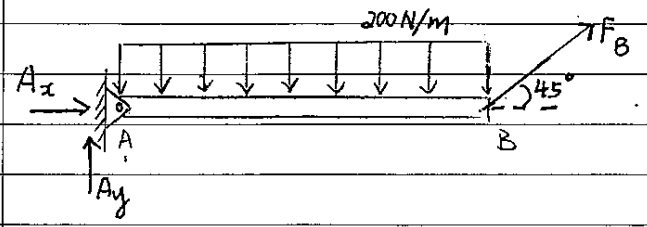
SEM 1 (2011-2012)

Yes, U can!

CV 2101 - Mechanics of Materials

1. a) because member BC is two force, so the force will along BC.



$\circlearrowleft \Sigma M_A = 0$

$3 \times 200 (1.5) - F_B \sin 45^\circ (3) = 0$

$F_B \sin 45^\circ = 1.5 \times 200$

$F_B = 424.26\ N$

$\Sigma F_x = 0$

$A_x + F_B \cos 45^\circ = 0$

$A_x = -(424.26) \cos 45^\circ$

$= -300\ N$

$\Sigma F_y = 0$

$A_y + F_B \sin 45^\circ - 200 \times 3 = 0$

$A_y = 600 - 424.26 \sin 45^\circ$

$= 300\ N$

$\Sigma F_x = 0$

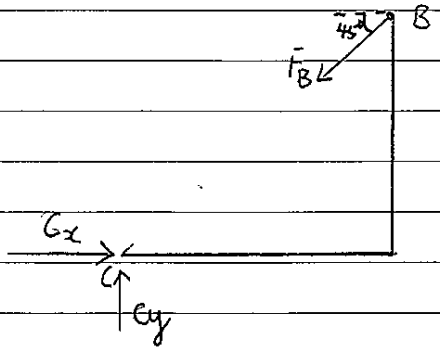
$C_x = F_B \cos 45^\circ$

$= 300\ N$

$\Sigma F_y = 0$

$C_y = F_B \sin 45^\circ$

$= 300 N$



1. b)

$240^2 = 400^2 + 320^2 - 2(400)(320)\cos\beta$

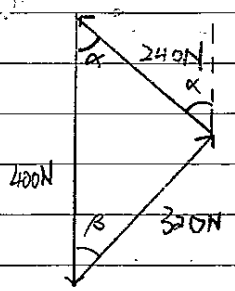
$\cos\beta = 0.8$

$\beta = 36.87^\circ$

$320^2 = 400^2 + 240^2 - 2(400)(240)\cos\alpha$

$\cos\alpha = 0.6$

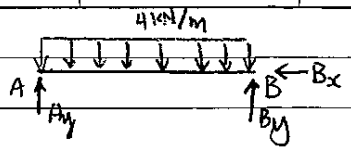
$\alpha = 53.13^\circ$



Yes, U can!

2a) $\Sigma F_x = 0$

$B_x = 0$



② $\Sigma M_A = 0$

$4 \times 4 \times 2 - B_y \times 4 = 0$

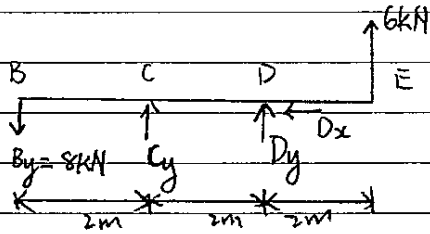
$B_y = 8\ kN$

$\Sigma F_y = 0$

$A_y + B_y - 4 \times 4 = 0$

$A_y = 16 - 8$

$= 8\ kN$



$\Sigma F_x = 0$, $D_x = 0$

② $\Sigma M_C = 0$

$B_y \times 2 + D_y \times 2 + 6 \times 4 = 0$

$2 \times 8 + 2D_y + 24 = 0$

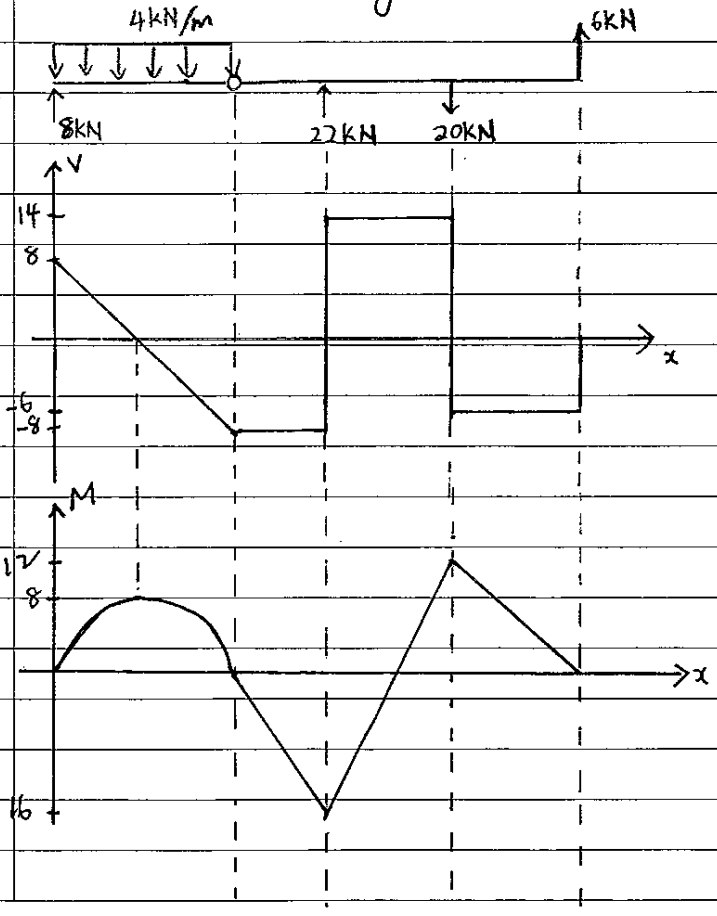
$D_y = -20kN$

$\Sigma F_y = 0$

$C_y + D_y + 6 - 8 = 0$

$C_y - 20 + 6 - 8 = 0$

$C_y = 22\ kN$



Yes, U can!

b) i) $\Delta l_A = 2\Delta l_B$

$\frac{P_A L}{AE} = 2\frac{P_B L}{AE}$

$P_A = 2P_B$

② $\sum M_c = 0$

$P_A(2b) + P_B(b) - 2.2\times(2b) = 0$

$4(2P_B)(2b) + P_B b = 4.4b$

$5P_B = 4.4$

$= 0.88\ kN$

$P_A = 2(0.88)$

$= 1.76\ kN$

ii) $\Delta l_A = 2\Delta l_B$

$\left(\frac{P_A L}{AE} + \alpha\Delta T L\right) = 2\left(\frac{P_B L}{AE} + \alpha\Delta T L\right)$

$\frac{P_A L}{AE} = \frac{2P_B L}{AE} + \alpha\Delta T L$

$\frac{P_A}{AE} = \frac{2P_B}{AE} + \alpha\Delta T$

$\frac{P_A}{540} = \frac{2P_B}{540} + (23\times10^{-6})(100)$

$P_A = 2P_B + 1.242$

② $\sum M_c = 0$

$P_A(2b) + P_B(b) = (2.2)(2b)$

$(2P_B + 1.242)(2) + P_B = 4.4$

$5P_B + 2.484 = 4.4$

$P_B = 0.3832\ kN$

$P_A = 2(0.3832) + 1.242$

$= 2.0084\ kN$

iii) $\Delta l_A = 2\Delta l_B$

$\left(\frac{P_A L}{AE} + \alpha\Delta T L\right) = 2\left(\frac{P_B L}{AE} + \alpha\Delta T L\right)$

$\frac{P_A L}{AE} = \alpha\Delta T L$

$P_A = AE\alpha\Delta T$

② $\sum M_c = 0$

$2b(P_A) = 2b(2.2)$

$P_A = 2.2$

$AE\alpha\Delta T = 2.2$

$(540)(23\times10^{-6})\Delta T = 2.2$

$\Delta T = 177.13\ °C$

Yes, U can!

3.a) i) $\phi = \frac{T_A L_A}{J_A G} - \frac{T_B L_B}{J_B G} = 0$

$\frac{T_A L_A}{J_A} = \frac{T_B L_B}{J_B}$

$\frac{T_A(0.5)}{\frac{\pi}{2}(0.04)^4} = \frac{T_B(0.2)}{\frac{\pi}{2}(0.02)^4}$

$T_A = 6.4\,T_B$

ii) $\tau_A = \frac{T_A \rho}{J}$

$55\times10^6 = \frac{T_A(0.04)}{\frac{\pi}{2}(0.04)^4}$

$T_A = 5529.2$ Nm

$\tau_B = \frac{T_B \rho}{J}$

$55\times10^6 = \frac{T_B(0.02)}{\frac{\pi}{2}(0.02)^4}$

$= 691.15$ Nm

$T_B = \frac{5529.2}{6.4}$

$= 863.9375$ Nm > 691.15 Nm (no suitable)

$\therefore T_A = 6.4\,T_B$

$= 6.4(691.15)$

$= 4423.36$ Nm

$T_0 = T_A + T_B$

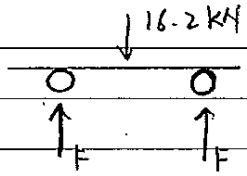
$= 4423.36 + 691.15$

$= 5114.51$ Nm

i)

b) $F_w = 3.6 \times 1.5 \times 3$

$= 16.2$ kN



$2F = 16.2$

$F = 8.1$ kN

$M_{max} = 6.75(8.1)$

$= 54.675$ KNm

$V_{max} = 8.1$ kN

$I = \frac{\pi}{64}\left[d^4 - \left(\frac{9}{10}d\right)^4\right]$

$= 0.0169\,d^4$

$\sigma = \frac{Mc}{I}$

$50\times10^6 = \frac{(54.675\times10^3)\left(\frac{d}{2}\right)}{0.0169\,d^4}$

$d^3 = 0.03235$

$d = 0.3186$ m

0.2662 m

Yes, U can

ii) $Q = y_1 A_1 - y_2 A_2$

$= \frac{4(\frac{d}{2})}{3\pi}\left[\pi(\frac{d}{2})^2\right] - \frac{4(\frac{9d}{20})}{3\pi}\left[\pi\left(\frac{9d}{20}\right)^2\right]$

$= \frac{4}{3}(\frac{d}{2})^3 - \frac{4}{3}(\frac{9}{20}d)^3$

$= 0.04517\,d^3$

$\tau = \frac{VQ}{It}$

$16\times10^6 = \frac{8.1\times10^3(0.04517d^3)}{0.0169d^3(\frac{2d}{10})}$

$d = \frac{8.1\times10^3(0.04517)}{16\times10^6\times0.0169\times\frac{2}{10}}$

$d = 6.765\times10^{-3}\ m$

4. a) $\sigma_N = \frac{P_z}{A}$

$= \frac{3.07\times10^3}{\pi(0.03)^2}$

$= 1.086\times10^6\ Pa$

$\sigma_M = \frac{Mc}{I}$

$= \frac{(0.4)(3.07\times10^3)(0.03)}{\frac{\pi}{4}(0.03)^4}$

$= 57.91\times10^6\ Pa$

$\sigma_T = 58.996\times10^6\ Pa$

$\tau = \frac{Tp}{J}$

$= \frac{(2.02\times10^3)(0.4)(0.03)}{\frac{\pi}{2}(0.03)^4}$

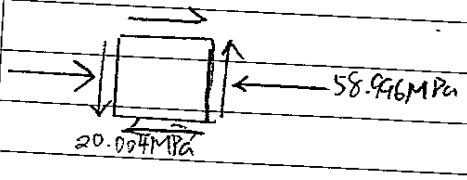
$= 19.051\times10^6\ Pa$

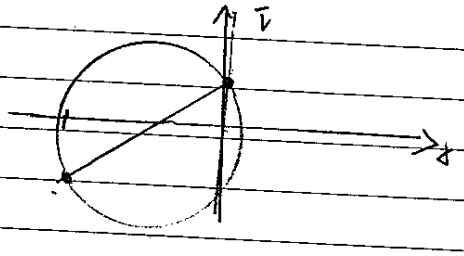
$\tau = \frac{VQ}{It}$

$= \frac{2.02\times10^3\left[\frac{4\times0.03}{3\pi}\times\frac{\pi}{2}(0.03^2)\right]}{\frac{\pi}{4}(0.03)^4(0.06)}$

$= 0.953\times10^6\ Pa$

$\tau_T = 20.004\ MPa$





$R = \sqrt{(\frac{\sigma_x - \sigma_y}{2})^2 + \tau_{xy}^2}$

$= \sqrt{(\frac{58.996}{2})^2 + 20.004^2}$

$= 35.64\ MPa$

$C = \frac{\sigma_x + \sigma_y}{2}$

$= \frac{-58.996}{2}$

$= -29.498\ MPa$

$\sigma_{mc} = -35.64 - 29.498$

$= -65.138\ MPa$

$\sigma_{mT} = 35.64 - 29.498$

$= 6.142\ MPa$

$\tau_{max} = 35.64\ MPa$

$\sigma_{max\,c} = -65.138\ MPa$

$\sigma_{max\,T} = 6.142\ MPa$

Yes, U can!

b) $P\cos\theta = F_{AB}$ — ①

$P\sin\theta = F_{BC}$ — ②

②/①

$\tan\theta = \frac{F_{BC}}{F_{AB}}$

$= \left(\frac{L_{AB}}{L_{BC}}\right)^2$

$\tan\theta = (\tan 30)^2$

$\theta = 18.435^{**\circ}$