THE UNIVERSITY OF MANITOBA

Date : Thursday, December 10, 2001
Department & Course No : 130.135
Examination: Engineering Statics
Paper No : 193
Place : U. Centre Room 210 - 213
Seat Numbers: 1 - 237

Page No : 1 of 5
Time : 13:30
Duration : 2 Hours
Examiners : J. Frye, B. Stimpson, and A. Shah

PRINT STUDENT NAME IN FULL

STUDENT SIGNATURE

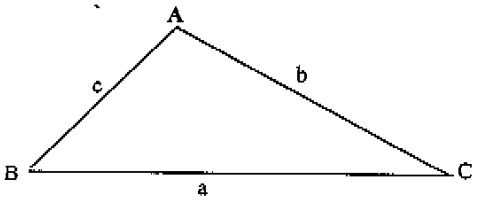
STUDENT NUMBER

SEAT NUMBER

Problem	Marks
1	
2	
3	
4	
TOTAL out of 40	

Notes:

- **CLOSED BOOK. Textbooks, notes, problems NOT permitted.**
- **Calculators are permitted.**
- **There are Four Questions. All questions are of equal value.**
- **STRAIGHT EDGE IS REQUIRED.**



$$a^2 = b^2 + c^2 - 2bc\cos A$$

$$\frac{a}{\sin A} = \frac{b}{\sin B} = \frac{c}{\sin C}$$

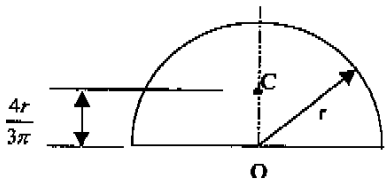
$$\vec{P} \times \vec{Q} = \begin{vmatrix} \hat{i} & \hat{j} & \hat{k} \\ P_x & P_y & P_z \\ Q_x & Q_y & Q_z \end{vmatrix} = \hat{i}(P_yQ_z - P_zQ_y) - \hat{j}(P_xQ_z - P_zQ_x) + \hat{k}(P_xQ_y - P_yQ_x)$$

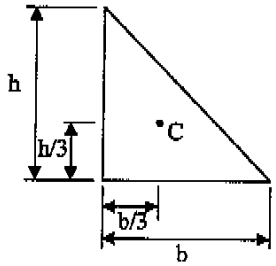
$$V = |\vec{V}| = \sqrt{V_x^2 + V_y^2 + V_z^2}$$

$$\cos\theta_x = \frac{V_x}{V}, \cos\theta_y = \frac{V_y}{V}, \cos\theta_z = \frac{V_z}{V}$$

$$\vec{M} = \vec{r} \times \vec{F}$$

$$M_{OL} = \vec{\lambda}_{OL} \bullet \vec{M}_O$$





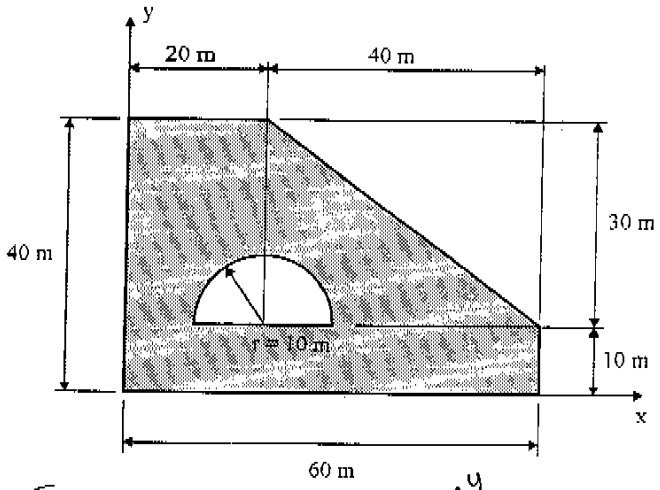
THE UNIVERSITY OF MANITOBA

Date : Thursday, December 10, 2001
Department & Course No : 130.135
Examination: Engineering Statics
Paper No : 193
Place : U. Centre Room 210 - 213
Seat Numbers: 1 - 237

Page No : 2 of 5
Time : 13:30
Duration : 2 Hours
Examiners : J. Frye, B. Stimpson, and A. Shah

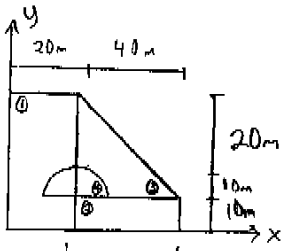
Question 1:

The cross section of a hydroelectric dam shown in the figure has a semicircular inspection gallery located as shown. Determine the location of the centroid of the dam. **PRESENT YOUR RESULTS IN TABULAR FORM.**



$\bar{X}\Sigma A = \Sigma \bar{x}A$

$\bar{Y}\Sigma A = \Sigma \bar{y}A$



Section	$\bar{x}$	$\bar{y}$	A	$\bar{x}A$	$\bar{y}A$
+ ①	10m	20m	$20 \cdot 40 = 800 m^2$	$8000 m^3$	$16000 m^3$
+ ②	40m	5m	$400 m^2$	$16000 m^3$	$2000 m^3$
+ ③	$\frac{1}{3}(40)+20 = 33.33$m	$\frac{30}{3}+10 = 20$m	$600 m^2$	$19998 m^3$	$12000 m^3$
− ④	20m	$10+\frac{4(10)}{3\pi} = 14.24$m	$\pi(10)^2 = 157.05 m^2$	$3141 m^3$	$-2236.39 m^3$

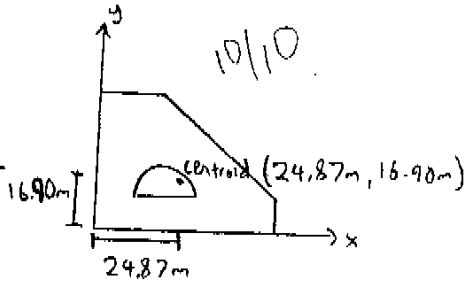
$\Sigma A = 1642.95 m^2$

$\Sigma \bar{x}A = 40857 m^3$ $\Sigma \bar{y}A = 27763.61 m^3$

$$\bar{X} = \frac{\Sigma \bar{x}A}{\Sigma A} = \frac{40857 m^3}{1642.95 m^2} = 24.87 m = \bar{X}$$

$$\bar{Y} = \frac{\Sigma \bar{y}A}{\Sigma A} = \frac{27763.6 m^3}{1642.95 m^2} = 16.90 m = \bar{Y}$$

10/10



THE UNIVERSITY OF MANITOBA

Date : Thursday, December 10, 2001
Department & Course No : 130.135
Examination: Engineering Statics
Paper No : 193
Place : U. Centre Room 210 - 213
Seat Numbers: 1 - 237

Time : 13:30
Duration : 2 Hours
Examiners : J. Frye, B. Stimpson, and A. Shah

Question 2:

Determine the force in each member of the truss shown in Figure 2(a) and state whether it is in tension or compression. Show your results on Figure 2(b).

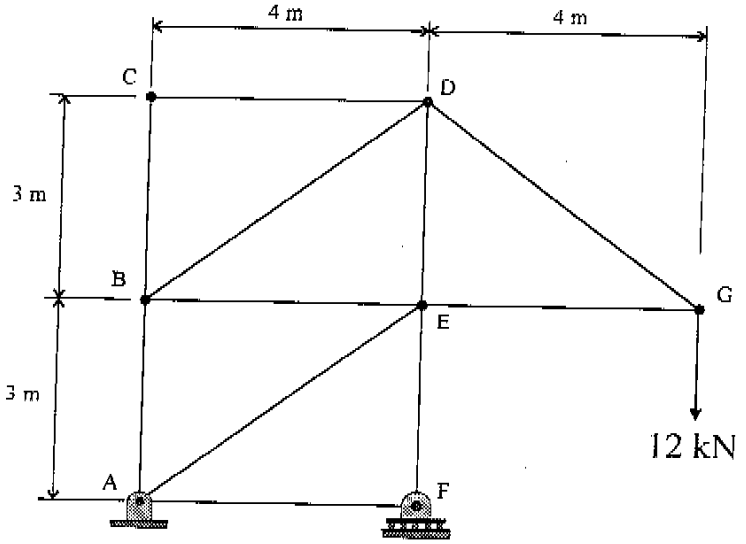


Figure 2(a)

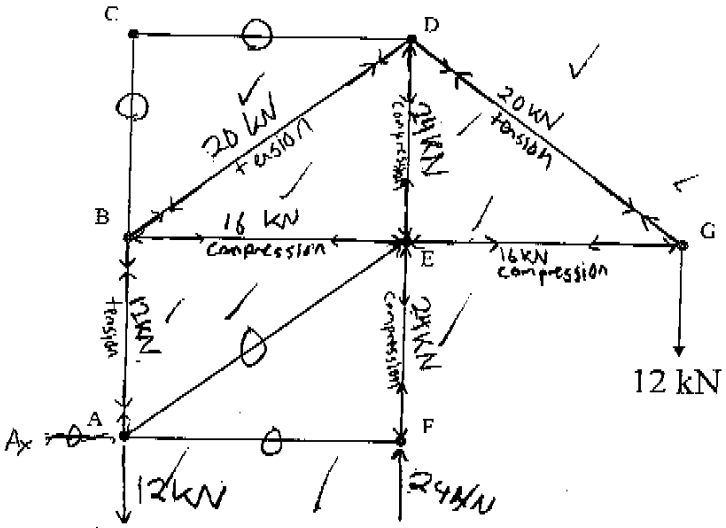


Figure 2(b)

Check $+\uparrow \Sigma F_y = 24kN - 12kN - 12kN = 0$ ✓

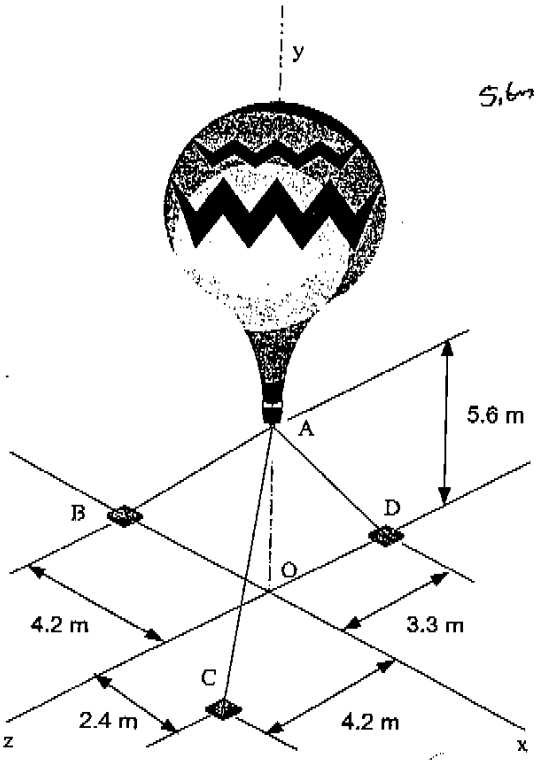
THE UNIVERSITY OF MANITOBA

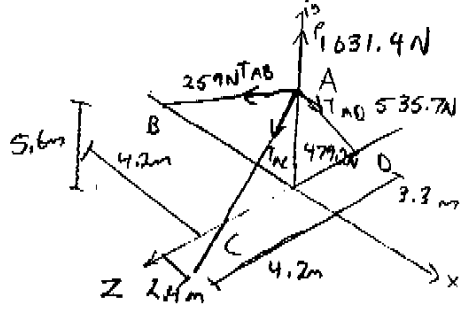
Date :
Department & Course No : 130.135
Paper No :
Examination : Engineering Statics
Place :

Page No : 4 of 5
Time :
Duration : 2 Hours
Examiners :
Seats:

Question 3:

Three cables, *AB*, *AC*, and *AD* are used to tie down a balloon as shown in the figure. The balloon is in equilibrium. Determine the vertical force ***P*** exerted by the balloon at point *A* knowing that the tension in cable *AB* is *259 N*.





A: (0, 5.6m, 0) d:
B: (-4.2m, 0, 0) d:
C: (2.4m, 0, 4.2m) d:
D: (0, 0, -3.3m) d:

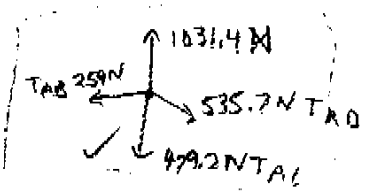
$\lambda_{AD} = \frac{0 - 5.6\hat{j} - 3.3\hat{k}}{6.5}$

$= -0.8615\hat{j} - 0.5077\hat{k}$

$\lambda_{AC} = \frac{2.4\hat{i} - 5.6\hat{j} + 4.2\hat{k}}{7.4}$

$= 0.3243\hat{i} - 0.7568\hat{j} + 0.5676\hat{k}$

$\lambda_{AB} = \frac{-4.2\hat{i} - 5.6\hat{j}}{7} = -0.6\hat{i} - 0.8\hat{j}$



$\Sigma F = 0$:

$0 = (0.3243 T_{AC} - 0.6 T_{AB})\hat{i} + (-0.8615 T_{AD} - 0.7568 T_{AC} - 0.8 T_{AB} + P)\hat{j} + (-0.5077 T_{AD} + 0.5676 T_{AC})\hat{k}$

$0.3243 T_{AC} - 0.6(259N) = 0$ ✓

$T_{AC} = 479.2\,N$ ✓

$T_{AB} = 259N$ ✓

$-0.5077 T_{AD} + 0.5676(479.2N) = 0$

$T_{AD} = 535.7\,N$

$-0.8615(535.7N) - 0.7568(479.2N) - 0.8(259N) + P = 0$

$P = 1031.4\,N$ ✓

10/10

THE UNIVERSITY OF MANITOBA

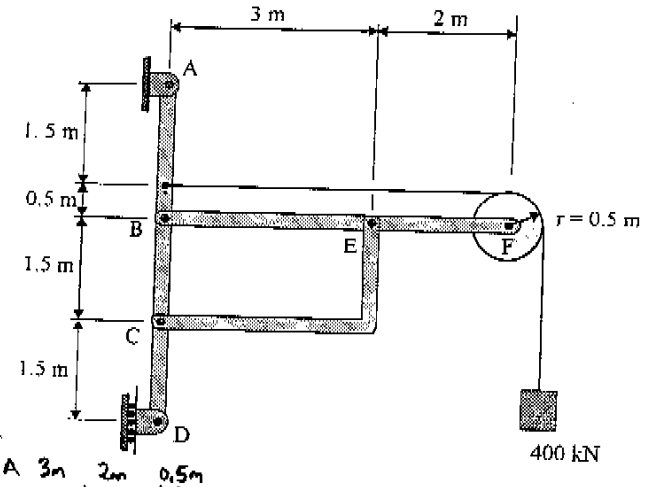
Date : Thursday, December 10, 2001
Department & Course No : 130.135
Examination: Engineering Statics
Paper No : 193
Place : U. Centre Room 210 - 213
Seat Numbers: 1 - 237

Time : 13:30
Duration : 2 Hours
Examiners : J. Frye, B. Stimpson, and A. Shah

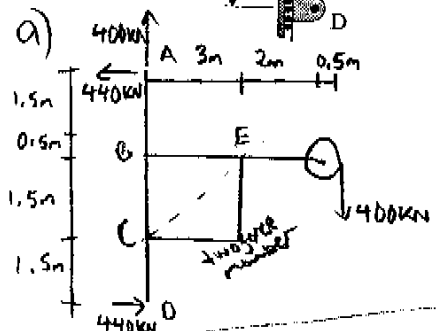
Question 4:

The frame supports a *400 kN* load as shown in the figure. Determine:

(a) The reactions at *A* and *D*,
(b) The forces acting at points *B*, *E* and *F* on member *BEF*, and
(c) The forces acting at *B* and *C* on member *ABCD*.



a)



$+\uparrow \Sigma F_y = 0$: $\quad 0 = +\circlearrowleft \Sigma M_A = D_x(5m) - 400kN(5.5m)$

$A_y - 400kN = 0$ $\qquad D_x = 440\,kN \rightarrow$

$A_y = 400kN \uparrow$

$\pm \rightarrow \Sigma F_x = 0$:

$0 = A_x + 440kN$

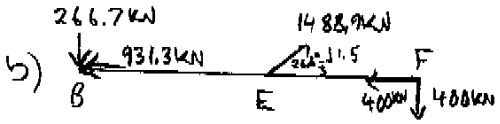
$A_x = 440\,kN \leftarrow$

member BEF

$0 = +\circlearrowleft \Sigma M_B = F_E \sin 26.6° \cdot 3m - 400 \cdot 5m$ $\qquad F_x = 440kN \leftarrow$

$F_E = 1488.9\,kN$ $\qquad F_y = 400kN \downarrow$

b)



$+\uparrow \Sigma F_y = 0$:

$0 = 1488.9\,kN \sin 26.6° - 400\,kN + B_y$

$B_y = -266.7kN = 266.7kN \downarrow$

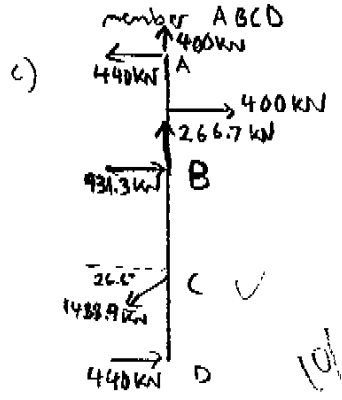
$\pm \rightarrow \Sigma F_x = 0$:

$0 = 1488.9\,kN \cos 26.6° - 400kN + B_x$

$B_x = -931.3\,kN = 931.3\,kN \leftarrow$

member ABCD

c)



Check:

$+\uparrow \Sigma F_y = 0$ ✓

$\pm \rightarrow F_x = 0$ ✓

$B_x = 931.3\,kN \rightarrow$

$B_y = 266.7kN \uparrow$

$C = 1488.9\,kN$ 26.6°

10/10