

# CE 201 STATICS (Sections A & B)

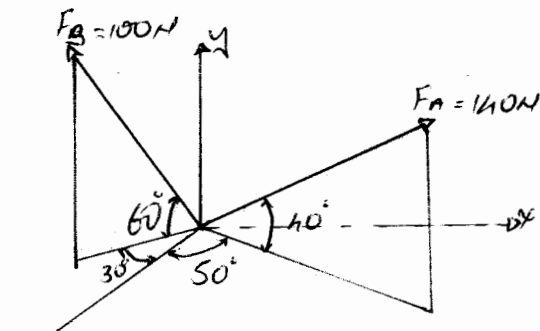
FIRST SEMESTER - OS1, H.W.#2 Solution

1/4

## PROBLEM 1

Given: The figure shown

Required: Value and direction of the resultant.



## Solution

Obtaining the forces in cartesian vectors

$$F_{Ay} = 140 \sin 40^\circ = 89.9903j$$

$$F_{Ax} = (140 \cos 40^\circ) \sin 50^\circ = 82.1554i$$

$$F_{Az} = (140 \cos 40^\circ) \cos 50^\circ = 68.9365k$$

$$\vec{F}_A = 82.1554i + 89.9903j + 68.9365k \text{ (N)}$$

$$F_{Bx} = (100 \cos 60^\circ) \sin 30^\circ = -25i$$

$$F_{By} = 100 \sin 60^\circ = 86.6025j$$

$$F_{Bz} = (100 \cos 60^\circ) \cos 30^\circ = 43.3013k$$

$$\vec{F}_B = -25i + 86.6025j + 43.3013k \text{ (N)}$$

Resultant?  $\vec{F}_R = \vec{F}_A + \vec{F}_B$

$$\vec{F}_R = 57.1554i + 176.5928j + 112.2378k$$

$$F_R = \left[ (57.1554)^2 + (176.5928)^2 + (112.2378)^2 \right]^{1/2}$$

$$F_R = 216.91 \text{ N}$$

$$\cos \theta_x = \frac{F_x}{F_R} = \frac{57.1554}{216.91}, \quad \cos \theta_y = \frac{F_y}{F_R} = \frac{176.5928}{216.91}, \quad \cos \theta_z = \frac{F_z}{F_R} = \frac{112.2378}{216.91}$$

$$\theta_x = 74.72^\circ$$

$$\theta_y = 35.50^\circ$$

$$\theta_z = 58.84^\circ$$

# CE 201 STATICS (Sections 4 & 6)

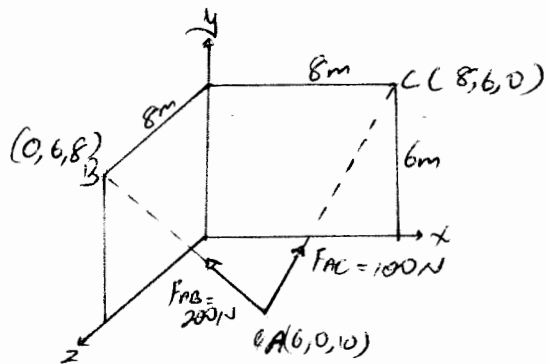
FIRST SEMESTER - 081, H.W. # 2

(2)

## PROBLEM 2

Given: The figure shown  
 $F_{AB} = 200\text{N}$ ,  $F_{AC} = 100\text{N}$

Required: Value and direction of  
 the resultant.



## Solution

Obtaining the cartesian vectors and length of the two forces

$$\vec{AB} = (0-6)\vec{i} + (6-0)\vec{j} + (8-10)\vec{k} = -6\vec{i} + 6\vec{j} - 2\vec{k}, \quad AB = \sqrt{76} \text{ m}$$

$$\vec{AC} = (8-6)\vec{i} + (6-0)\vec{j} + (0-10)\vec{k} = 2\vec{i} + 6\vec{j} - 10\vec{k}, \quad AC = \sqrt{140} \text{ m}$$

$$\vec{F}_{AB} = F_{AB} \frac{\vec{AB}}{AB} = 200 \frac{-6\vec{i} + 6\vec{j} - 2\vec{k}}{\sqrt{76}}$$

$$\vec{F}_{AB} = (-137.65\vec{i} + 137.65\vec{j} - 45.8831\vec{k}) \text{ N}$$

$$\vec{F}_{AC} = \frac{100}{\sqrt{140}} (2\vec{i} + 6\vec{j} - 10\vec{k}),$$

$$\vec{F}_{AC} = (16.9031\vec{i} + 50.7093\vec{j} - 84.5151\vec{k}) \text{ N}$$

$$\vec{R} = \vec{F}_{AB} + \vec{F}_{AC} = -120.7469\vec{i} + 188.3593\vec{j} - 130.3985\vec{k} \text{ N}$$

$$|\vec{R}| = \left[ (-120.7469)^2 + (188.3593)^2 + (-130.3985)^2 \right]^{1/2}$$

$$\boxed{R = 259.0\text{N}}$$

## Direction

$$\cos \theta_x = \frac{R_x}{R}$$

$$\theta_x = \cos^{-1} \left[ \frac{-120.7469}{259} \right]$$

$$\boxed{\theta_x = 117.8^\circ}$$

$$\cos \theta_y = \frac{R_y}{R}$$

$$\theta_y = \cos^{-1} \left[ \frac{188.3593}{259} \right]$$

$$\boxed{\theta_y = 43.3^\circ}$$

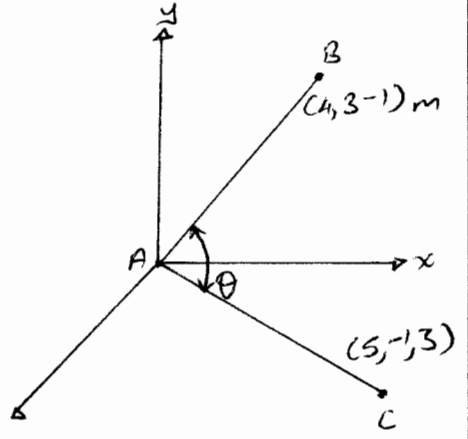
$$\cos \theta_z = \frac{R_z}{R}$$

$$\theta_z = \cos^{-1} \left[ \frac{-130.3985}{259} \right]$$

$$\boxed{\theta_z = 120.23^\circ}$$

PROBLEM 3

Given: The diagram shown

Required:  $\theta$  between lines AB and ACSolution

$$\vec{AB} = (4-0)\vec{i} + (3-0)\vec{j} + (-1-0)\vec{k}$$

$$= 4\vec{i} + 3\vec{j} - \vec{k}$$

$$AB = \sqrt{4^2 + 3^2 + 1^2} = \sqrt{26} \text{ m}$$

$$\vec{AC} = (5-0)\vec{i} + (-1-0)\vec{j} + (3-0)\vec{k}$$

$$= 5\vec{i} - \vec{j} + 3\vec{k}$$

$$AC = \sqrt{5^2 + (-1)^2 + 3^2} = \sqrt{35} \text{ m}$$

$$\vec{BC} = (5-4)\vec{i} + (-1-3)\vec{j} + (3-(-1))\vec{k}$$

$$= \vec{i} - 4\vec{j} + 4\vec{k}$$

$$BC = \sqrt{1^2 + (-4)^2 + 4^2} = \sqrt{33} \text{ m}$$

a) By Using Law of Cosine.

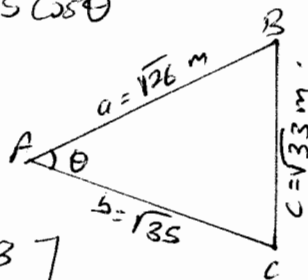
$$c^2 = a^2 + b^2 - 2ab \cos \theta$$

$$33 = 26 + 35 - 2\sqrt{26}\sqrt{35} \cos \theta$$

$$\cos \theta = \frac{26 + 35 - 33}{2\sqrt{26}\sqrt{35}}$$

$$\theta = \cos^{-1} \left[ \frac{26 + 35 - 33}{2\sqrt{26}\sqrt{35}} \right]$$

$$\theta = 62.35^\circ$$



b) By Using the dot product.

$$\cos \theta = \frac{\vec{AB} \cdot \vec{AC}}{(AB)(AC)}$$

$$= \frac{(4\vec{i} + 3\vec{j} - \vec{k}) \cdot (5\vec{i} - \vec{j} + 3\vec{k})}{(\sqrt{26})(\sqrt{35})}$$

$$\cos \theta = \frac{(4)(5) + (3)(-1) + (-1)(3)}{\sqrt{26}\sqrt{35}}$$

$$\theta = 62.35^\circ$$

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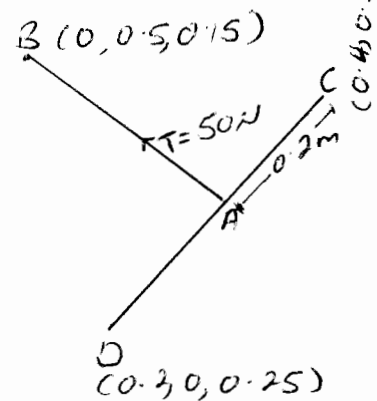
FIRST SEMESTER - 081, H.W. # 2

(4)

## Problem 4

Given: As in the diagram shown.

Required: a) Angle between AB and AD  
b) Component of T normal to CD.



Solution:

$$B(0, 0.5, 0.15)$$

$$C(0.4, 0.3, 0)$$

$$D(0.2, 0, 0.25)$$

$$a) \vec{CD} = -0.2\vec{i} - 0.3\vec{j} + 0.25\vec{k}$$

$$CD = \sqrt{0.1925} \approx 0.43875 \text{ m}$$

$$AD \approx 0.43875 - 0.2 \approx 0.23875 \text{ m}$$

$$A_x = \left[ \frac{0.2(0.2) + 0.23875(0.4)}{0.43875 \cdot 0.43875} \right] = 0.30883$$

$$A_y = \left[ \frac{0.2(0) + 0.23875(0.3)}{0.43875 \cdot 0.43875} \right] = 0.16325$$

$$A_z = \left[ \frac{0.2(0.25) + 0.23875(0)}{0.43875 \cdot 0.43875} \right] = 0.11396$$

$$\vec{AB} = -0.30883\vec{i} + 0.33675\vec{j} + 0.03604\vec{k}$$

$$AB = 0.45834 \text{ m}$$

$$\vec{AD} = -0.10883\vec{i} - 0.16325\vec{j} + 0.13604\vec{k}$$

$$AD = 0.23875 \text{ m}$$

$$\vec{U}_{AD} = \frac{\vec{AD}}{AD} = -0.45583\vec{i} - 0.68377\vec{j} + 0.36780\vec{k}$$

Problem 11

$$\cos \theta = \frac{\vec{AB} \cdot \vec{AD}}{(AB)(AD)}$$

$$= -0.15043$$

$$\theta = 98.652^\circ$$

b) (i) Component of T normal to CD utilizing result in (a) above

$$T_{\perp} = T \sin \theta$$

$$= 50 \sin(98.652)$$

$$T_{\perp} = 49.43N$$

(ii) Component of T normal to CD using general method  
Assuming angle in (a) is not known.

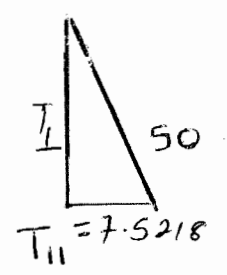
$$T_{||} = \vec{T} \cdot \vec{CD}$$

$$T = \frac{T}{AB} = -33.690\vec{i} + 36.736\vec{j} + 3.9316\vec{k}$$

$$T_{||} = -7.5218N \text{ (- means in AC not AD)}$$

$$T_{\perp} = \sqrt{50^2 - (-7.5218)^2}$$

$$T_{\perp} = 49.43N$$



as in b(i) above.