Higher Technological Institute | Civil Eng. Department

Final Exam – (Sept-Jan 2014)

Dr.Manal Kamal Zaki | Theory of Structures (1) | Time: $1\frac{1}{2}$ hrs.

Q1

For the given cross-section:

1. Find Ix.
2. Draw the distribution of the shear flow.
3. Find the shear forces resisted by the elements of the cross-section.
4. Find the shear centre.

	ILO's	
1	[d3]	[4 marks]
2	[d1,c3]	[6 marks]
3	[a3]	[4 marks]
4	[a3]	[2 marks]
		[Total 16]

$t = 1\ cm$

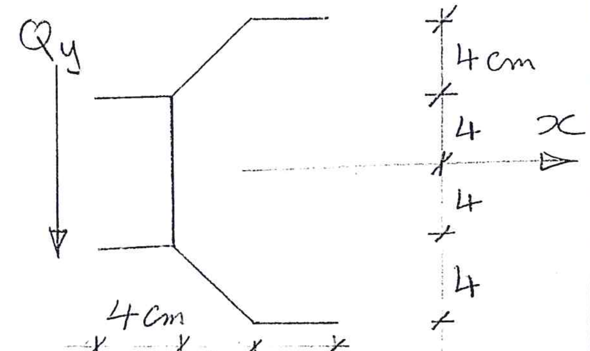


Fig. (Q1)

Q2

For the shown structure:

1. Draw the T.M.D.
2. Draw the T.A.D.
3. Compute the maximum shear stress.

Given :
G=800 t\cm2

Shaft:
D = 0.4m

	ILO's	
1	[a3]	[4 marks]
2	[a3]	[4 marks]
3	[d1]	[4 marks]
		[Total 12]

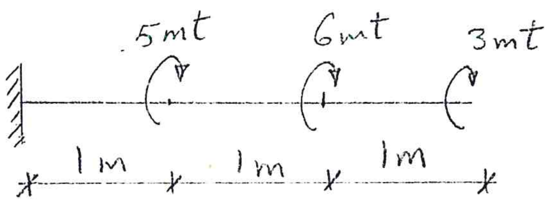


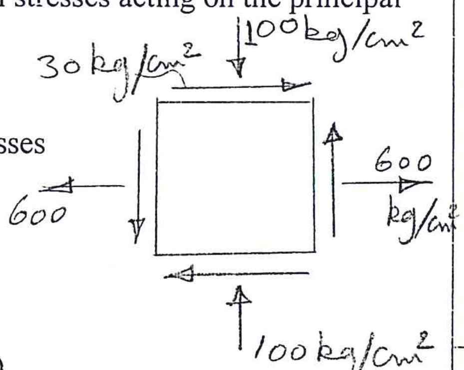
Fig. (Q2)

Q3

For the shown stress element:

1. Compute analytically the principal normal stress plane.
2. the maximum and minimum normal stresses acting on the principal plane.
3. Check graphically.
4. The principal shear plane.
5. The direction and values of the stresses acting on the principal shear plane.

	ILO's	
1	[a3,b3]	[3 marks]
2	[a3,b3]	[3 marks]
3	[d1]	[3 marks]
4	[a3,b3]	[3 marks]
5	[a3,b3]	[2 marks]
		[Total 12]



$\sigma_x = +600\ kg/cm^2$

$\sigma_y = -100$

$\tau = -30$

Fig. (Q3)

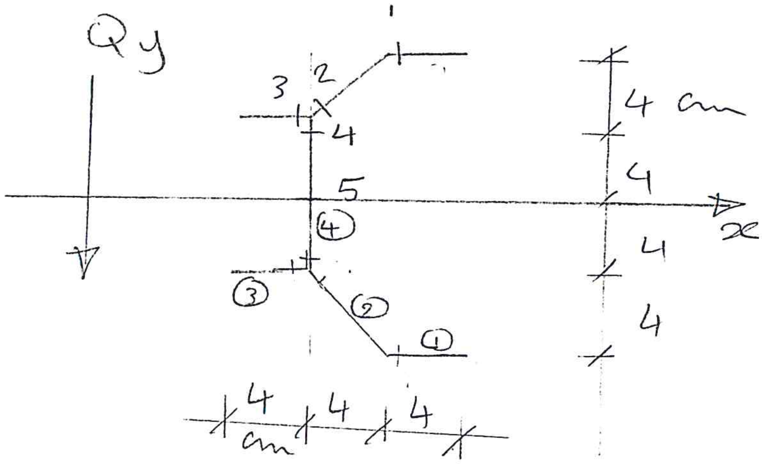
Mail:

F. Jan 2014

Q1

$t = 1\,cm$

$$f = \frac{Q_y S_x}{I_x}$$



Assume $Q_y = I_x$

$$\therefore \boxed{f \equiv S_x}$$

$$* \quad I_x = 2\left[(4*1)(8)^2 + \frac{(4\sqrt{2}*1)(4)^2}{12} + (4\sqrt{2}*1)(6)^2 + (4*1)(4)^2\right] + \frac{(1)(8)^3}{12} = 1105.05\ cm^4$$

$$* \quad S_{x1} = (4\times1)(8) = 32$$

$$S_{x2} = S_{x1} + (1)(4\sqrt{2})(6) = 65.94$$

$$S_{x3} = 4*1*4 = 16$$

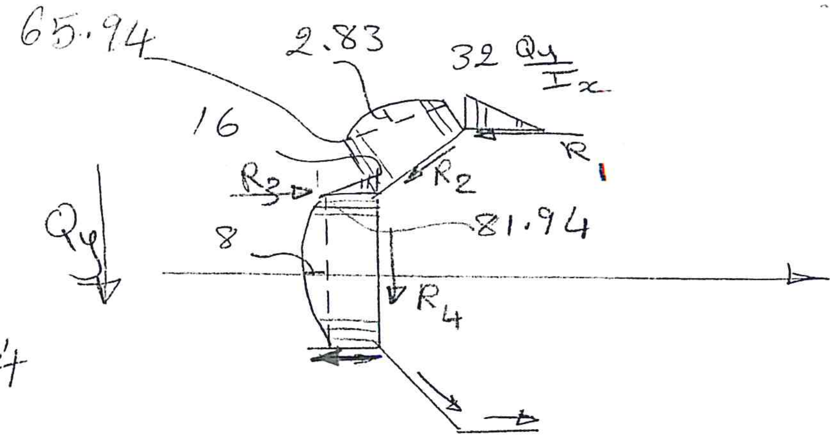
$$S_{x4} = S_{x2} + S_{x3} = 81.94$$

$$S_{x5} = S_{x4} + (4*1)(2) = 89.94$$

$$* \quad \Delta_1 = \frac{(1*4\sqrt{2})*4}{8} \quad 2.83$$

$$\Delta_2 = \frac{(1*8)*8}{8} = 8$$

F. Jan 2014



* $R_1 = \frac{1}{2} \times 4 * 32 = 64$

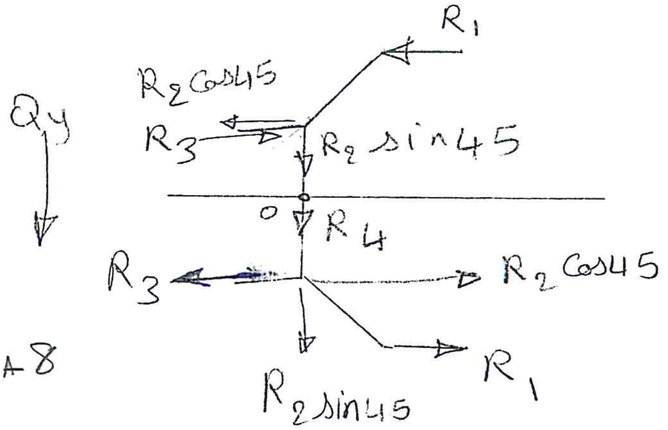
$R_2 = \left(\frac{32 + 65.94}{2}\right)(4\sqrt{2})$
$\quad + \frac{2}{3} * (4\sqrt{2})(2.83) = 287.7$ Shear flow Diagram

$R_3 = \frac{1}{2} \times 4 * 16 = 32$

$R_4 = 81.94 * 8 + \frac{2}{3} * 8 * 8 = 698.19$

* Shear Center

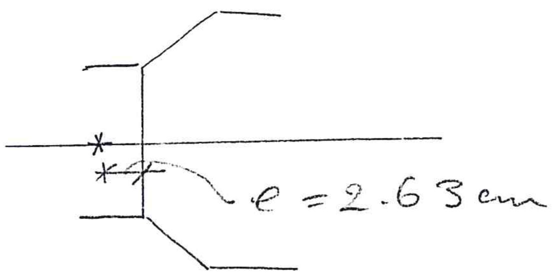
$\Sigma M_o = 0$



$Q_y e = R_1 * 16$
$\quad + R_2 \cos 45 * 8 - R_3 * 8$

$Q_y e = 2395.4$
$\llcorner = I_x$

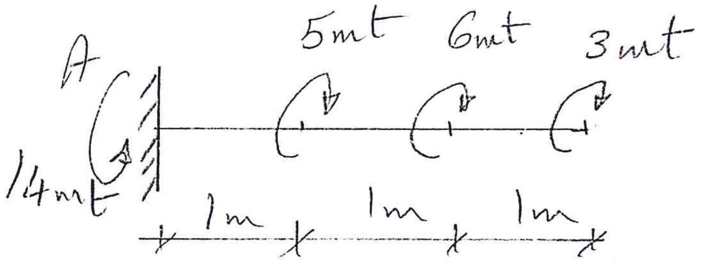
$\therefore e = 2.47$ cm



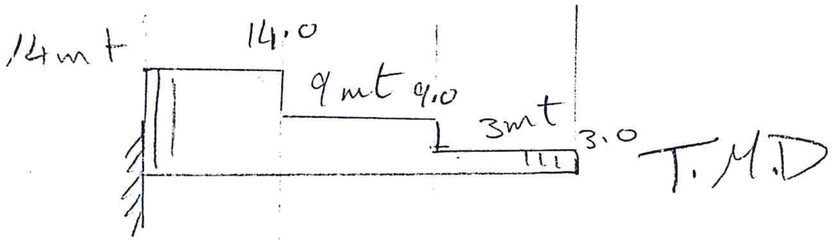
F. Jan 2014

Q2

$D = 0.4\,m$



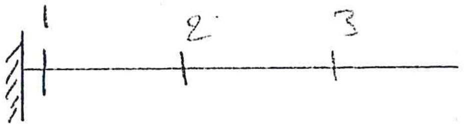
$\tau_{max} = \frac{M_t R}{I_p}$



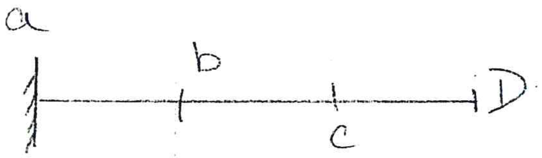
$R = 0.2\,m$

$I_p = 2\left[\frac{\pi D^4}{64}\right]$

$= 2\left[\frac{\pi (40)^4}{64}\right]$

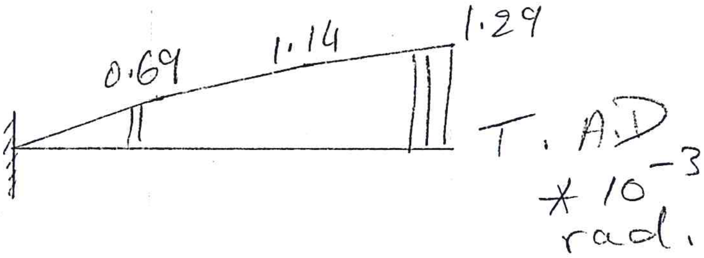


$= 2513274\,cm^4$



$\tau_{at\,sec\,1} = \frac{14 * 100 * 20}{I_p}$

$\boxed{= 0.111\ t/cm^2}$



$\tau_2 = \frac{9 * 100 * 20}{I_p} = 0.072\ t/cm^2$

$\tau_3 = \frac{3 * 100 * 20}{I_p} = 0.024\ t/cm^2$

$\theta = \frac{M_t\, l}{G I_p} = \frac{M_t * l}{800 * I_p}$, $\theta_a = 0$

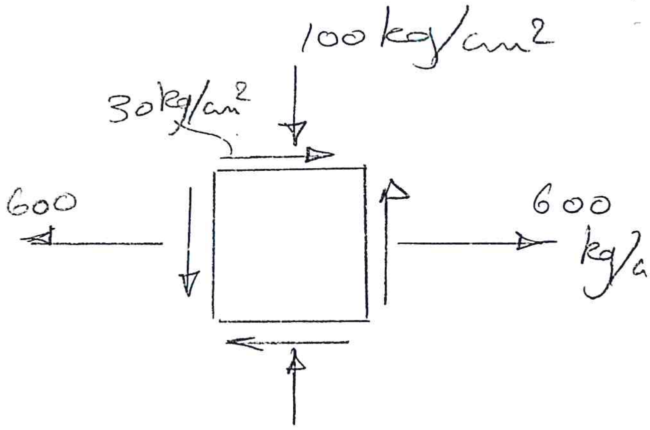
$\theta_b = 0 + \frac{14 \times 100 * 100}{800 I_p} = 6.96 * 10^{-4}$

$\theta_c = \theta_b + \frac{9 * 100 * 100}{800\, I_p} = 1.144 * 10^{-3}$

$\theta_D = \theta_c + \frac{3 * 100 * 100}{800\, I_p} = 1.293 * 10^{-3}$

F. Jan 2014

Q3



$\therefore \quad \sigma_x = +600 \ kg/cm^2$

$\sigma_y = -100$

$\tau = -30$

Principal Normal Stresses

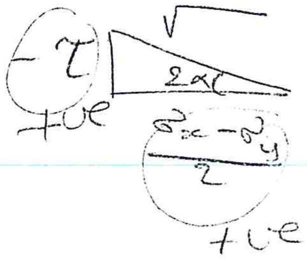
$$\sigma_{\substack{max \\ min}} = \frac{\sigma_x + \sigma_y}{2} \pm \sqrt{\left(\frac{\sigma_x - \sigma_y}{2}\right)^2 + (-\tau)^2}$$

$$= \frac{600 - 100}{2} \pm \sqrt{\left[\frac{600-(-100)}{2}\right]^2 + (+30)^2}$$

$$= 250 \pm 351.3$$

$\therefore \boxed{\sigma_{max} = 601.3} \qquad \boxed{\sigma_{min} = -101.3}$

$$2\alpha = \frac{-\tau}{\frac{\sigma_x - \sigma_y}{2}} = \frac{-(-30)}{\frac{600-(-100)}{2}}$$



$$= \frac{30}{350} = 0.086$$

$\therefore 2\alpha = 4.9^\circ \quad \therefore \boxed{\alpha = 2.45^\circ}$ $\quad \therefore$ 1st quad.

Principal Shear plane

$\theta = \alpha + 45^\circ = 47.45^\circ$

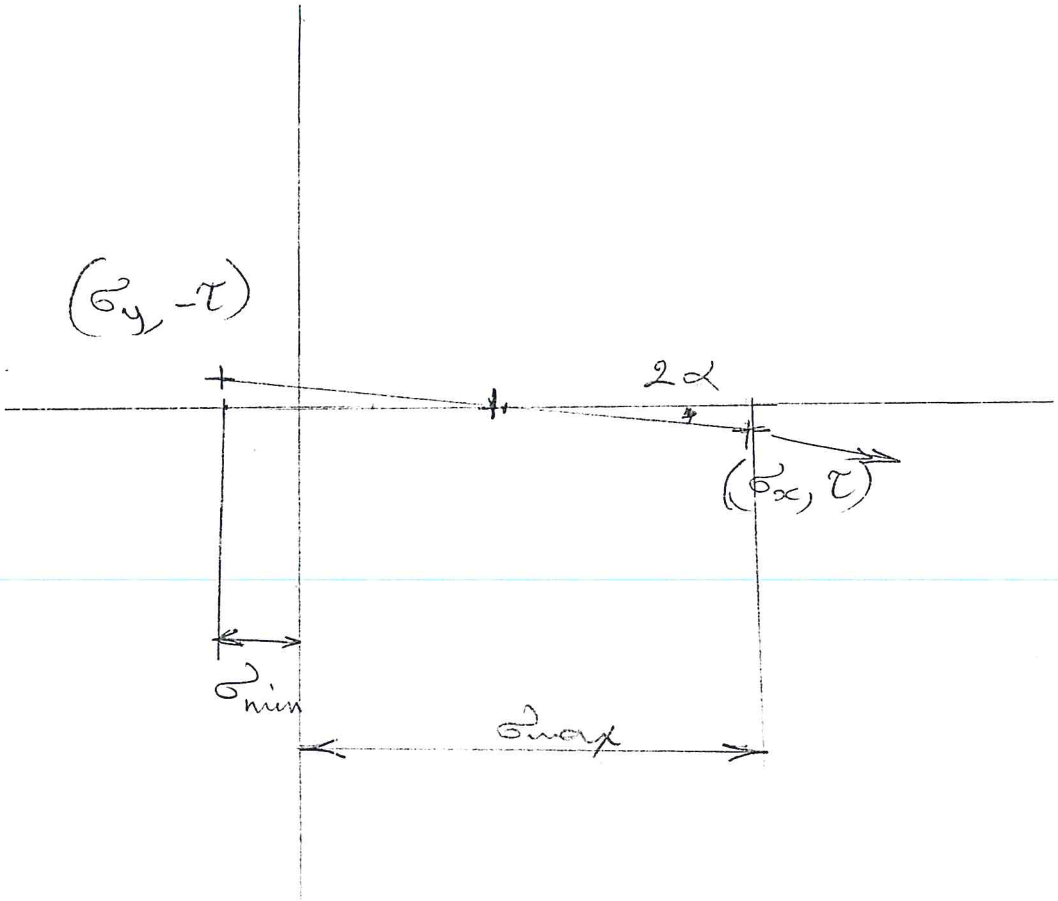
F. Jan 2014

$$\tau_{\substack{max\\min}} = \pm\left(\frac{\sigma_{max} - \sigma_{min}}{2}\right)$$

$$= \pm\left[\frac{601.3 - (-101.3)}{2}\right]$$

$$= \pm\ 351.3\ kg/cm^2$$

Mohrs circle for principal Normal stresses.



Higher Technological Institute

Civil Eng. Department

Final Exam – (Sept-Jan 2015/2016)

Theory of Structures (1)

CT 153

Dr.Manal Kamal Zaki

Time: $1\frac{1}{2}$ hrs.

Q1

For the given cross-section:

1. Find Ix.
2. Draw the distribution of the shear stress due to Q_y=10t

$t = 1.0$ cm

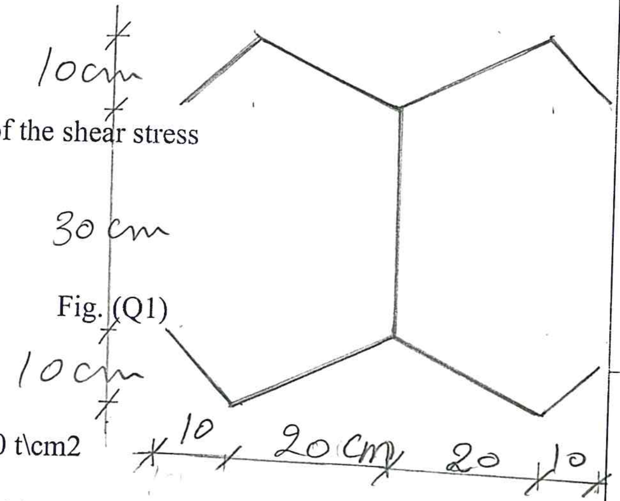


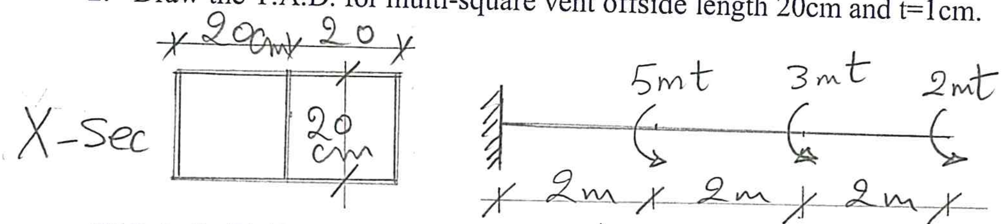
Fig. (Q1)

ILO's	
[d1 1]	[2 marks]
[d1]	[4 marks]
[a3]	[4 marks]
	[Total 10]

Q2

For the shown structure: G=800 t\cm2

1. Draw the T.M.D.
2. Draw the T.A.D. for multi-square vent offside length 20cm and t=1cm.



$2G\Theta A_0/L=\sum (f*s/t)$ $M_t= M_{t1}+ M_{t2}=2 A_{01} *f_1+2 A_{01} *f_1$

Fig. (Q2)

[a3]	[4 marks]
[a3]	[8 marks]
	[Total 12]

Q3

For section S-S of the shown column:

1. Find the properties of the cross-section: A, I_x, I_y.
2. Find the weight of the column: γ=2 t/m^3.
3. Compute the straining actions: N, M_x, M_y, Q_x, Q_y, M_t.
4. Find the maximum shear stress due to Q_x, Q_y and M_t.
5. Find total shear stress at point "n".
6. Find the normal stress at point "n".
7. Draw the stress block.
8. Compute analytically: the principal normal stress plane:
9. the maximum and minimum normal stresses on the principal plane.
10. The principal shear plane.
11. The direction and values of the stresses acting on the principal shear plane.
12. Draw Mohr's circle.

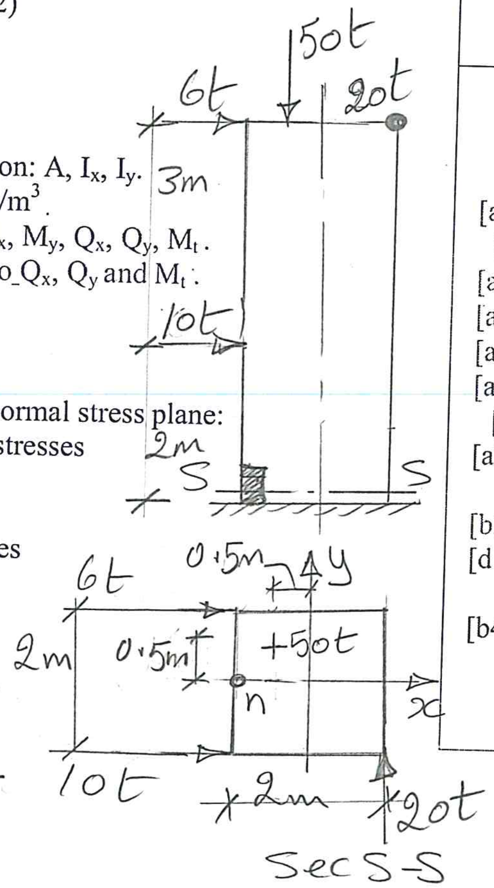


Fig. (Q3)

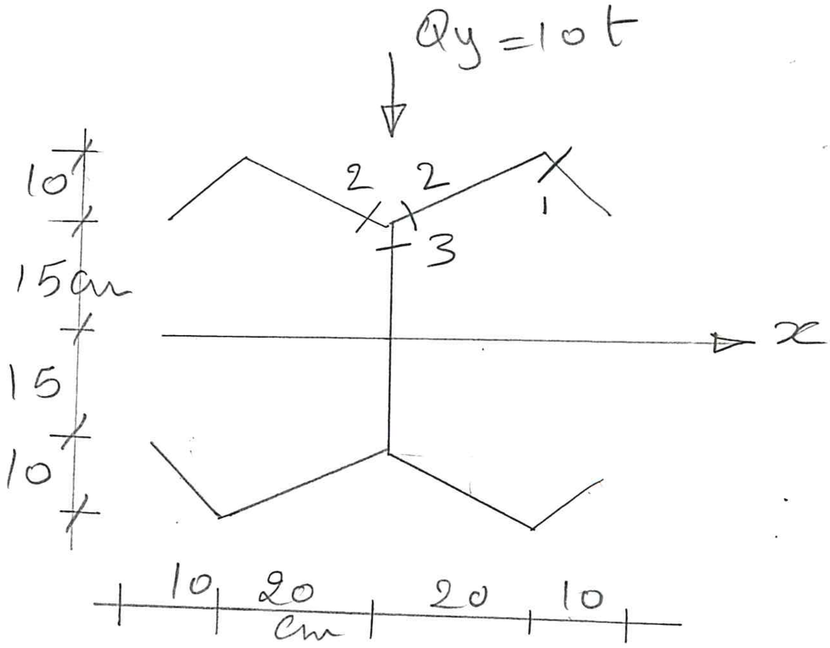
[d1]	[2 marks]
[a3,b3]	[2 marks]
[d1]	[3 marks]
[a3,b3]	[3 marks]
[a3,b3]	[1 marks]
[a3,b3]	[2 marks]
[a3,b3]	[1 marks]
[a4]	[1 marks]
[a3,b3]	[2 marks]
[b2,b3]	[1 marks]
[d1,d3]	[2 marks]
[b4,b3]	[2 marks]
	[Total 18]

Mail:

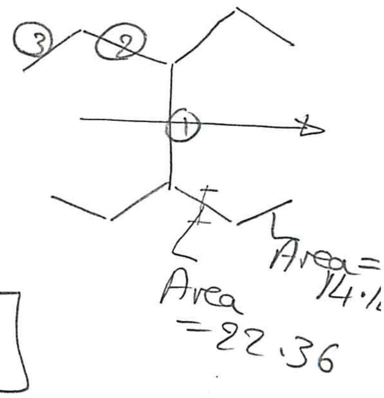
$$\tau_{max} = \frac{M_t}{\alpha a b^2} \ t/cm^2$$

$$\alpha = 0.208$$

Q1

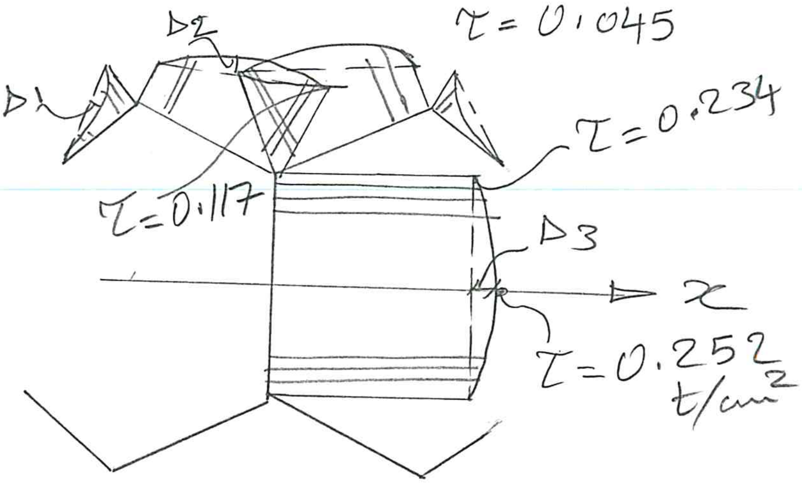


$$I_x = \left[\frac{(1)(30)^3}{12}\right]$$
$$+4\left[\frac{22.36(10)^2}{12} + 22.36(5+15)^2\right]$$
$$+4\left[\frac{14.14(10)^2}{12} + 14.14(5+15)^2\right]$$
$$= 2250 + 9130.3 * 4 + 5773.8 * 4 = 61866.4$$



$$\tau_y = \frac{Q_y S_x}{I_x b} = S_x\left[\frac{Q_y}{1 \times I_x}\right] = 1.6 * 10^{-4} S_x$$

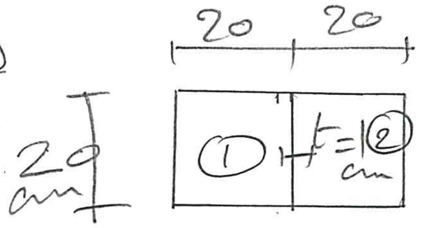
$$S_1 = (14.14)(20)$$
$$= 282.8$$
$$S_2 = S_1 + 22.36(20)$$
$$= 730$$
$$S_3 = 2S_2 = 1460$$

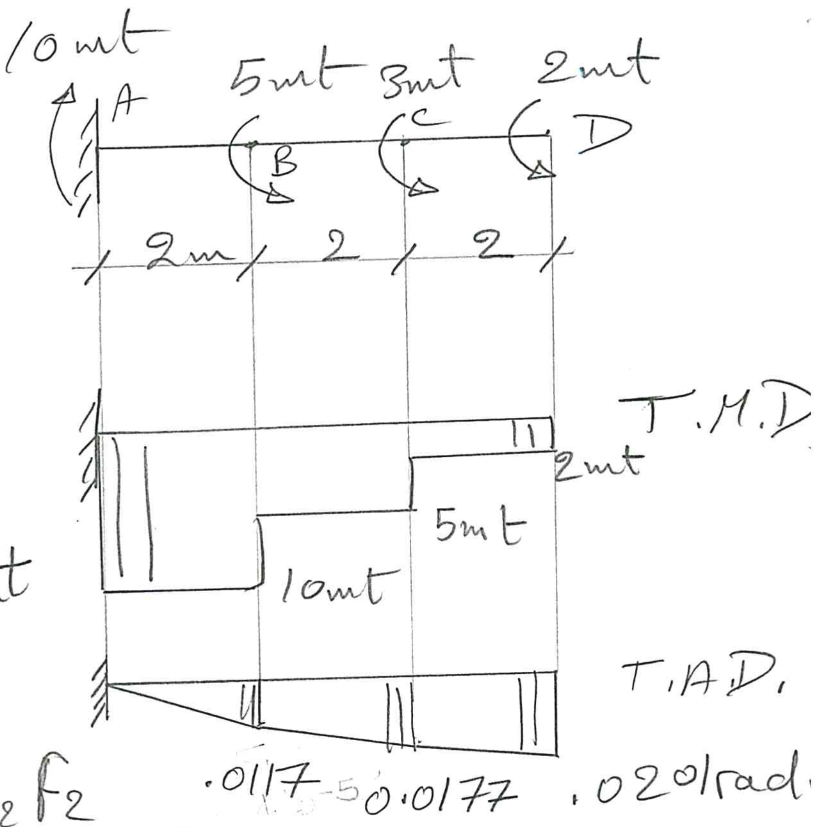


$$\Delta_1 = \frac{14.14 \times 10}{8} = 17.68$$
$$\Delta_2 = \frac{22.36 \times 10}{8} = 28.0$$
$$\Delta_3 = \frac{30 * 30}{8} = 112.5$$

$G = 800\ t/cm^2$

Q2





$A_{o_1} = A_{o_2} = 20 \times 20$

$= 400\ cm^2$

Part AB — $M_t = 10 \times 100\ cmt$

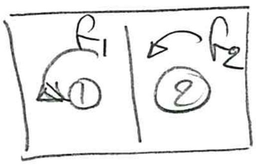
$M_t = M_{t_1} + M_{t_2}$

$= 2A_{o_1}f_1 + 2A_{o_2}f_2$

$= 2 \times 400 f_1 + 2 \times 400 f_2$

$= 800(f_1 + f_2) \longrightarrow ①$

<u>Vent 1</u>



$$\frac{2G\theta A_o}{L} = \Sigma \frac{f * S}{t}$$

$$\therefore 2G\frac{\theta}{L} * 400 = \left[4 f_1 \frac{\times 20}{1} - \frac{f_2 \times 20}{1}\right]$$

$$\therefore \frac{800}{L} G\theta = 80f_1 - 20f_2 \longrightarrow ②$$

<u>Vent 2</u>

$$2G\frac{\theta \times 400}{L} = \left[4f_2 \times \frac{20}{1} - f_1 \times \frac{20}{1}\right]$$

$$\therefore \frac{800G\theta}{L} = 80f_2 - 20f_1 \longrightarrow ③$$

② & ③ $\therefore 80f_1 - 20f_2 = 80f_2 - 20f_1$

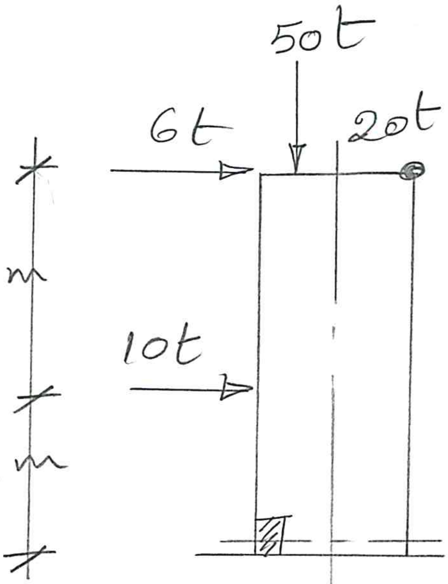
$60f_1 = 60f_2 \quad \therefore \boxed{f_1 = f_2}$

① $\rightarrow 1000 = 800(2f) \longrightarrow f_1 = f_2 = 0.625\ t/cm^2$

② $\theta_B = \frac{200}{800G}\left[60 * 0.625\right] = 0.0117\ rad.$

$\theta_C = \theta_B + .012 \times 5 \quad // \quad \theta_D = \theta_C + .012 \times 2$

$\boxed{Q3}$ $\quad \gamma = 2\,t/m^3$



$\boxed{1}$ $A = 2 \times 2 = 4\ m^2$

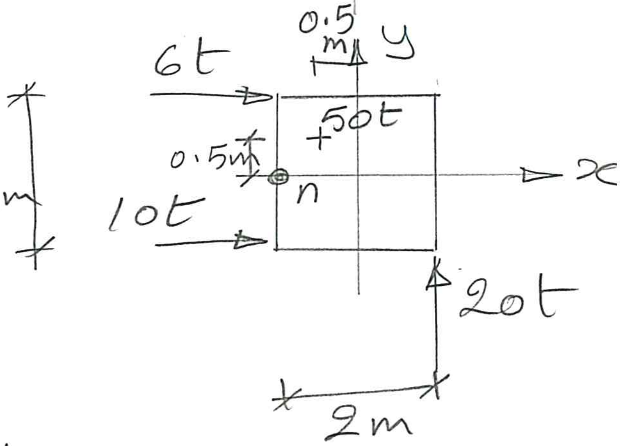
$I_x = I_y = \dfrac{2(2)^3}{12} = 4/3 = 1.33\,m^4$

$\boxed{2}$ $W = 4 * 5 \times 2 = 40\,t$

$\boxed{3}$ $N = -40 - 50 = -90\,t$

$M_x = -50 * 0.5 - 20 * 5$
$= -125\ mt$

$M_y = -6 \times 5 - 10 \times 2 + 50 \times 0.5$
$= -25\,mt$



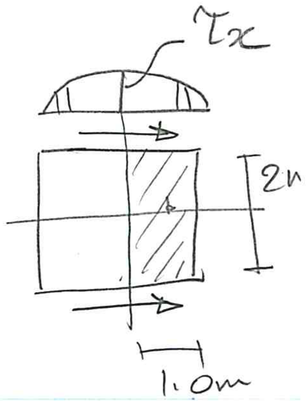
$Q_x = 6 + 10 = 16\,t$

$Q_y = +20\,t$

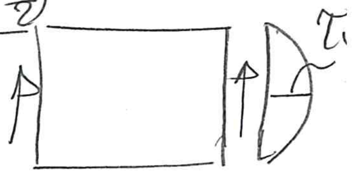
$M_t = 20*1 + 10*1 - 6*1$
$= +24\ mt$

$\boxed{4}$ Max Shear stress

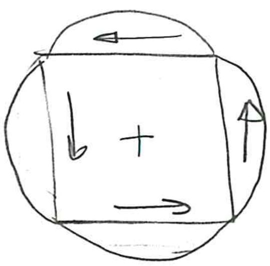
$Q_x \Longrightarrow \tau_x = \dfrac{Q_x S_y}{I_y b} = \dfrac{16 \times (2 \times 1 \times \frac{1}{2})}{1.33 \times 2}$
$= 6.0\,t/m^2$



$Q_y \Longrightarrow \tau_y = \dfrac{Q_y S_x}{I_x b} = \dfrac{20 \times (2 \times 1 \times \frac{1}{2})}{1.33 \times 2}$
$= 7.5\,t/m^2$



$M_t \Longrightarrow \tau = \dfrac{24 \times 100}{0.208(200)(200)^2}$
$= 1.44 \times 10^{-3}\,t/cm^2$
$= 14.4\,t/m^2$



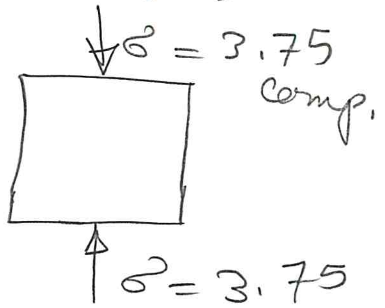
$\boxed{5}$ τ at $n = 7.5 - 14.4 = -6.92$

6 $\sigma = \frac{N}{A} + \frac{M_x}{I_x} y + \frac{M_y}{I_y} x$

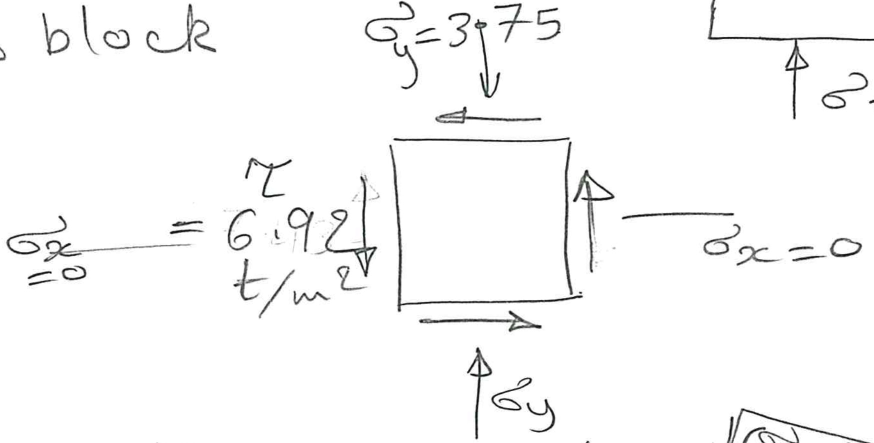
$\sigma = \frac{-90}{4} - \frac{125}{1.33} * y - \frac{25}{1.33} x$

$\sigma_n = -22.5 - 93.75(0) - 18.75(-1)$

$= -3.75 \ t/m^2$



7 stress block

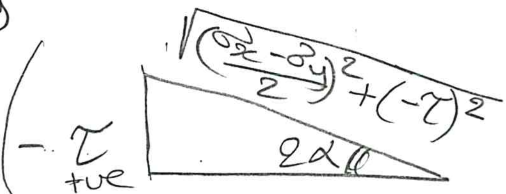


8 $\tan 2\alpha = \frac{-\tau}{\frac{\sigma_x - \sigma_y}{2}}$

$\therefore \tan 2\alpha = \frac{+6.92}{\frac{0-(-3.75)}{2}} = +3.69$

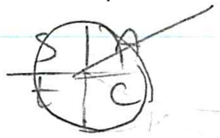
$2\alpha = 74.84^\circ$

$\therefore \boxed{\alpha = 37.42^\circ}$



$\frac{\sigma_x - \sigma_y}{2} = +ve$

sin +ve
cos +ve
tan +ve



9 $\sigma_{\substack{max \\ min}} = \frac{\sigma_x + \sigma_y}{2} \pm \sqrt{\left(\frac{\sigma_x - \sigma_y}{2}\right)^2 + (-\tau)^2}$

$= \frac{0 - 3.75}{2} \pm \sqrt{\left(\frac{3.75}{2}\right)^2 + (6.92)^2}$

$= -1.875 \pm 7.17 = \boxed{+5.29, \ -9.04 \ t/m^2}$

$\tau = 0$

$\boxed{10}$ Principal shear plane

$$2\alpha_2 = 90 - 2\alpha_1$$
$$= 90 - 74.84$$
$$\therefore \boxed{\alpha_2 = 7.58^\circ}$$

OR $\quad \alpha_2 = 45 - \dfrac{74.84}{2} = 7.58^\circ$

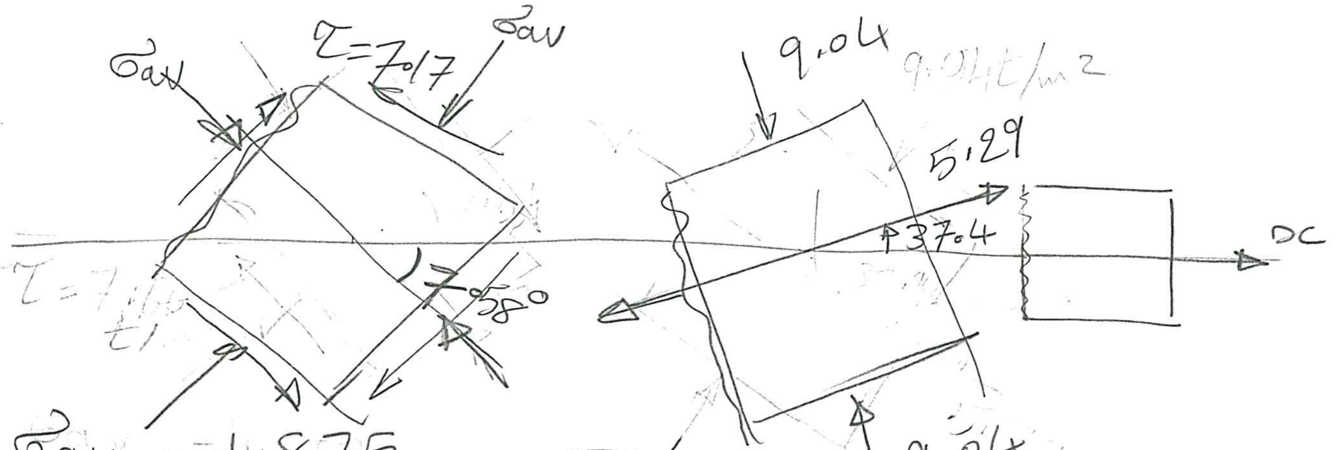
$\boxed{11}$

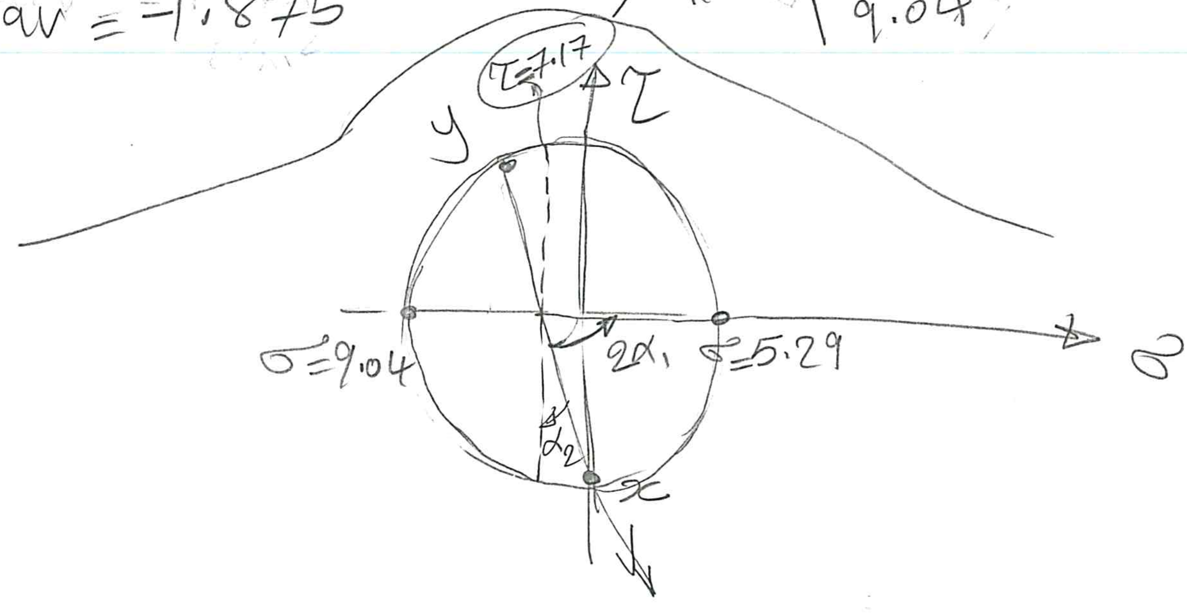
$$\tau_{max} = \sqrt{\left(\frac{\sigma_x - \sigma_y}{2}\right)^2 + (\tau)^2} = 7.17\ t/m^2$$

OR $\quad \tau_{max} = \dfrac{\sigma_{max} - \sigma_{min}}{2} = \dfrac{5.29 - (-9.04)}{2}$

$$= 7.17\ t/m^2$$

$$\sigma_{av} = \frac{\sigma_x + \sigma_y}{2} = \frac{0 - 3.75}{2} = -1.875\ t/m^2$$





Higher Technological Institute | Civil Eng. Department

Final Exam – (June-Aug. 2015)

Dr.Manal Kamal Zaki | Theory of Structures (1) | Time: $1\frac{1}{2}$ hrs.

Q1

For the given cross-section:

	ILO's	Marks
1. Find Ix.	[d11]	[4 marks]
2. Draw the distribution of the shear flow due to Q_y	[d1]	[6 marks]
3. Find the resultants of the drawn flow	[a3]	[3 marks]
4. Find the shear centre	[a3]	[2 marks]
		[Total 15]

$t = 1\ cm$

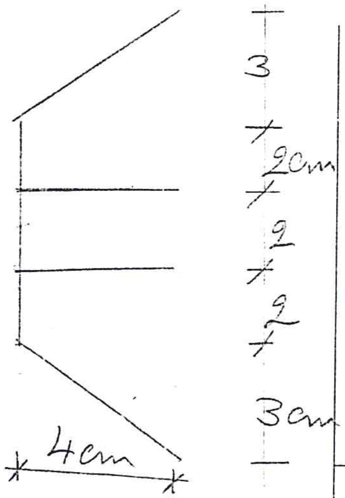


Fig. (Q1)

Q2

For the shown structure: G=800 t\cm2

	ILO's	Marks
1. Draw the T.M.D.	[a3]	[2 marks]
2. Draw the T.A.D.	[a3]	[4 marks]
3. Find the maximum tortional stress.	[d1]	[4 marks]
		[Total 10]

$r_{out} = 7\ cm$

$r_{in} = 3\ cm$

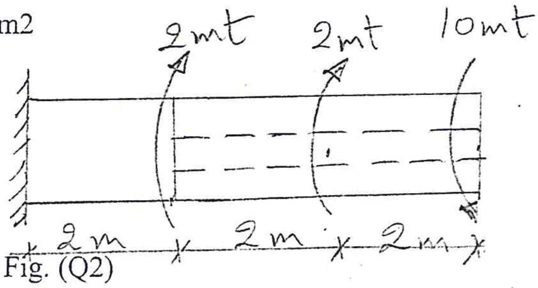


Fig. (Q2)

Q3

For the shown stress block:

	ILO's	Marks
1. Compute analytically: the principal normal stress plane:	[d1]	[3 marks]
2. Compute analytically: the maximum and minimum normal stresses acting on the principal plane.	[a3,b3]	[3 marks]
3. Draw Mohr's circle and check items (1 and 2) graphically.	[a3,b3]	[2 marks]
From Mohr's circle, determine:		
1. The principal shear plane.	[a3,b3]	[2 marks]
2. The direction and values of the stresses acting on the principal shear plane.	[a3,a4]	[3 marks]
3. The state of stresses of a plane that makes a clockwise angle=60° with the horizontal.	[b2,b3, b4,d3]	[2 marks]
		[Total 15]

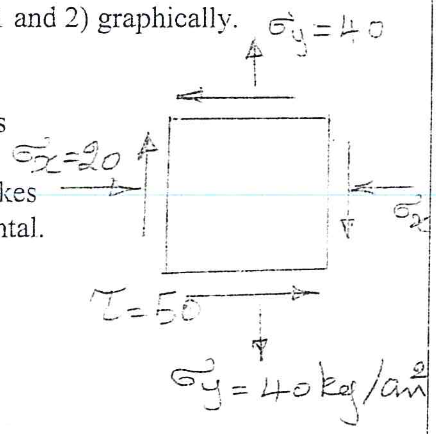
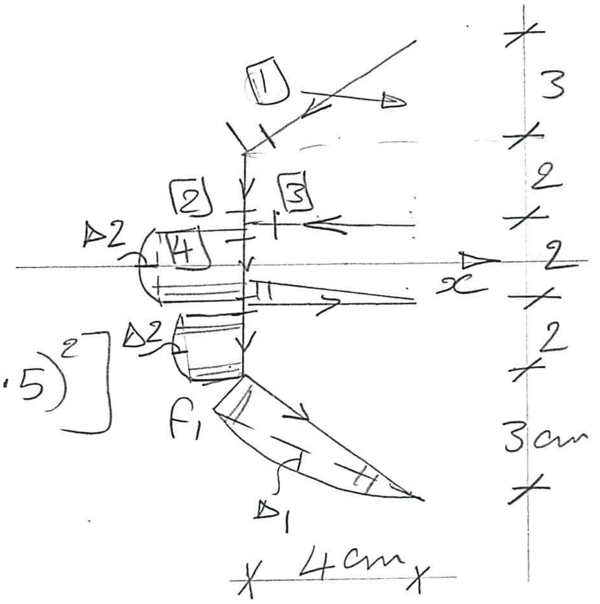


Fig. (Q3)

Mail:

Q1



(1) $$I_x = \frac{1(6)^3}{12} + 2\left[4*1(1)^2\right] + 2\left[\frac{(5*1)(3)^2}{12} + (5*1)(4.5)^2\right]$$

$$= 236$$

(2) Shear flow Dist.

$$f_y = \frac{Q_y S_x}{I_x} \quad \text{let} \quad Q_y = I_x$$

$$\therefore \boxed{f_y = S_x}$$

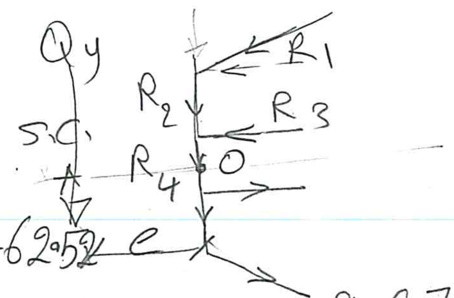
$$S_{\boxed{1}} = 5*1*4.5 = 22.5 \qquad \Delta_1 = \frac{1*5*(3)}{8} = 1.88$$

$$S_{\boxed{2}} = S_1 + (2*1)*2 = 26.5 \qquad \Delta_2 = \frac{1*2*(2)}{8} = 0.5$$

$$S_{\boxed{3}} = (4*1)*1 = 4$$

$$S_{\boxed{4}} = S_2 + S_3 = 30.5$$

(3) Resultants



$$R1 = \frac{1}{2}\times 5\times 22.5 + \frac{2}{3}\times 5\times 1.88 = 62.52$$

$$R2 = \frac{1}{2}\left[22.5 + 26.5\right]*2 + \frac{2}{3}*2*0.5 = 49.67$$

$$R3 = \frac{1}{2}\times 4*4 = 8$$

$$R4 = \cancel{26.5}\,30*2 + \frac{2}{3}\times 2*0.5 = \cancel{53.67}\ 60.67$$

(4) <u>S.C.</u> $\Sigma M @ o = 0 \quad \therefore 2\times\left[R3*1 + R1\cos\theta * 3\right] = eQ$

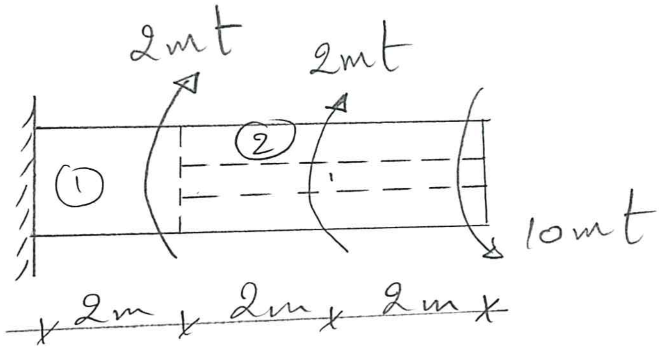
$$\therefore 2\times\left[8*1 + 62.52*0.8*3\right] = e*236$$

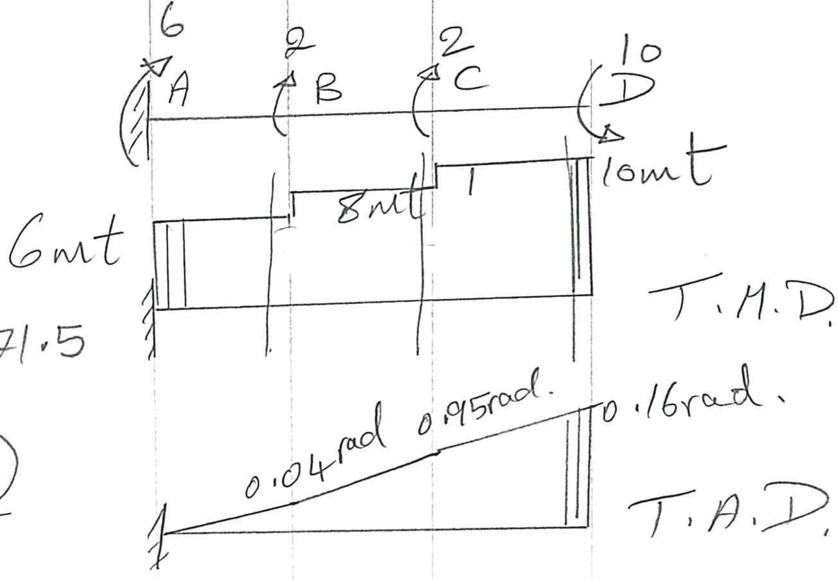
$$\therefore \boxed{e = \cancel{0.67}\ \text{cm}}$$

$\boxed{Q2}$

$r_{out} = 7\,cm$

$r_{in} = 3\,cm$





$$\theta = \frac{M_t\, L}{I_p\, G}$$

$$I_{p_1} = \frac{\pi (7)^4}{2} = 3771.5$$

$$I_{p2} = \frac{\pi \left((7)^4 - (3)^4 \right)}{2} = 3644.2$$

$$\theta_A = 0$$

$$\theta_B = 0 + \frac{600 * 200}{I_{p_1} * 800} = 0.04\ rad.$$

$$\theta_C = \theta_B + \frac{800 * 200}{I_{p2} * 800} = 0.095\ rad$$

$$\theta_D = \theta_C + \frac{1000 * 200}{I_{p2} * 800} = 0.16\ rad.$$

$$\tau_{max} = \frac{M_t\, r}{I_p} =$$

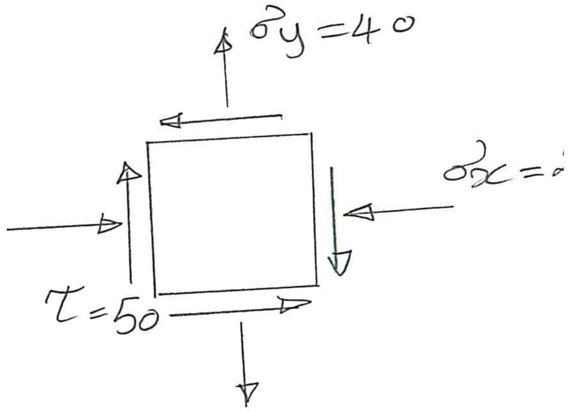
$$\therefore \tau_D = \frac{1000 * 7}{3644.2} = 1.92\ t/cm^2$$

Q3

$\sigma_x = -20$

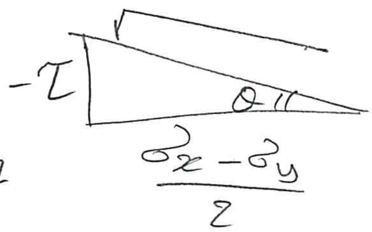
$\sigma_y = +40$

$\tau = +50$.



(1)

$$\tan 2\theta = \frac{-\tau}{\frac{\sigma_x - \sigma_y}{2}}$$



$$= \frac{-50}{\frac{-20-40}{2}} = +1.67$$

$$2\theta = 180 + 59° = 239.1°$$

$$\therefore \theta = 119.5°$$

cos −ve
sin −ve
tan +ve

S	A
T	C

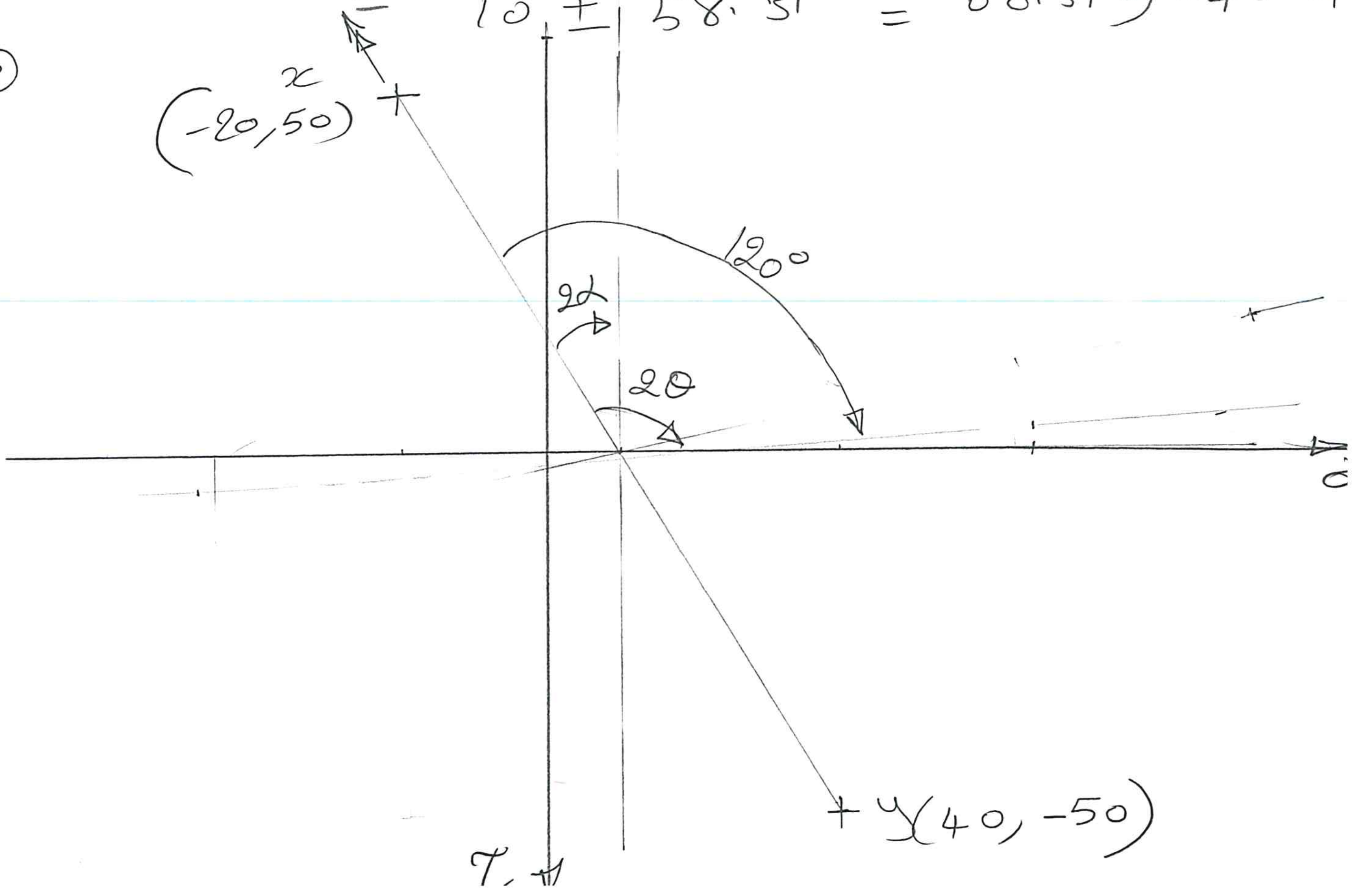
(2)

$$\sigma_{\substack{max \\ min}} = \frac{\sigma_x + \sigma_y}{2} \pm \sqrt{\left(\frac{\sigma_x - \sigma_y}{2}\right)^2 + (-\tau)^2}$$

$$= \frac{-20+40}{2} \pm \sqrt{\left(\frac{-20-40}{2}\right)^2 + (-50)^2}$$

$$= 10 \pm 58.31 = 68.31, \ -48.31$$

(3)



1- Principal shear Plane

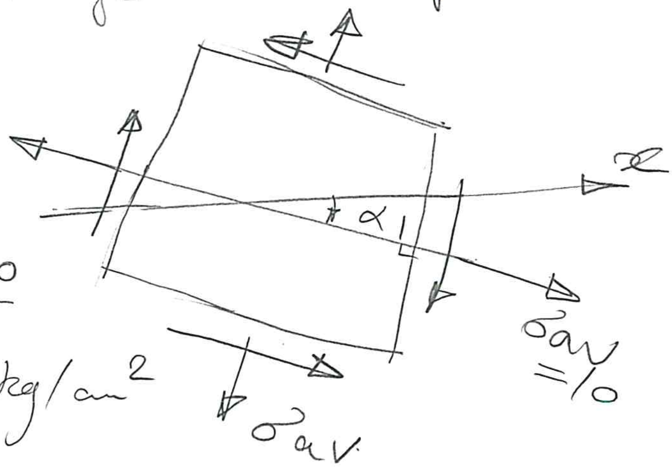
$$2\alpha_1 = 29^\circ$$

$$\therefore \alpha_1 = 14.5^\circ$$

check $2\theta - 2\alpha = 90$

$$119 - 29 = 90$$

2- stresses on Principal shear plane



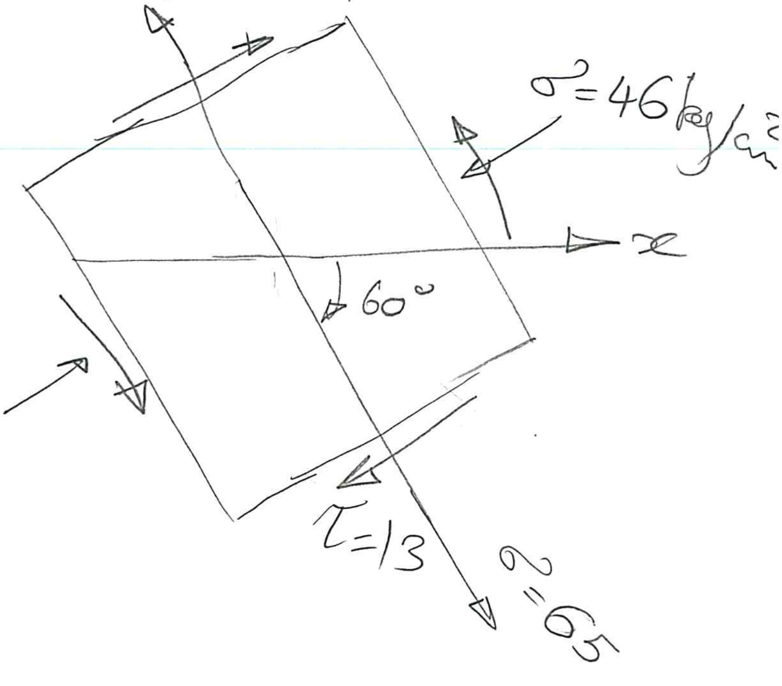
check $\sigma_{av} = \dfrac{-20+40}{2}$

$$= +10 \ kg/cm^2$$

check $\tau_{\substack{max \\ min}} = \sqrt{\left(\dfrac{\sigma_x - \sigma_y}{2}\right)^2 + (-\tau)^2}$

$$= 58 \ kg/cm^2$$

3-



Higher Technological Institute — Civil Eng. Department

Final Exam – (Jan-May 2016)
Theory of Structures (1)
CT 153

Dr.Manal Kamal Zaki

Time: $1\frac{1}{2}$ hrs.

Q1 — ILO's

For the given cross-section:

1. Find the centroid. [d11] [2 marks]
2. Find Ix. [d1] [4 marks]
3. Draw the distribution of the shear flow due to Q_y=10t [a3] [4 marks]

t=1cm

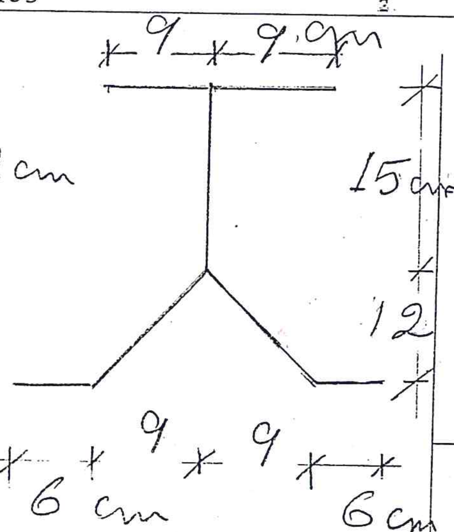


Fig. (Q1)

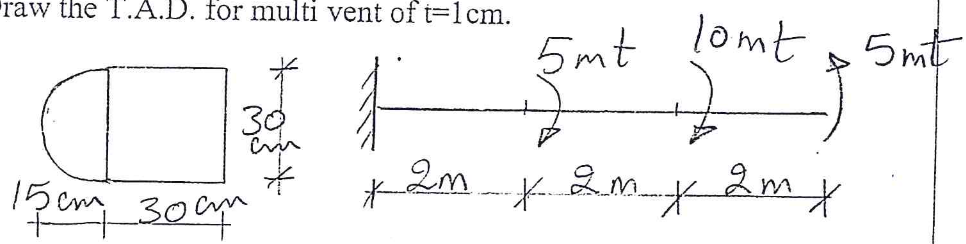
[Total 10]

Q2

For the shown structure: G=800 t\cm2

1. Draw the T.M.D. [a3] [4 marks]
2. Draw the T.A.D. for multi vent of t=1cm. [a3] [4 marks]

[d1] [4 marks]



$2G\Theta\, A_0/L=\sum (f*s/t)$ $M_t= M_{t1}+ M_{t2}=2\, A_{01} *f_1+2\, A_{02} *f_2$

Fig. (Q2)

[Total 12]

Q3

For section S-S of the shown column:

1. Find the properties of the cross-section: centroid, A, I_x, I_y. [d1] [2 marks]
2. Find the weight of the column: γ=2 t/m^3. [a3,b3] [2 marks]
3. Compute the straining actions: N, M_x, M_y, Q_x, Q_y, M_t. [d1] [3 marks]
4. Find the maximum shear stress due to Q_x, Q_y and M_t. [a3,b3] [3 marks]
5. Find total shear stress at point "n". [a3,b3] [1 marks]
6. Find the normal stress at point "n". [a3,b3] [2 marks]
7. Draw the stress block. [a3,b3] [1 marks]
8. Compute analytically: the principal normal stress plane: [a4] [1 marks]
9. the maximum and minimum normal stresses on the principal plane. [a3,b3] [2 marks]
10. The principal shear plane. [b2,b3] [1 marks]
11. The direction and values of the stresses acting on the principal shear plane. [d1,d3] [2 marks]
12. Draw Mohr's circle. [b4,b3] [2 marks]

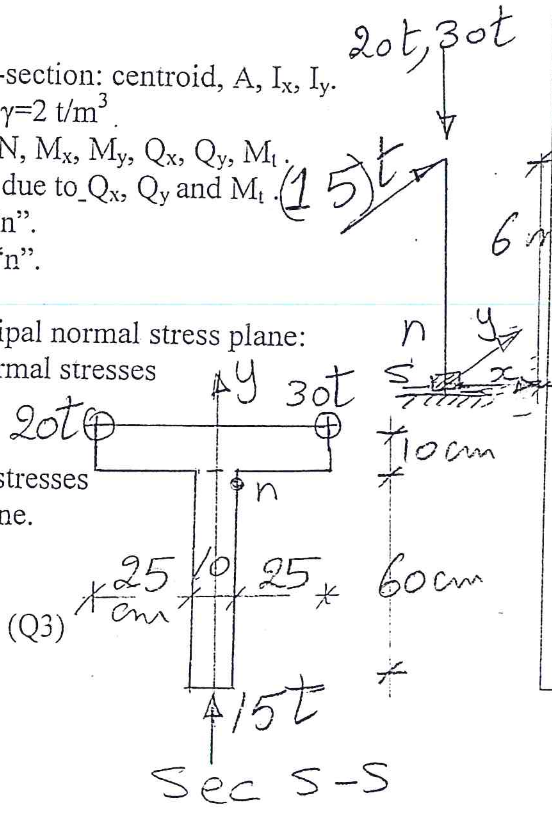


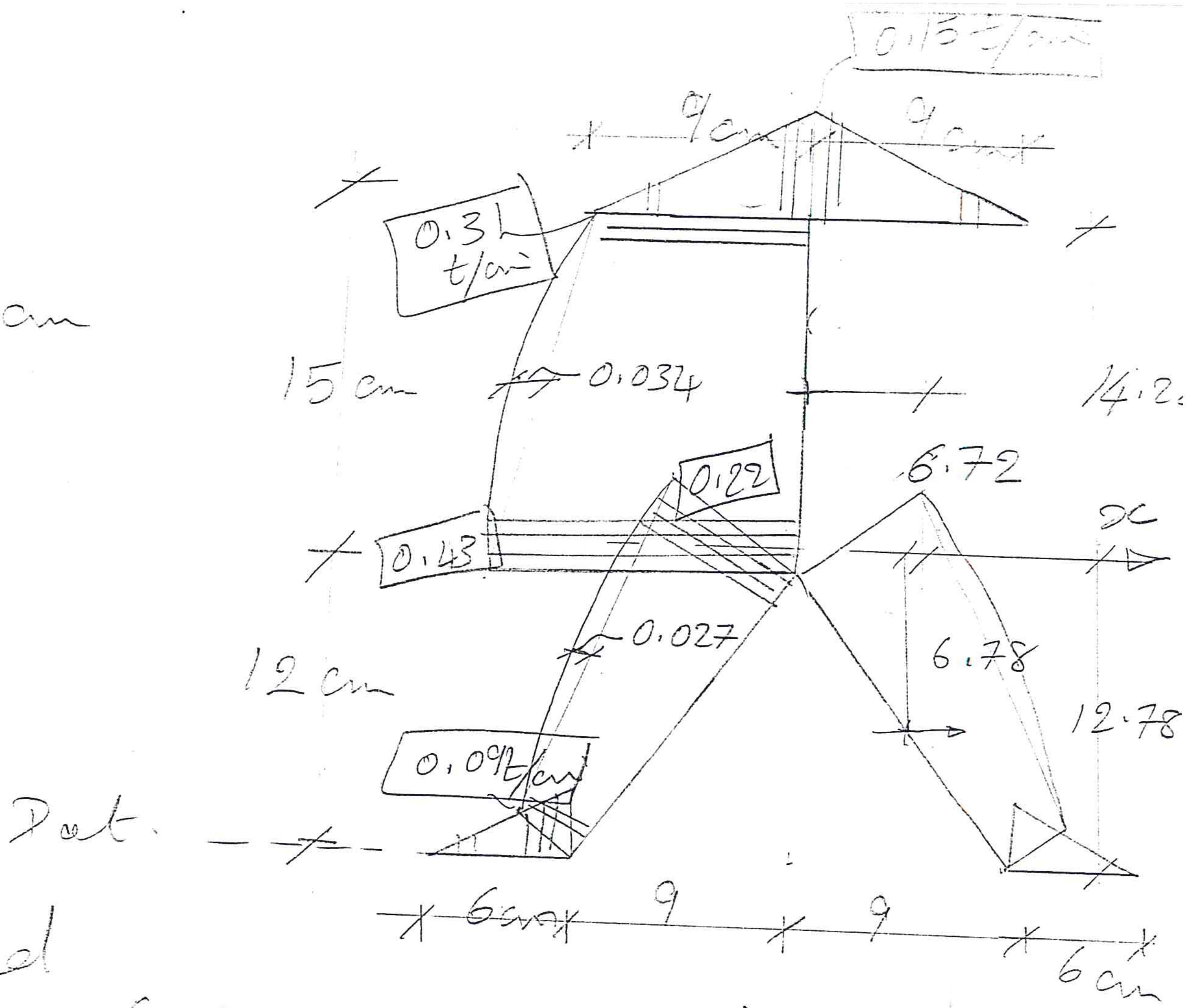
Fig. (Q3)

[Total 18]

Mail:

Q1.

$t = 1\,cm$



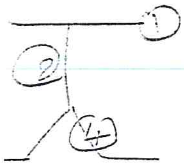
1) Centroid

$$Area = 1(15) + 1 * 2(9 + 6 + 15) = 75\ cm^2$$

$$\bar{y} = \frac{2[15*1*6] + [15*1*19.5] + 2[9*1*27]}{75}$$

$$\boxed{\bar{y} = 12.78\,cm}$$

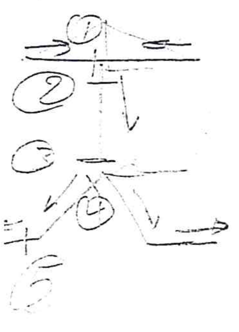
2) $$I_x = 18*1(14.22)^2 + \left[\frac{1(15)^3}{12} + 15(6.72)^2\right] + 2\left[6*1(12.78)^2\right] + 2\left[\frac{15*1(12)^2}{12} + 15(6.78)^2\right]$$



$$= 3639.75 + 958.63 + 1959.94 + 1739.05$$

$$= 8297.4\ cm^4$$

3) $$f = \frac{Q_y S_x}{I_x} = \frac{10}{8297.4} * S_x = 1.2*10^{-3} S_x$$



$f_1 = 1.2*10^{-3} * 9*1(7.23) = 1.2*10^{-3} * 127.9$

$= 0.15 \ t/m$

$f_2 = 2 f_1 = 0.31 \ t/m$

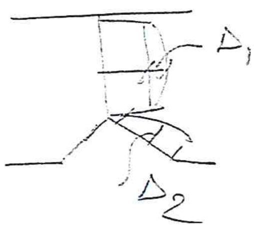
$f_3 = f_2 + 1.2*10^{-3} * (15*1*6.72)$

$= f_2 + 1.2*10^{-3} * 100.8 = 0.43$

$f_4 = \frac{f_3}{2} = 0.22 \ t/m$

$f_5 = (1*6*12.78) * 1.2*10^{-3} = 1.2*10^{-3} * 76.68$

$= 0.09 \ t/m$



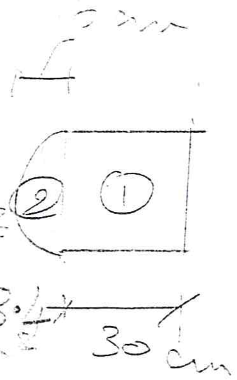
$\Delta_1 = \frac{15\times1\times15}{8} * 1.2*10^{-3}$

$= 28.13 * 1.2*10^{-3} = 0.034$

$\Delta_2 = \frac{15\times1*12}{8} * 1.2*10^{-3}$

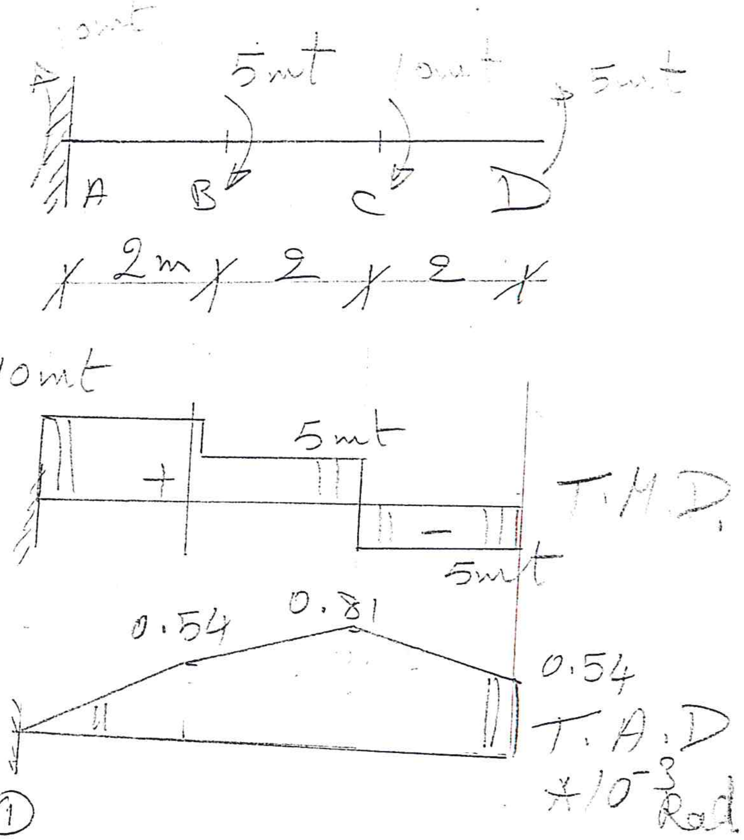
$= 22.5 * 1.2*10^{-3} = 0.027$

Q2



$A_{o_1} = 30 \times 30 = 900 \text{ cm}^2$

$A_{o_2} = \frac{\pi (15)^2}{2} = 353.4 \text{ cm}^2$



Part AB $M_t = 10 \text{ mt}$

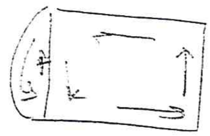
$M_t = 2A_{o_1} f_1 + 2A_{o_2} f_2$

$= 2(900) f_1 + 2(353.4) f_2$

$10 \times 100 = 1800 f_1 + 706.9 f_2 \rightarrow (1)$

Vent (1)

$\frac{2 G \theta A_o}{L} = \sum f \times \frac{S}{t}$



$\frac{2 G \theta}{L} \times 900 = 4\frac{(30)}{1} f_1 - \frac{30}{1} f_2 \rightarrow (2)$

Vent 2

$\frac{2 G \theta \times 353.4}{L} = \frac{30}{1} f_2 - \frac{30}{1} f_1 + \pi(15) f_2 \rightarrow (3)$

Divide (2) & (3)

$\therefore \frac{900}{353.4} = \frac{120 f_1 - 30 f_2}{-30 f_1 + 77.1 f_2}$

$\therefore -27000 f_1 + 69411.5 f_2 = 42408 f_1 - 10602 f_2$

$\therefore 80013.5 f_2 = 69408 f_1 \quad \therefore \boxed{f_1 = 1.153 f_2}$

Subs in (1)

$\therefore 10 \times 100 = 1800 \times 1.153 f_2 + 706.9 f_2$

$\therefore \boxed{f_2 = 0.36 \text{ t/cm}} \qquad \boxed{f = 0.41 \text{ t/cm}}$

Subs in (2)

$$\therefore \frac{2 \times 800\,\theta_A}{200} \times 900 = \frac{4(30)}{1}(0.41) - \frac{30}{1}(0.35)$$

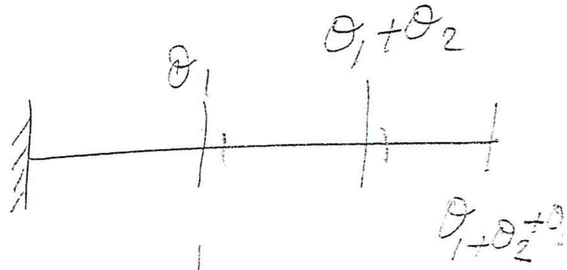
$$\therefore \boxed{\theta_1 = 5.41 \times 10^{-3} \text{ rad.}}$$

Part BC

$$\theta_2 = \frac{\theta_1}{2} = 2.7 \times 10^{-3}$$

Part CD

$$\theta_3 = -\theta_2 = -2.7 \times 10^{-3}$$



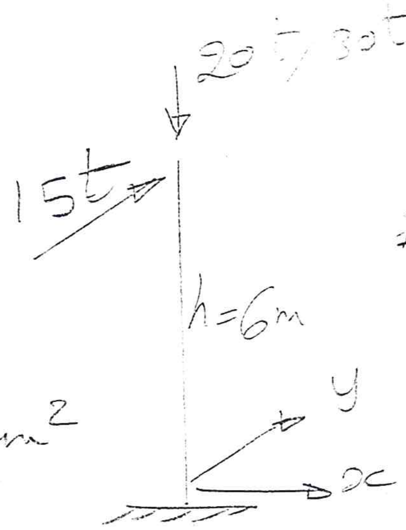
$$\theta_A = 0$$

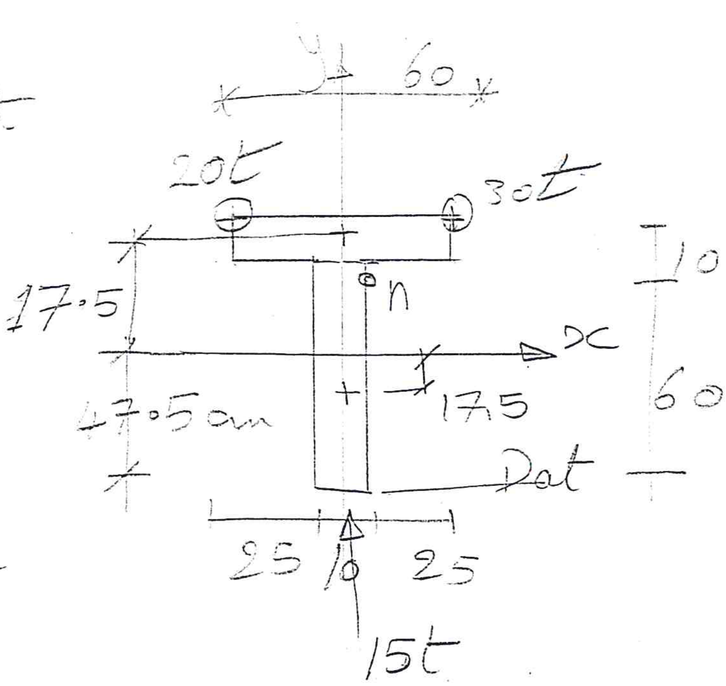
$$\theta_B = 0 + \theta_{AB} = 5.41 \times 10^{-3} \text{ rad.}$$

$$\theta_C = \theta_B + \theta_{BC} = 5.41 \times 10^{-3} + 2.7 \times 10^{-3} = 8.1 \times 10^{-3}$$

$$\theta_D = \theta_C + \theta_{CD} = 8.1 \times 10^{-3} - 2.7 \times 10^{-3} = 5.4 \times 10^{-3}$$

$\boxed{Q3}$





$A = 60 \times 10 \times 2$
$= 1200 \text{ cm}^2$

1) Centroid

$$\bar{y} = \frac{10 * 60 * 30 + 60 * 10 * 65}{1200} = 47.5$$

$$I_x = \left[\frac{10(60)^3}{12} + 600(17.5)^2\right] + \left[\frac{60(10)^3}{12} + 600(17.5)^2\right]$$

$$= 552500 \text{ cm}^4$$

$$I_y = \frac{60(10)^3}{12} + \frac{(10)(60)^3}{12} = 185000$$

2) $w = \frac{1200}{(100)^2} * 6 * 2 = 1.44 \text{ t}$

3) $N = -(30 + 20 + 1.44) = -51.44 \text{ t}$

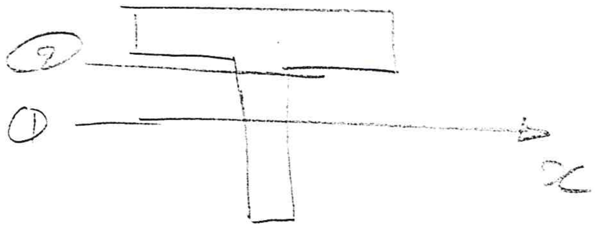
$$M_x = -20 * \frac{22.5}{100} - 30 * \frac{22.5}{100} - 15 \times 6$$

$$= -101.25 \text{ mt}$$

$$M_y = -30 * 0.3 + 20 * 0.3 = -3.0 \text{ t}$$

$Q_x = 0$, $Q_y = +15$ $M_t = 0$

4) $Q_y = +5t$



$$\tau_y = \frac{Q_y S_x}{I_x b}$$

$$\tau_1 = \frac{Q}{I_x} * \frac{1}{10} * 47.5 * 10 * \frac{47.5}{2} = \boxed{2256.3\frac{Q}{I}}$$

0.03 t/cm²

$$\tau_2 = \frac{Q}{I} * \frac{1}{10} * 60 * 10 * 17.5 = 1050\frac{Q}{I} = 0.0$$

5) $$\tau_n = \frac{1050 * 15}{552500} = 0.03 \quad t/cm^2$$

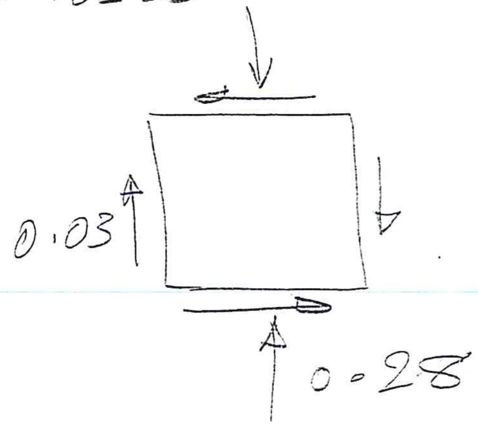
6) $$\sigma = \frac{N}{A} \pm \frac{M_x}{I_x} y + \frac{M_y}{I_y} x$$

$$\sigma_A (5, 12.5) = -\frac{51.44}{1200} - \frac{101.25 \times 100}{552500} y - \frac{3 \times 100}{185000} * x$$

$$= -0.0429 - 0.0183y - 0.00162x$$

$$= -0.28$$

7)



8) $$\tan 2\alpha = \frac{-\tau}{\frac{\sigma_x - \sigma_y}{2}} = \frac{-0.03}{\frac{0.28}{2}}$$

$\sigma_x = 0$

$\sigma_y = -0.28$

$\tau = +0.03$

$$= -0.214$$

$$\therefore 2\alpha = -12.09$$

$$\therefore \alpha = -6.04°$$

9) $$\sigma_{\substack{max \\ min}} = \frac{\sigma_x + \sigma_y}{2} \pm \sqrt{\left(\frac{\sigma_x - \sigma_y}{2}\right)^2 + (-\tau)^2}$$

$$= \frac{0 - 0.28}{2} \pm \sqrt{\left(\frac{0 + 0.28}{2}\right)^2 + (-0.03)^2}$$

$$= -.14 \pm .143 = \boxed{\pm 0.003, -0.283\, t/cm^2}$$

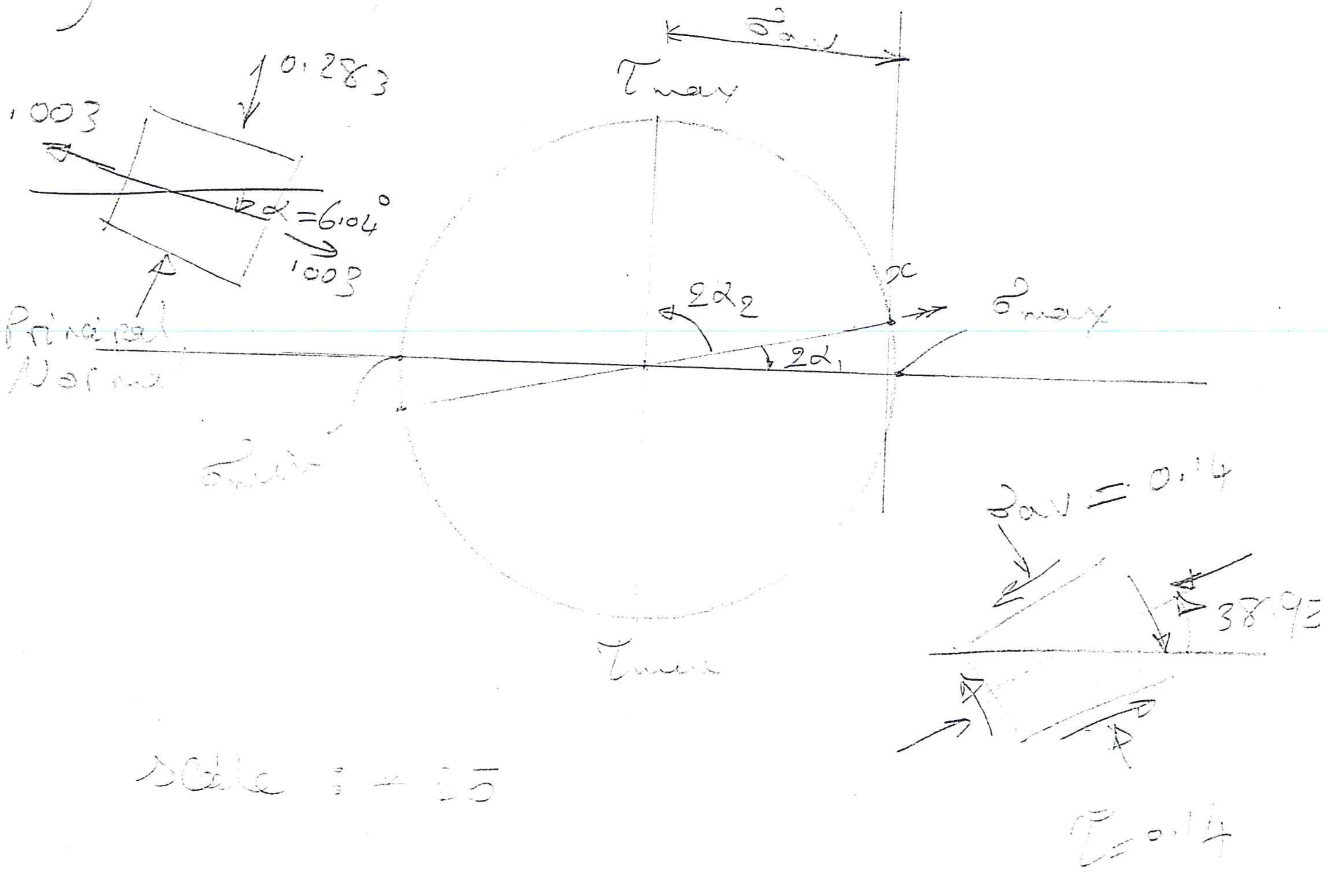
10) $$\tan 2\alpha_2 = \frac{\frac{\sigma_x - \sigma_y}{2}}{\tau} = \frac{\frac{0.28}{2}}{.03} = 4.67$$

$$\therefore \quad 2\alpha_2 = 77.9 \qquad \therefore \alpha_2 = 38.95^\circ$$

11) $$\tau_{\substack{max \\ min}} = \frac{\sigma_{max} - \sigma_{min}}{2} = \pm 0.143\, t/cm^2$$

$$\sigma_{av} = \frac{\sigma_x + \sigma_y}{2} = \frac{0 - 0.28}{2} = -0.14$$

12)



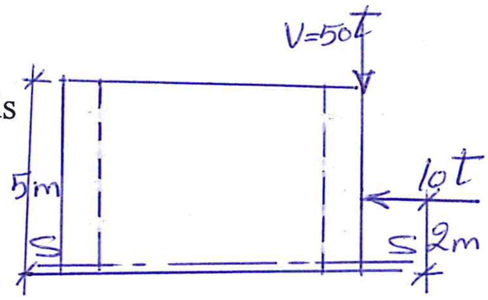
Scale 1 = 25

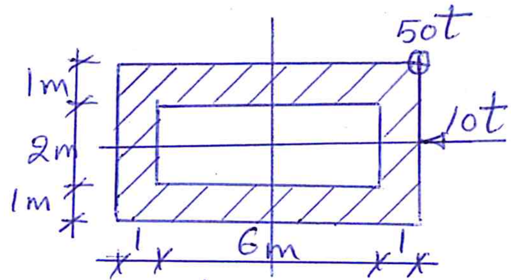
Higher Technological Institute
6th October Branch
Ministry of Education

Theory of Structures(1) CT 153
Final Exam April 2005
Time Allowed 2 hours

Question 1 (12 marks)

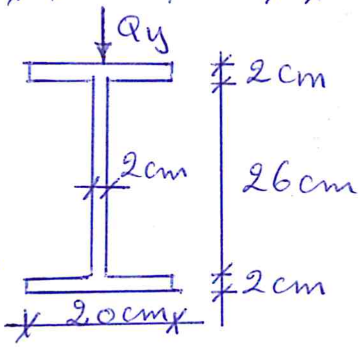
For section s-s of the shown structure weighing 2 t/m^3
And subjected to the given horizontal and vertical loads
-Draw the normal stress distribution
-Find the vertical load v if the maximum allowable compressive normal stress at section s-s is 20 t/m^2



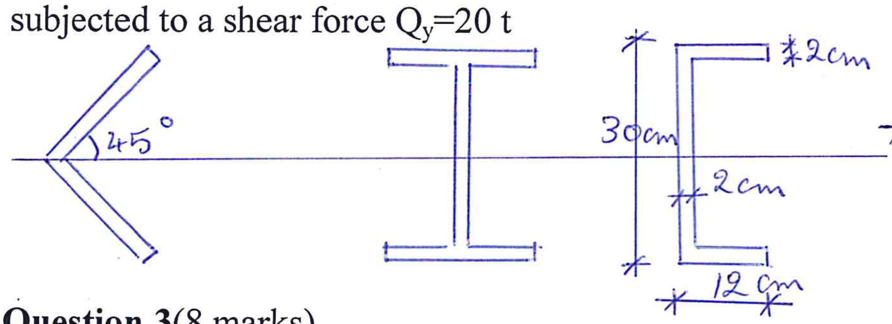


Question 2 (12marks)

Draw the shear stress distribution for the shown cross-section subjected to a shear force Q_y=30 t



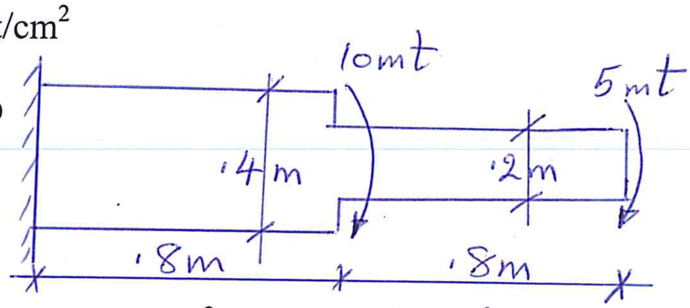
-Determine the shear center for the shown sections subjected to a shear force Q_y=20 t



Question 3(8 marks)

For the shown circular shaft having G=800 t/cm^2

a) Draw the torsional moment diagram
b) Draw the twisting angle diagram T.A.D
c) Determine the maximum shear stress and the maximum angle of twist



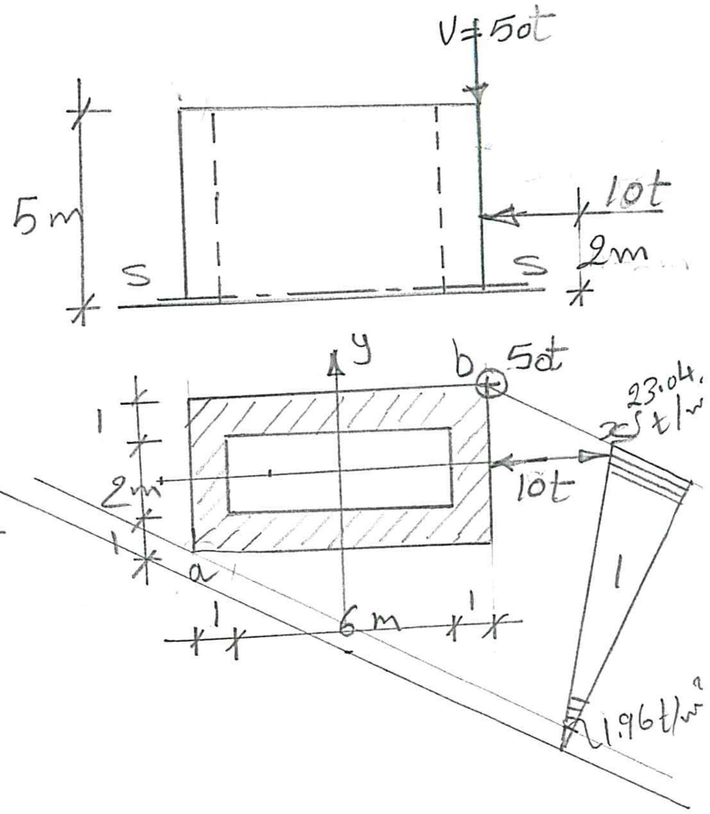
Question 4(8 marks)

For a section subjected to σ_x=400 kg/cm^2 , σ_y=200 kg/cm^2 and τ=100 kg/cm^2

a)Determine analytically the maximum and minimum normal stresses
b)Verify your calculations using Mohr's circle

Final Exam CT 153

Question 1



1. Straining Actions

$W = (8\times4 - 6\times2)\times5\times\overset{\gamma}{2}$

$= (20)\times5\times2 = 200t$

$N = -200 - 50 = -250t$

$M_x = -50\times2 = -100mt$

$M_y = -50\times4 + 10\times2$

$= -180\ mt$

2. Prop. of sec.

$A = 20\ m^2$

$I_x = \frac{8(4)^3}{12} - \frac{6(2)^3}{12} = 38.67\ m^4$

$I_y = \frac{4(8)^3}{12} - \frac{2(6)^3}{12} = 134.67\ m^4$

3. $\sigma = \frac{N}{A} + \frac{M_x}{I_x}y + \frac{M_y}{I_y}x$

$= \frac{-250}{20} - \frac{100}{38.67}y - \frac{180}{134.67}x$

$\sigma = -12.5 - 2.59y - 1.34x$

For N.A. $\longrightarrow \sigma = 0$

at $x = 0 \longrightarrow y = -4.83\ m$

at $y = 0 \longrightarrow x = -9.33\ m$

$\sigma_{a\,(-4,-2)} = -12.5 - 2.59(-2) - 1.34(-4) = -1.96\ t/m^2$

$\sigma_{b\,(4,2)} = -12.5 - 2.59(2) - 1.34(4) = -23.04\ t/m^2$

b) $V = ?$ $\qquad \sigma = 20$

$\ast \quad M_x = -2V \quad , N = -200 - V$

$M_y = -4V + 20$

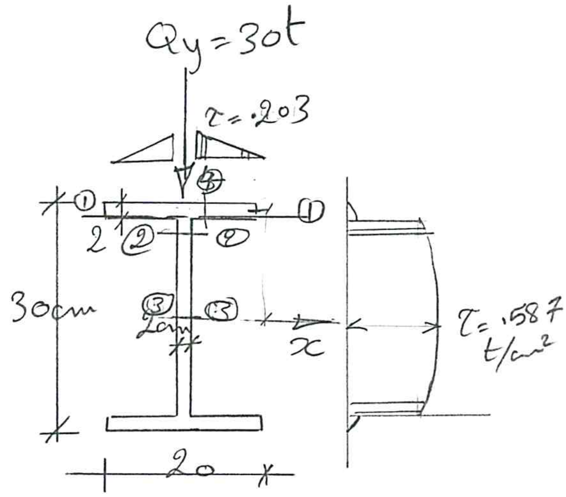
$$\sigma_b \, (4,2) = \frac{-200-V}{20} \quad \frac{-2V}{38.67} \overset{2}{y} + \frac{(-4V+20)}{134.67} \overset{4}{x} = -20$$

$\therefore \quad -10 \; -.05V \; -.1034V - .1188V + .594 = -20$

$\therefore \quad -.2722V = -10.594$

$\therefore \boxed{V = -38.61 \ t}$

Question 2



$$\tau = \frac{Q_y \, S_x}{I_x \, b}$$

$$I_x = \left[\frac{20(2)^3}{12} + 20\times 2(14)^2\right] * 2 + \frac{2(26)^3}{12} = 18636 \text{ cm}^4$$

Sec 1-1

$S_x = 2\times 20\times 14 = 560$, $b=20$

Sec 3-3

$S_x = 2\times 20\times 14 + 13\times 2\times 6.5 = 729$, $b=2$

Sec 4-4

$S_x = 9\times 2\times 14 = 252$, $b=2$

Sec 1-1

$$\tau = \frac{30}{18636} * \frac{S_x}{b} = .045 \ t/cm^2$$

Sec 2-2

$b = 2 \longrightarrow \tau = .451 \ t/cm^2$

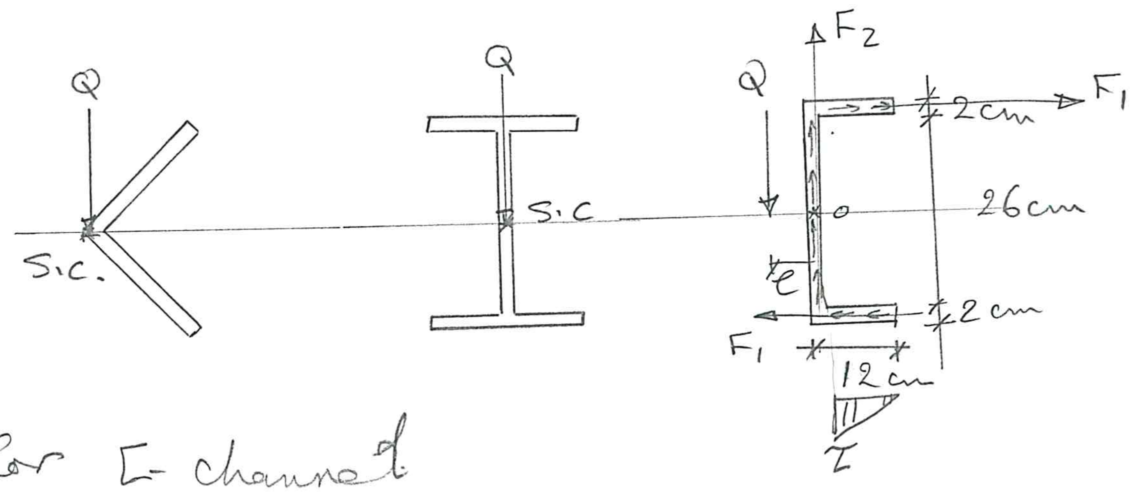
Sec 3-3

$\tau = .587 \ t/cm^2$

Sec 4-4

$\tau = .203 \ t/cm^2$

2-b)



For [- channel

$$\tau = \frac{Q_y S_x}{I_x b}$$

$$I_x = \left[\frac{12(2)^3}{12} + 12\times2(14)^2\right]*2 + \frac{2(26)^3}{12}$$

$$= 12353.33 cm^4$$

$$\tau = \frac{20*[2*10*14]}{I_x*2} = .227\ t/cm^2$$

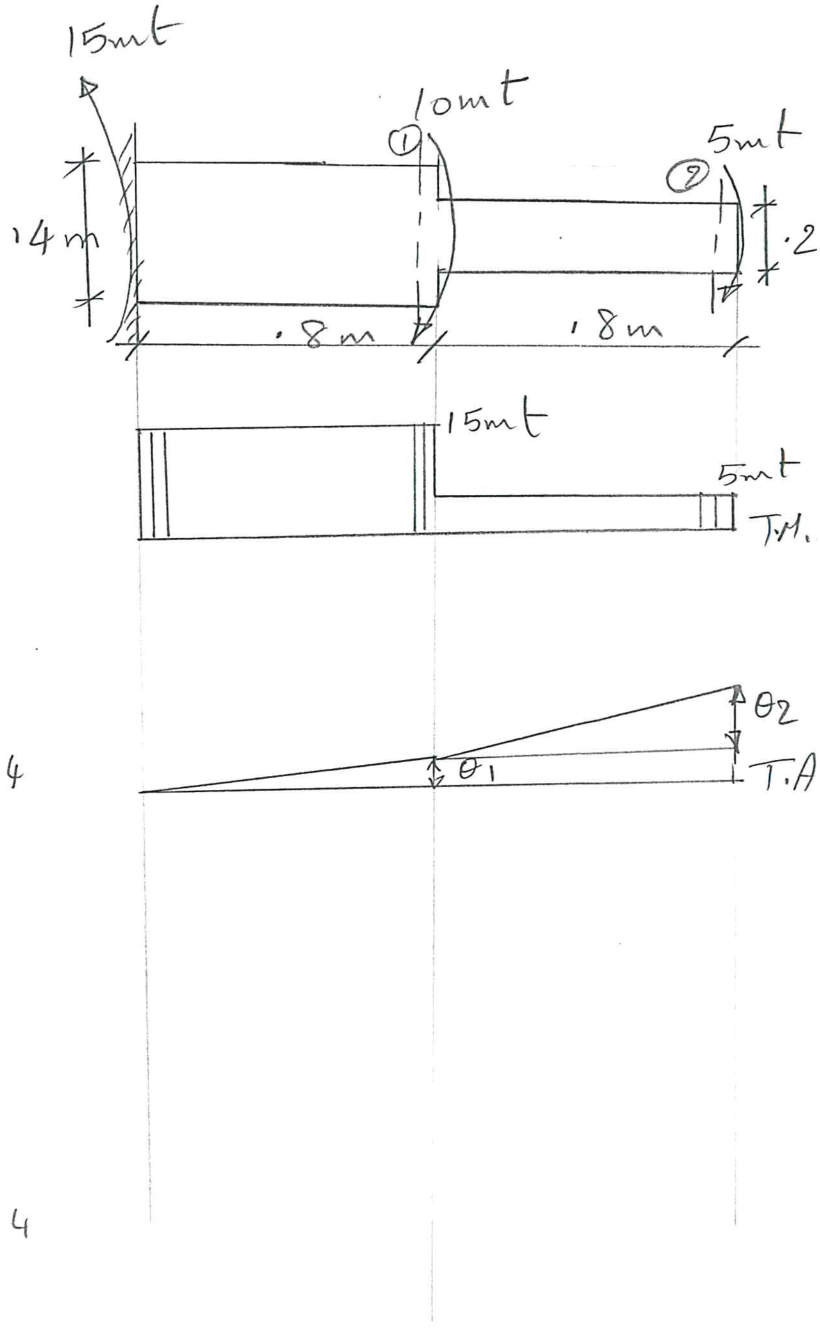
$$\therefore F_1 = \frac{.227*10}{2}*2 = 2.27\ t$$

$$\Sigma M_o = 0$$

$$\therefore F_1 * 28 = Q\ e$$

$$\therefore 2.27\times28 = 20\ e \longrightarrow e = 3.18 cm$$

Question 3



$$\tau = \frac{M_t r}{I_p}$$

$$\theta = \frac{M_t x}{G I_p}$$

$$I_{p_1} = \frac{\pi (40)^4}{32}$$

$$= 251327.4 \text{ cm}^4$$

$$\therefore \theta_1 = \frac{15 \times 100 (80)}{800 * 251327.4}$$

$$= 5.97 * 10^{-4}$$

$$I_{p2} = \frac{\pi (20)^4}{32}$$

$$= 15707.96 \text{ cm}^4$$

$$\theta_2 = \frac{5 * 100 (80)}{800 * 15707.96}$$

$$= 3.18 * 10^{-3}$$

$$\theta_{max} = \theta_1 + \theta_2 = 3.78 * 10^{-3} \text{ rad.}$$

$$\tau_1 = \frac{15 \times 100 \times 20}{251327.4} = .1194 \text{ t/cm}^2$$

$$\tau_2 = \frac{5 \times 100 * 10}{15707.96} = \boxed{.3183 \text{ t/cm}^2 = \tau_{max}}$$

Question 4

$\sigma_x = 400 \ kg/cm^2$, $\sigma_y = 200 \ kg/cm^2$

$\tau = 100 \ kg/cm^2$

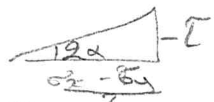
a) $$\sigma_{\substack{max \\ min}} = \frac{\sigma_x + \sigma_y}{2} \pm \sqrt{\left(\frac{\sigma_x - \sigma_y}{2}\right)^2 + \tau^2}$$

$$= \frac{400+200}{2} \pm \sqrt{\left(\frac{400-200}{2}\right)^2 + 100^2}$$

$\therefore \sigma_{max} = 441.42 \ t/cm^2$

$\sigma_{min} = 158.58 \ t/cm^2$

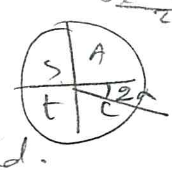
$$\tan 2\alpha = \frac{-\tau}{\frac{\sigma_x - \sigma_y}{2}} = \frac{-100}{\frac{400-200}{2}} = -1$$

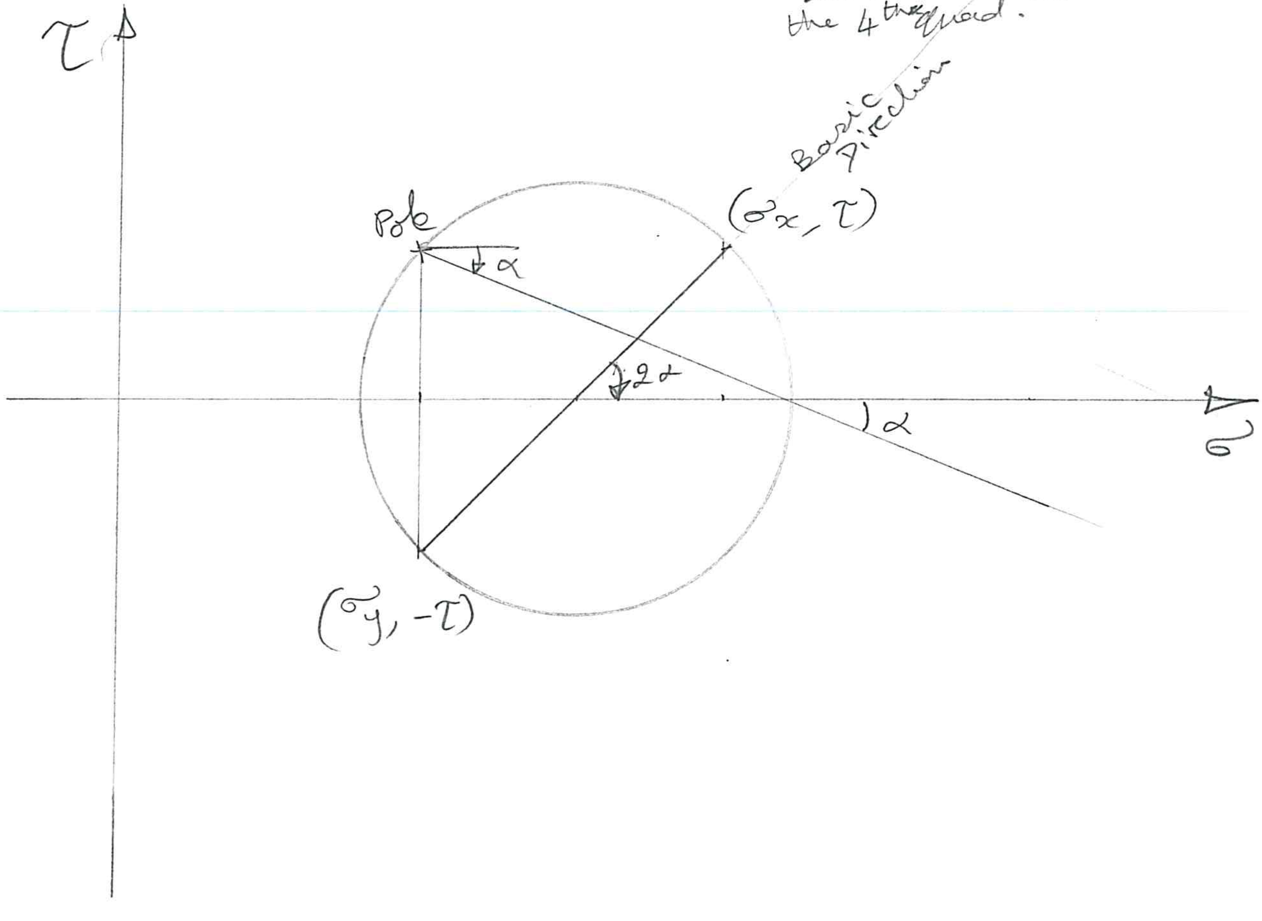


$\therefore 2\alpha = -45^\circ$

$\therefore \alpha = -22.5^\circ$

$\tan 2\alpha = -ve$
$\sin 2\alpha = -ve$
$\therefore 2\alpha$ is in the 4th quad.





Higher Technological Institute
10th Ramadan City
(6th October Branch)
Department of Civil Engineering

Course :Theory of structures 1 (CIV 124)
Examiner: Dr. Manal Kamal Zaki

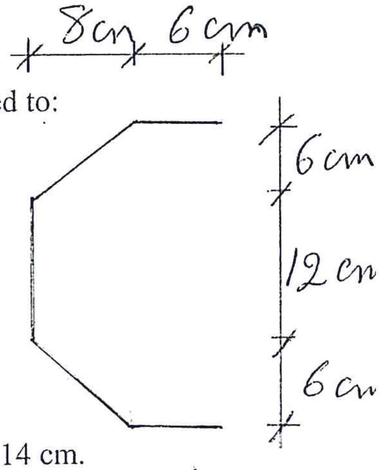
Term : May-Aug. 2018
Time : 90 min

Final Exam

Question 1 [a3,b1,b2,c4] {12 Marks}

The given cross-section has a thickness of 1 cm and is subjected to Q_y .It is required to:

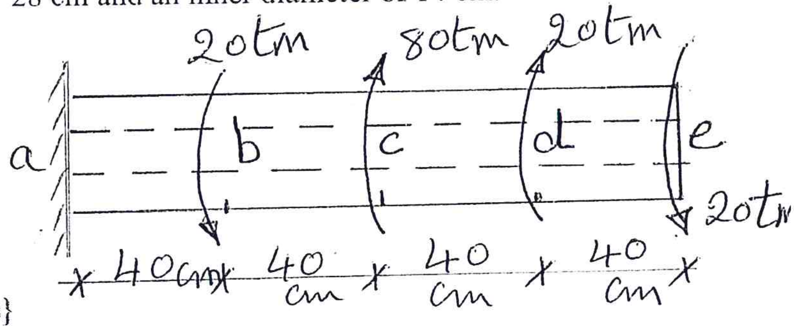
1. Find the centroidal moment of inertia I_x. {3 M}
2. Draw the distribution of the shear stress. {5 M}
3. Find the resultant forces due to the drawn shear stresses. {3 M}
4. Find the shear centre if the cross-section. {1 M}



Question 2 [a4,b1,c4] {12 Marks}

The shown hollow shaft has an outer diameter of 28 cm and an inner diameter of 14 cm.
G=800 t\cm2

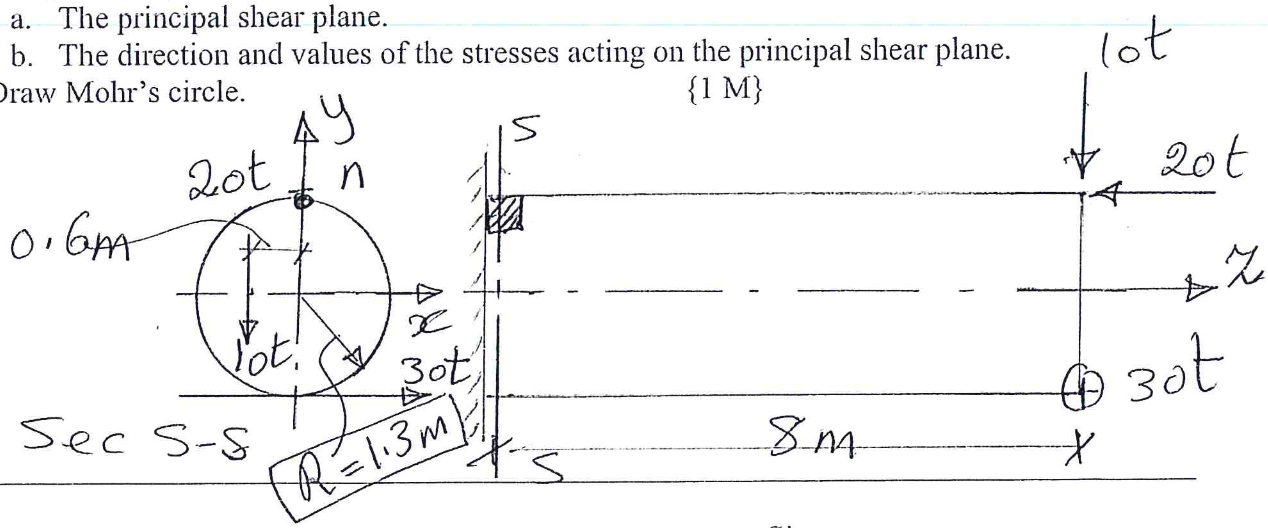
1. Draw the T.M.D. {4 M}
2. Draw the T.A.D. {4 M}
3. Find the maximum shear stress on the shaft at section "a". {4 M}



Question 2 [a5,b1,b3,b4,c2,c3,c4] {16 Marks}

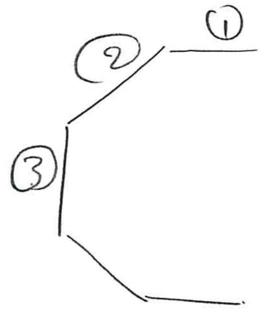
For section S-S of the shown beam:

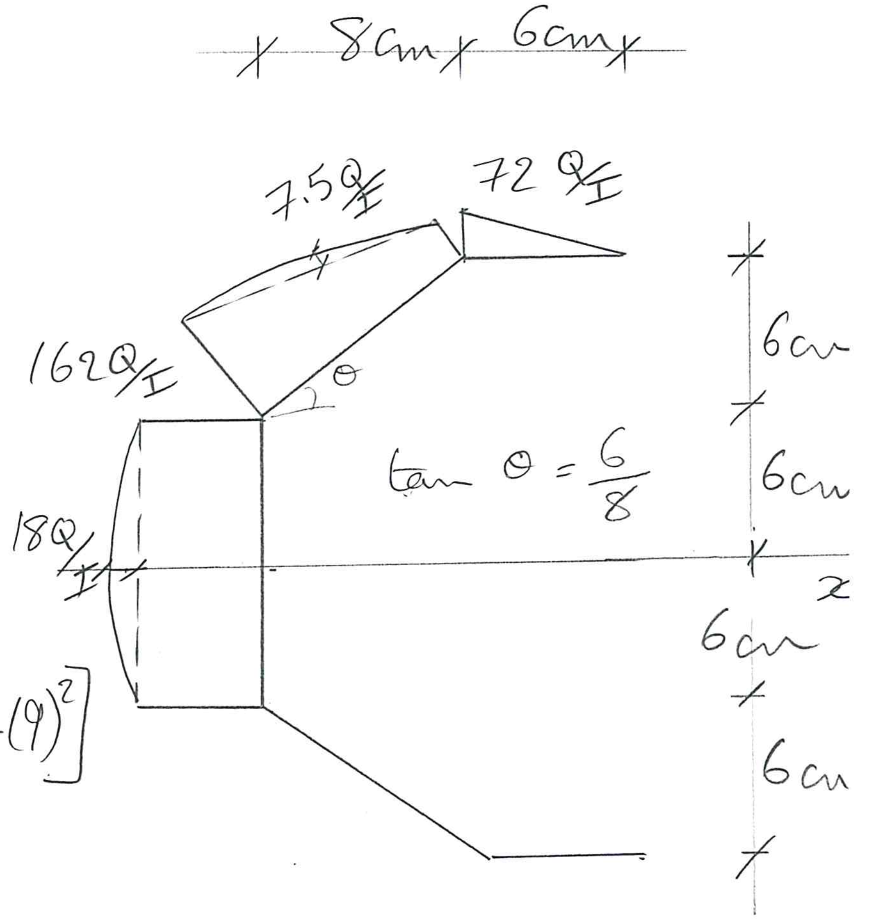
1. Find the properties of the cross-section: A, I_x, I_y. {2 M}
2. Compute the straining actions: N, M_x, M_y, Q_x, Q_y, M_t . {3 M}
3. Find the normal stress at point "n". {2 M}
4. Find the maximum shear stress due to Q_x, Q_y and M_t . {3 M}
5. Find total shear stress at point "n". {1 M}
6. Draw the stress block. {1 M}
7. Compute analytically: {2 M}
   a. The direction of the principal normal stress plane:
   b. The maximum and minimum normal stresses acting on the principal plane.
8. Compute analytically: {2 M}
   a. The principal shear plane.
   b. The direction and values of the stresses acting on the principal shear plane.
9. Draw Mohr's circle. {1 M}



Examination committee: 1-Name Signature
2-Name Signature

$\boxed{1}$





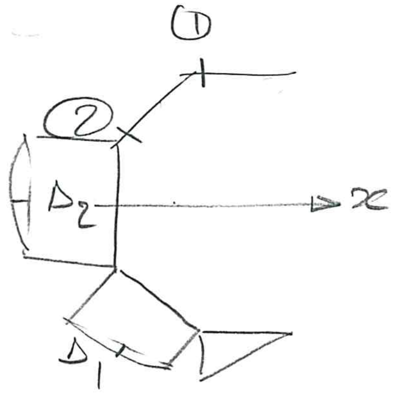
$\boxed{I_x}$

$$I_x = 2\left[6*1*(12)^2\right] + 2\left[\frac{10*1(6)^2}{12} + 10*(9)^2\right] + \left[\frac{1(12)^3}{12}\right]$$

$$= 1728 + 1680 + 144$$

$$\boxed{I_x = 3552\ cm^4}$$

$\boxed{\text{Flow}}$



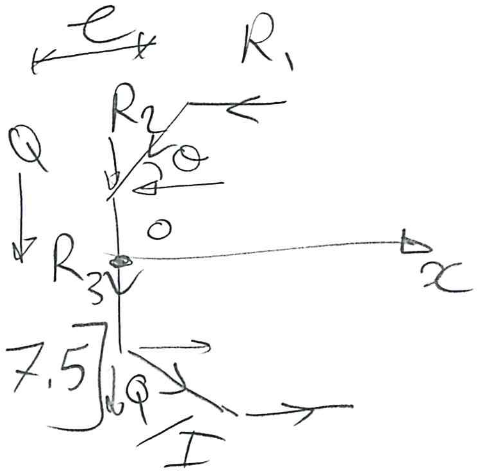
$$f_1 = 6*1*12 = 72\frac{Q}{I}$$

$$f_2 = f_1 + 10*9 = 162\frac{Q}{I}$$

$$\Delta_1 = \frac{10*6}{8} = 7.5\ Q/I$$

$$\Delta_2 = \frac{12\times 12}{8} = 18\ Q/I$$

$\boxed{\text{Resultant forces}}$



$$R_1 = \frac{1}{2}\times 6\times 72\,Q/I = 216\frac{Q}{I}$$

$$R_2 = \left[\left(\frac{162+72}{2}\right)(10) + \frac{2}{3}\times 10\times 7.5\right]\frac{Q}{I}$$

$$= 1220\ Q/I$$

$$R_3 = \left[162 \times 12 + \frac{2}{3} \times 12 \times 18\right] \frac{Q}{I} = 2088 \frac{Q}{I}$$

$\boxed{\text{Shear Centre}}$

$$R_1 * 12 * 2 + R_2 \cos\theta \times 6 * 2 = Q\, e$$

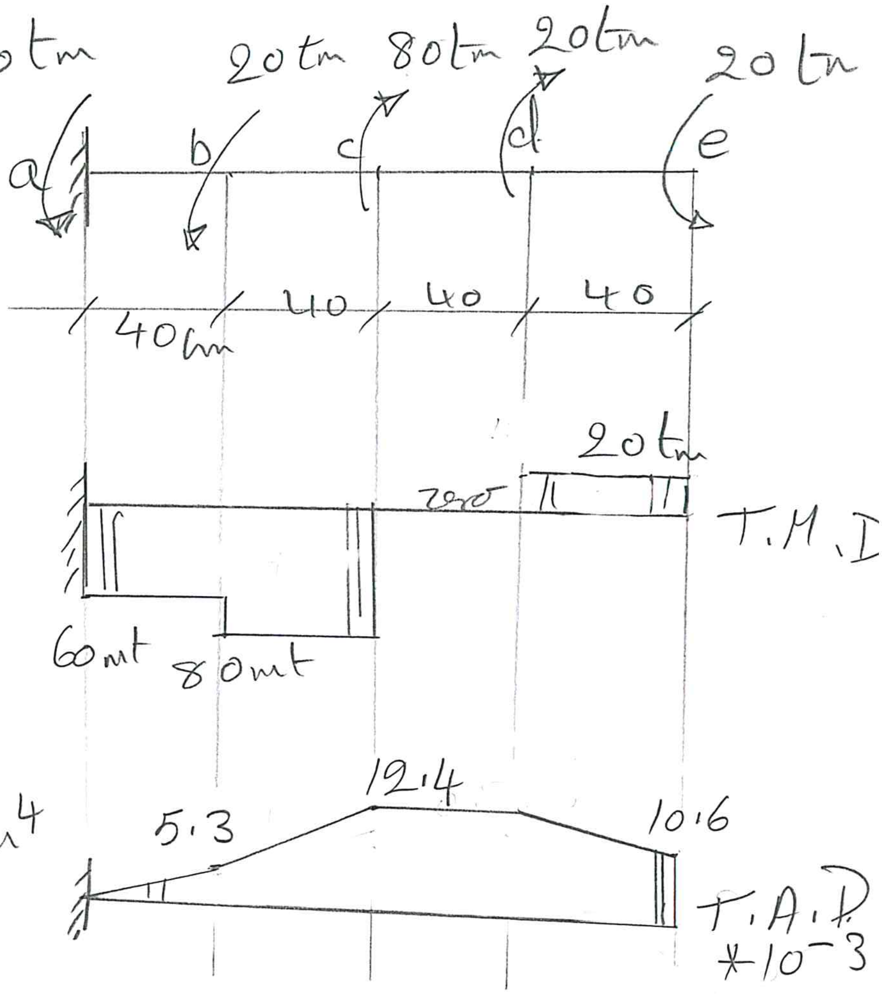
$$\therefore 216 \frac{\cancel{Q}}{I} * 12 \times 2 + 1220 \frac{\cancel{Q}}{I} * 0.8 \times 6 \times 2 = \cancel{Q}$$

$$\boxed{4.75\ \text{cm} = e}$$

$\boxed{2}$ $G = 800 \, t/cm^2$

$D_{out} = 28 \, cm$

$D_{in} = 14 \, cm$



T.A.D.

$$\theta = \frac{M_t \, L}{G \, I_p}$$

$$I_p = \frac{\pi \left[(14)^4 - (7)^4 \right]}{2}$$

$$\boxed{I_p = 56595} \; cm^4$$

$$\theta_a = 0$$

$$\theta_b = \theta_a + \frac{60 \times 100 \times 40}{800 \, I_p} = 5.3 \times 10^{-3} \, rad$$

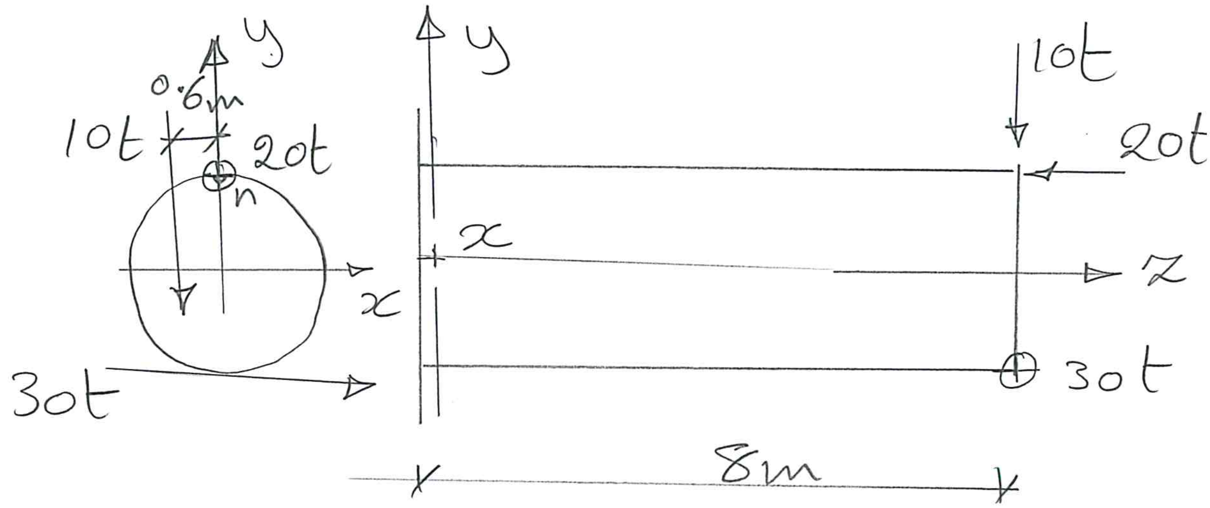
$$\theta_c = \theta_b + \frac{80 \times 100 \times 40}{800 \, I_p} = 0.0124 \, rad = \theta_d = 12.4 \times 10^{-3}$$

$$\theta_e = \theta_d - \frac{20 \times 100 \times 40}{800 \, I_p} = 0.0106 \, rad = 10.6 \times 10^{-3}$$

$$\tau_a = \frac{M_t \, R}{I_p} = \frac{60 \times 100 \times 14}{56595}$$

$$= 1.48 \; t/cm^2$$

$\boxed{Q3}$



① $A = \pi (1.3)^2 = 5.31 \, m^2$ $\quad R = 1.3 \, m$

$$I_x = I_y = \frac{\pi (1.3)^4}{4} = 2.24 \, m^4$$

② $N = -20t$, $M_t = +10 * 0.6 + 30 \times 1.3 = \boxed{45 mt = M_t}$

$Q_x = +30t$, $Q_y = -10t$

$M_x = -20 * 1.3 + 10 \times 8 = + \boxed{54 mt = M_x}$

$M_y = -30 \times 8 = \boxed{-240 mt = M_y}$

③ $$\sigma = \frac{N}{A} + \frac{M_x}{I_x} y + \frac{M_y}{I_y} x$$

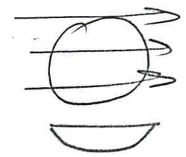
$$\sigma_{n\,(0,1.3)} = \frac{-20}{5.31} + \frac{54}{2.24}(1.3) - \frac{240}{2.24}(0)$$

$$\therefore \boxed{\sigma_n = 27.57 \; t/m^2}$$

(4) $$\tau_x = \frac{Q_x S_y}{I_y b} = \frac{Q_x * \frac{\pi(1.3)^2}{2} \times \frac{4(1.3)}{3\pi}}{2.24 \times 2.6}$$

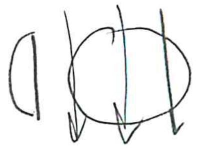
$$\therefore \tau_x = Q_x * 0.25 = 30 \times 0.25$$

$$\therefore \tau_x = 7.5 \ t/m^2$$



& $$\tau_y = \frac{Q_y S_x}{I_x b} = Q_y * 0.25 = 10 \times 0.2$$

$$\therefore \tau_y = 2.5 \ t/m^2$$

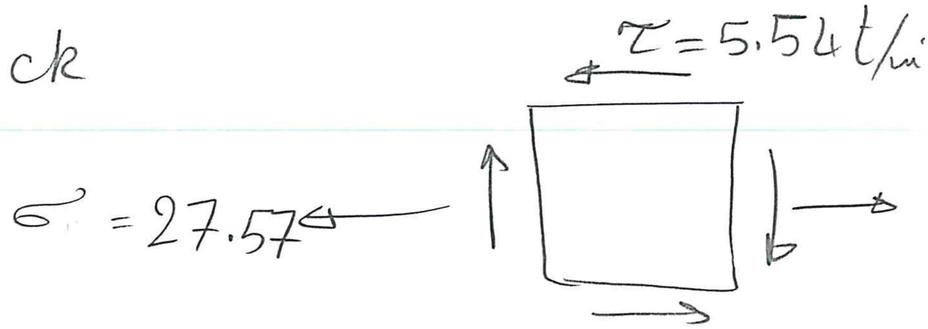


$$\tau_t = \frac{M_t R}{I_p} = \frac{45 \times 1.3}{\frac{\pi(1.3)^4}{2}} =$$

$$\tau_t = 13.04 \ t/m^2$$

(5) $$\tau_n = \overrightarrow{7.5} - \overleftarrow{13.04} = \boxed{\overleftarrow{5.54} = \tau_n}$$

(6) stress block



(7) $\sigma_x = 27.57$, $\sigma_y = 0$, $\tau = +5.54$

$$\tan 2\alpha_1 = \frac{-\tau}{\frac{\sigma_x - \sigma_y}{2}} = \frac{-5.54}{\frac{27.57-0}{2}}$$

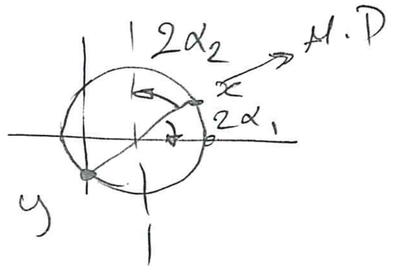
$$\therefore \tan 2\alpha_1 = \frac{-5.54}{13.79} = \boxed{-0.40 = \tan 2\alpha_1}$$

$$\sigma_{\substack{max \\ min}} = \frac{\sigma_x + \sigma_y}{2} \pm \sqrt{\left(\frac{\sigma_x - \sigma_y}{2}\right)^2 + (-\tau)^2}$$

$$= 13.79 \pm 14.86$$

$\therefore \sigma_{max} = 28.65$

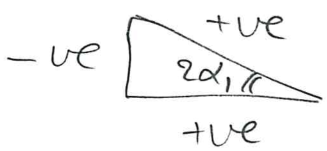
$\sigma_{min} = -1.07$



$\therefore$ Sin $-$ve

cos + ve

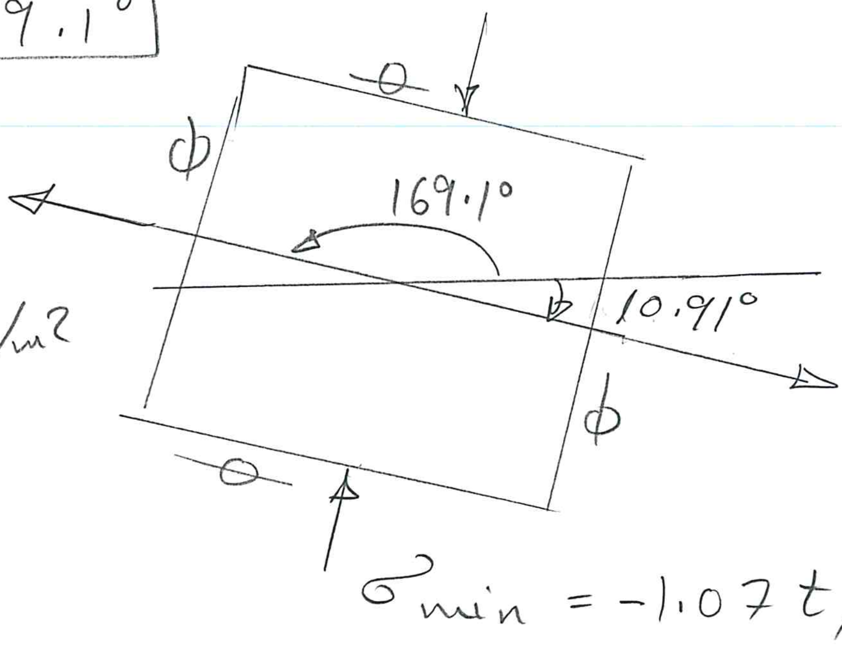
tan $-$ ve



$\therefore 2\alpha_1 = 360 - 21.8° = 338.2°$

$\therefore \boxed{\alpha_1 = 169.1°}$

$\sigma_{max} = 28.65 t/m^2$

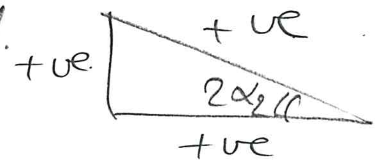


$\tau = 0$

$\sigma_{min} = -1.07 t/m^2$

(8) $\tan 2\alpha_2 = + \dfrac{\frac{\sigma_x - \sigma_y}{2}}{\tau} = 2.5$

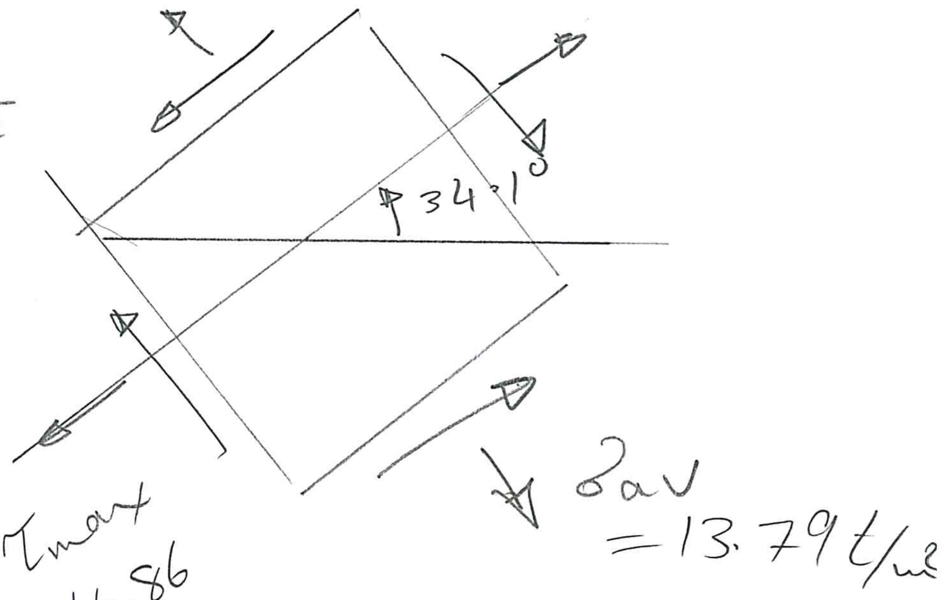
$\therefore 2\alpha_2 = 68.2^\circ$ 1st quad.



$\therefore \alpha_2 = 34.1^\circ$

$\tau_{\substack{max \\ min}} = \sqrt{\left(\frac{\sigma_x - \sigma_y}{2}\right)^2 + \tau^2}$

$\boxed{\tau_{\substack{max \\ min}} = \pm 14.86}$



$\sigma_{av} = \dfrac{\sigma_x + \sigma_y}{2}$

$\therefore \sigma_{av} = 13.79\ t/m^2$

(9) Mohr's circle