \frac{1}{2}\cdot 2\cdot 8 \cdot \frac{16}{3} = D_y \cdot 8$

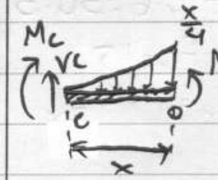
$M_C = 8\cdot\frac{95}{12} - \frac{128}{3}$

$M_C = \frac{62}{3}\,kNm$

$M_C \approx 20.67\,kNm$

Shear force diagram





$\Sigma F_y = 0$

$V_C = \frac{1}{2}\cdot x \cdot \frac{x}{4}$

$\frac{1}{12} = \frac{x^2}{8}$

$x = \sqrt{\frac{2}{3}} = 0.82m$

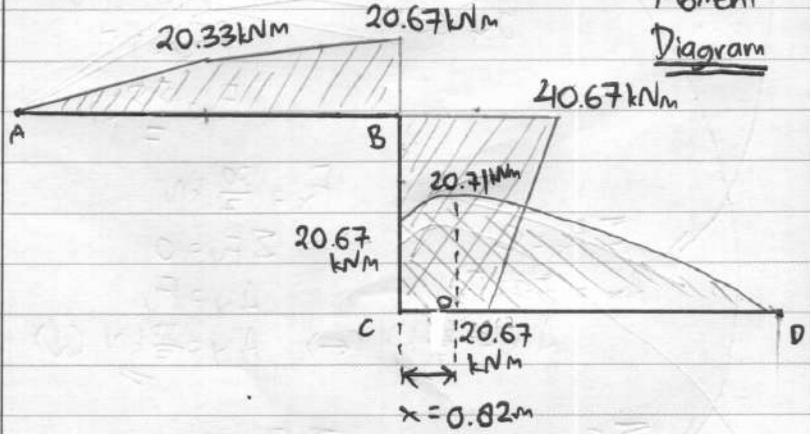
$\Sigma M_C = 0$

$M_O = M_C + \frac{x^2}{8}\cdot\frac{2}{3}x$

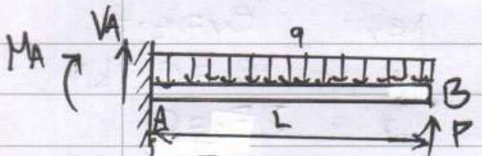
$M_O = \frac{62}{3} + \frac{1}{12}x^3$

$M_O = 20.71kNm$

Bending Moment Diagram



3. (a)



$\Sigma F_y = 0$

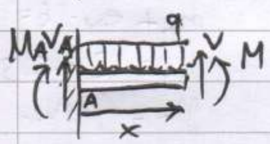
$V_A + P = qL$

$V_A = qL - P$

$\Sigma M_A = 0$

$M_A + \frac{1}{2}qL^2 = PL$

$M_A = PL - \frac{1}{2}qL^2$



$\Sigma M = 0$

$M + \frac{1}{2}qx^2 = M_A + V_A \cdot x$

$M = PL - \frac{1}{2}qL^2 + (qL - P)x - \frac{1}{2}qx^2$

$EI \cdot v'' = M$

$EI \cdot v' = \int \left(PL - \frac{1}{2}qL^2 + (qL-P)x - \frac{1}{2}qx^2\right)dx$

$EI \cdot v' = (PL - \frac{1}{2}qL^2)x + \frac{(qL-P)}{2}x^2 - \frac{qx^3}{6} + C_1$

$x = 0 \rightarrow v' = 0$

$C_1 = 0$

$EI \cdot v = \int \left[(PL - \frac{1}{2}qL^2)x + \left(\frac{qL-P}{2}\right)x^2 - \frac{q}{6}x^3\right]$

$EI \cdot v = \left(\frac{PL}{2} - \frac{qL^2}{4}\right)x^2 + \frac{(qL-P)}{6}x^3 - \frac{q}{24}x^4 + C_2$

$x = 0 \rightarrow v = 0$

$C_2 = 0$

$EI \cdot v = \left(\frac{PL}{2} - \frac{qL^2}{4}\right)x^2 + \frac{(qL-P)}{6}x^3 - \frac{q}{24}x^4$

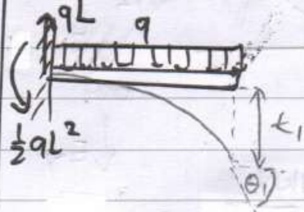
$x = L \rightarrow v = 0$

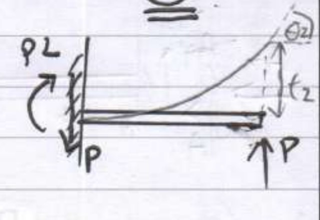
$0 = \frac{PL^3}{2} - \frac{qL^4}{4} + \frac{qL^4 - PL^3}{6} - \frac{q}{24}L^4$

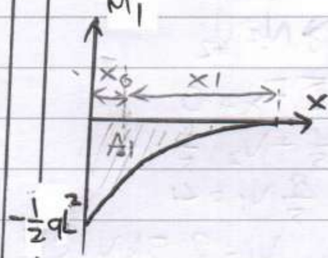
$0 = \frac{PL^3}{3} - \frac{1}{8}qL^4$

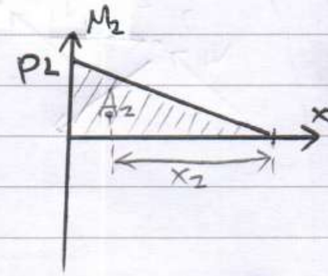
$P = \frac{3}{8}qL$

(b) ① ②









$A_1 = \frac{1}{3} \cdot \left(-\frac{1}{2}qL^2\right) \cdot L$

$A_1 = -\frac{1}{6}qL^3$

$A_2 = \frac{1}{2} \cdot PL \cdot L$

$A_2 = \frac{1}{2}PL^2$

Rotation ($\theta = 0$)

$\theta = \theta_1 + \theta_2$

$\theta = \frac{A_1}{EI} + \frac{A_2}{EI}$

$\theta = 0 \rightarrow A_1 = -A_2$

$-\frac{1}{6}qL^3 = -\frac{1}{2}PL^2$

$P = \frac{1}{3}qL$

Deflection

$EI \cdot t_1 = A_1 x_1$

$EI \cdot t_1 = A_1 \cdot (L - x_0)$

$EI \cdot t_1 = -\frac{1}{6}qL^3\left(L - \frac{L}{4}\right)$

$t_1 = -\frac{1}{8}\frac{qL^4}{EI}$

$EI \cdot t_2 = A_2 x_2$

$EI \cdot t_2 = \frac{1}{2}PL^2 \cdot \frac{2}{3}L$

$EI \cdot t_2 = \frac{1}{3}PL^3$

$EI \cdot t_2 = \frac{1}{3} \cdot \frac{1}{3}qL \cdot L^3$

$t_2 = \frac{1}{9}\frac{qL^4}{EI}$

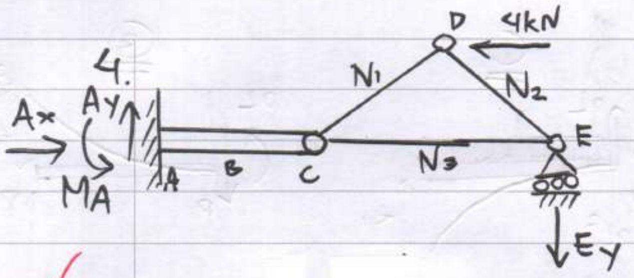
$\delta_B = t_2 + t_1$

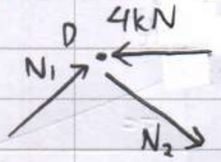
$\delta_B = \frac{1}{9}\frac{qL^4}{EI} + \left(-\frac{1}{8}\frac{qL^4}{EI}\right)$

$\delta_B = -\frac{1}{72}\frac{qL^4}{EI}$

$\delta_B = \frac{1}{72}\frac{qL^4}{EI}$ (downward)

4.





$\Sigma F_y = 0$

$N_1 = N_2$

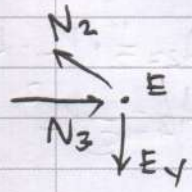
$\Sigma F_x = 0$

$N_1 \cdot \frac{4}{5} + N_2 \cdot \frac{4}{5} = 4$

$\frac{8}{5} N_1 = 4$

$N_1 = 2.5kN\,(C)$

$N_2 = 2.5kN\,(T)$



$\Sigma F_y = 0$

$E_y = N_2 \cdot \frac{3}{5}$

$E_y = 1.5kN$

$\Sigma F_x = 0$

$N_3 = N_2 \cdot \frac{4}{5}$

$N_3 = 2kN\ (C)$

$\Sigma F_x = 0$ $\quad$ $\Sigma F_y = 0$

$A_x = 4kN$ $\quad$ $A_y = 1.5kN$

$\Sigma M_A = 0$

$M_A + 4 \cdot 3 = E_y \cdot 16$

$M_A = 1.5 \cdot 16 - 12$

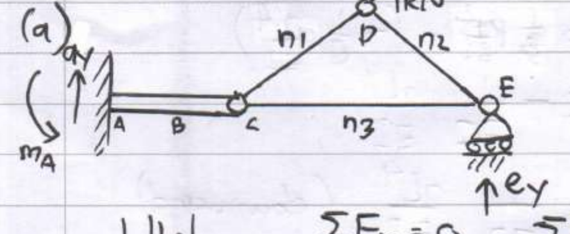
$M_A = 12kNm$

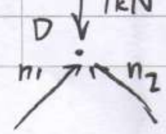
$\Sigma M = 0$

$M + M_A = A_y \cdot x$

$M = 1.5x - 12$

(a)



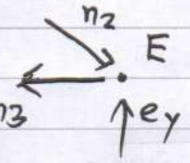


$\Sigma F_x = 0$ $\quad$ $\Sigma F_y = 0$

$n_1 = n_2$ $\quad$ $\frac{3}{5}(n_1 + n_2) = 1$

$n_1 = \frac{5}{6} kN\,(C)$

$n_2 = \frac{5}{6} kN\,(C)$



$\Sigma F_y = 0$

$e_y = n_2 \cdot \frac{3}{5}$

$e_y = 0.5kN$

$\Sigma F_x = 0$

$n_3 = n_2 \cdot \frac{4}{5}$

$n_3 = \frac{2}{3} kN\,(T)$

$\Sigma F_y = 0$

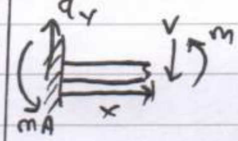
$a_y = 0.5kN$

$\Sigma M_A = 0$

$m_A + e_y \cdot 16 = 1 \cdot 12$

$m_A = 12 - 0.5 \cdot 16$

$m_A = 4kNm$



$\Sigma M = 0$

$m + m_A = a_y \cdot x$

$m = 0.5x - 4$

$n_1 = -\frac{5}{6} kN$	$N_1 = -2.5kN$	$L_1 = 5m$
$n_2 = -\frac{5}{6} kN$	$N_2 = 2.5kN$	$L_2 = 5m$
$n_3 = \frac{2}{3} kN$	$N_3 = -2kN$	$L_3 = 8m$

$n_1 N_1 L_1 = \frac{125}{12}$

$n_2 N_2 L_2 = -\frac{125}{12}$

$n_3 N_3 L_3 = -\frac{32}{3}$ +

$\Sigma nNL = -\frac{32}{3}$

$$1 \cdot \Delta = \int_0^8 \frac{Mm}{EI} dx + \sum n \cdot \frac{NL}{AE}$$

$$\delta_D = \frac{1}{EI} \cdot \int_0^8 \left[(1.5x - 12) \cdot (0.5x - 4)\right] dx - \frac{32}{3AE}$$

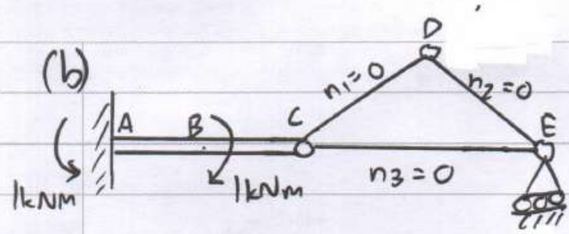
$$\delta_D = \frac{1}{EI} \cdot \int_0^8 \left(\frac{3}{4}x^2 - 12x + 48\right) dx - \frac{32}{3AE}$$

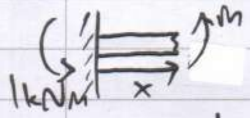
$$\delta_D = \frac{1}{EI} \left[\frac{1}{4}x^3 - 6x^2 + 48x\right]_0^8 - \frac{32}{3AE}$$

$$\delta_D = \frac{128}{EI} - \frac{32}{AE} \quad \text{(downward)}$$

//

(b)





$m = -1\,kNM$ for $0 \leq x \leq 4m$

$1 \cdot \theta_B = \int_0^4 Mm \, dx \cdot \frac{1}{EI}$

$\theta_B = \int_0^4 (1.5x - 12) \cdot (-1) \, dx \cdot \frac{1}{EI}$

$\theta_B = \int_0^4 (12 - 1.5x) dx \cdot \frac{1}{EI}$

$\theta_B = \left[12x - \frac{3}{4}x^2\right]_0^4 \cdot \frac{1}{EI}$

$\theta_B = \frac{36}{EI}$ (clockwise)