Roll No: _____

Applied Mechanics Department

Class: B. Tech – I (Div.: I) 1st Class Test

Subject: Engineering Mechanics AM 104

Date: 20.09.2019 | Max. Marks: 20 (Weightage 50%) | Time: 45 Minutes

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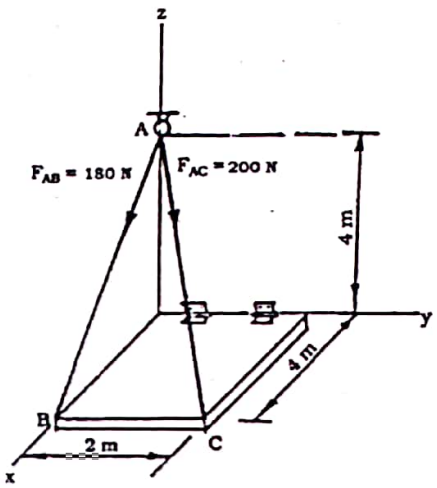
**1** Two cable exert forces FAB = 180 N and FAC = 200 N on the ring at A as shown in Figure. Determine the magnitude and direction of the resultant force acting at A. **10 Marks**



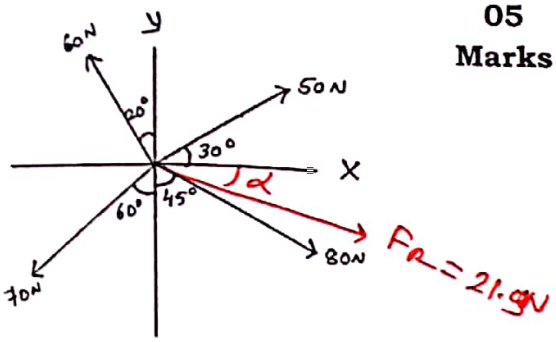

$F_R = 374.42\ N$

$\theta_x = 45.90^\circ$

$\theta_y = 79.66^\circ$

$\theta_z = 134.10^\circ$

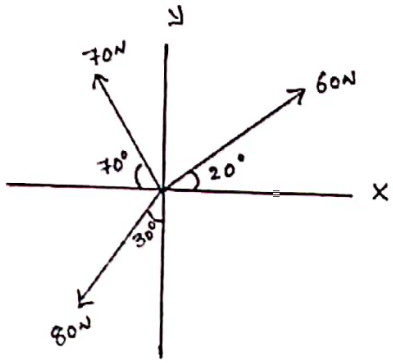
**2** Determine the resultant and its direction of given force system. **05 Marks**




$F_R = 21.03\ N$

$\alpha = 28.54^\circ$

**3** Determine the resultant and only use law of parallelogram given force system. **05 Marks**



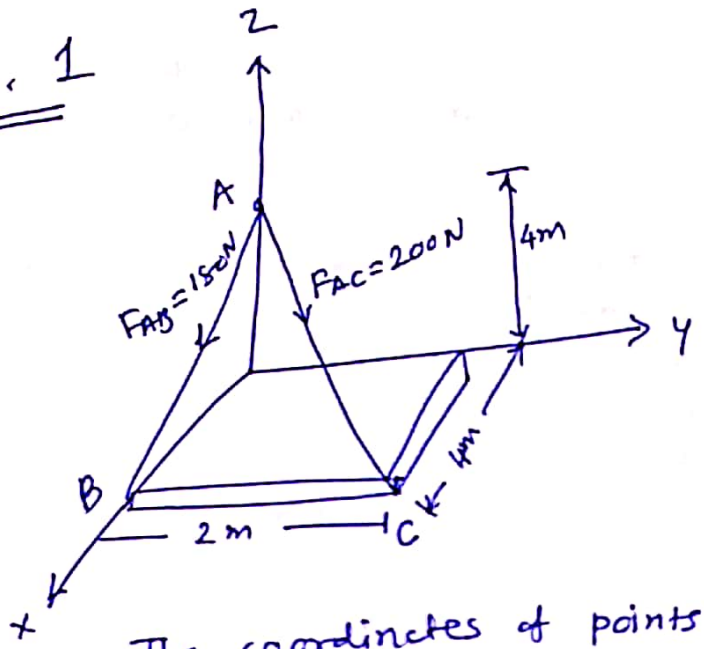
# Class Test

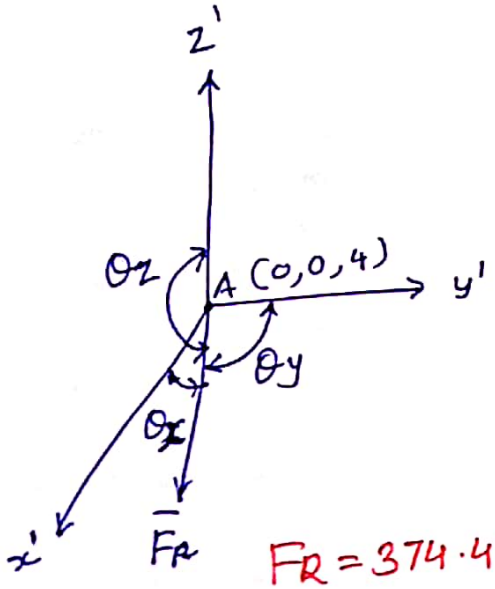
Dt. 20.09.2019

Subject : Engineering Mechanics

Class : (Div : I) B.Tech. - I Sem.-I

**Q. 1**




$F_R = 374.42\,N$

The coordinates of points are

A (0, 0, 4), B (4, 0, 0), C (4, 2, 0)

$\theta_x = 45.90^\circ$

$\theta_y = 79.66^\circ$

$\theta_z = 134.10^\circ$

Here $\bar{F}_{AB} = F_{AB} \cdot \bar{\lambda}_{AB}$

$$\bar{\lambda}_{AB} = (\lambda_{AB})_x\, i + (\lambda_{AB})_y\, j + (\lambda_{AB})_z\, k$$

$$= \frac{(4-0)}{5.66}\, i + \frac{(0-0)}{5.66}\, j + \frac{(0-4)}{5.66}\, k$$

$$\bar{\lambda}_{AB} = \frac{4}{5.66}\, i + \frac{4}{5.66}\, k$$

$$\bar{F}_{AB} = 180\left(\frac{4}{5.66}\, i - \frac{4}{5.66}\, k\right) = 127.20\, i - 127.20\, k$$

Similarly $\bar{F}_{AC} = F_{AC} \cdot \bar{\lambda}_{AC} = 200\left(\frac{4}{6}\, i + \frac{2}{6}\, j - \frac{4}{6}\, k\right)$

$$= 133.33\, i + 66.66\, j - 133.33\, k$$

Resultant force

$$\bar{F}_R = \bar{F}_{AB} + \bar{F}_{AC} = (127.20\, i - 127.20\, k)\,N + (133.33\, i + 66.66\, j - 133.33\, k)\,N$$

$$= 260.53\, i + 66.66\, j - 260.53\, k$$

Magnitude

$$F_R = \sqrt{260.53^2 + 66.66^2 + (-260.53)^2} = 374.42\,N$$

$$\theta_x = \cos^{-1}\frac{260.53}{374.42} = 45.90^\circ \qquad \theta_y = \cos^{-1}\frac{66.66}{374.42} = 79.66^\circ \qquad \theta_z = \cos^{-1}\frac{-260.53}{374.42} = 134.1^\circ$$

Q.2 Determine the resultant & its direction.

| Force (N) | Fx (N) | Fy (N) |
|---|---|---|
| 50 | $+50\cos 30$ $+43.30$ | $+50\sin 30$ $+25.00$ |
| 60 | $-60\sin 20^\circ$ $-20.52$ | $+60\cos 20^\circ$ $+56.38$ |
| 70 | $-70\sin 60^\circ$ $-60.62$ | $-70\cos 60^\circ$ $-35.00$ |
| 80 | $+80\cos 45$ $+56.56$ | $-80\cos 45$ $-56.56$ |
| | $\Sigma Fx = 18.72$ | $\Sigma Fy = -10.18$ |

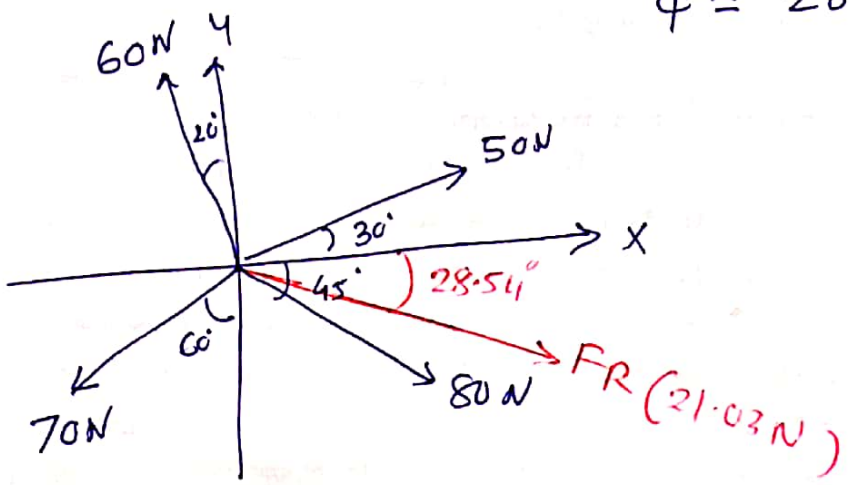
$$R = \sqrt{\Sigma Fx^2 + \Sigma Fy^2} = \sqrt{18.72^2 + (-10.18)^2}$$

$$R = \sqrt{350.43 + 103.63}$$

$$R = 21.03\ N$$

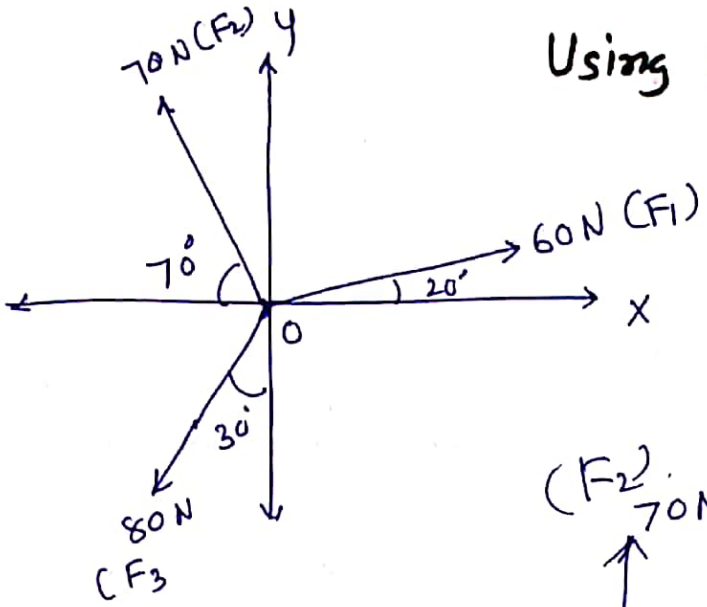
$$\tan\phi = \frac{\Sigma Fy}{\Sigma Fx} = \frac{-10.18}{18.72} \Rightarrow \tan^{-1}\frac{-10.18}{18.72}$$

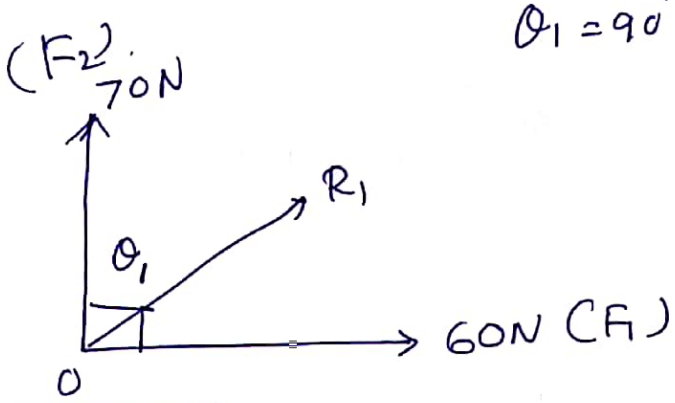
$$\phi = 28.54^\circ$$



Q.3

## Using Law of Parallelogram




$\theta_1 = 90^\circ$

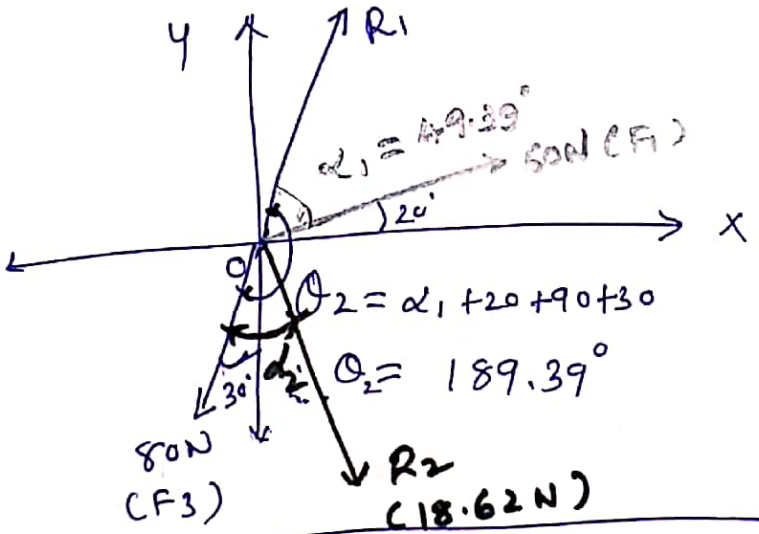
$$R_1 = \sqrt{F_1^2 + F_2^2 + 2F_1F_2\cos\theta_1}$$

$$R_1 = \sqrt{60^2 + 70^2 + 2\times 60\times 70\cos 90^\circ} = 92.20\,N$$

$$\tan\alpha_1 = \frac{F_2\sin\theta_1}{F_1 + F_2\cos\theta_1}$$

$$\alpha_1 = \tan^{-1}\frac{70\sin 90^\circ}{60 + 70\cos 90^\circ}$$

$$\therefore \alpha_1 = 49.39^\circ \text{ w.r.t. } F_1$$




$$R_2 = \sqrt{R_1^2 + F_3^2 + 2R_1F_3\cos\theta_2}$$

$$= \sqrt{92.20^2 + 80^2 + 2\times 92.20\times 80\times \cos 189.39^\circ}$$

$$= \sqrt{8500.84 + 6400 - 14554.33}$$

$$R_2 = \sqrt{346.51} = 18.62\,N$$

$$\tan\alpha_2 = \frac{R_1\sin\theta_2}{F_3 + R_1\cos\theta_2} \Rightarrow \alpha_2 = 53.93^\circ$$

Q.3 Using Rectangular Components Method.

| Force (N) | Fx Comp. (N) | Fy Comp. (N) |
|---|---|---|
| 60 | $60 \cos 20^\circ = 56.38$ | $60 \sin 20^\circ = 20.52$ |
| 70 | $-70 \cos 70^\circ = 23.94$ | $70 \sin 70^\circ = 65.78$ |
| 80 | $-80 \sin 30^\circ = 40$ | $-80 \cos 30^\circ = -69.28$ |
| | $\Sigma Fx = -7.56$ | $\Sigma Fy = 17.02$ |

$$R = \sqrt{\Sigma Fx^2 + \Sigma Fy^2}$$

$$R = \sqrt{(-7.56)^2 + (17.02)^2}$$

$$\therefore R = 18.62\ N$$

$$\tan \alpha = \frac{\Sigma Fy}{\Sigma Fx} = \frac{17.02}{-7.56} \Rightarrow \alpha = 31.26^\circ$$