THE MOMBASA POLYTECHNIC UNIVERSITY COLLEGE

FACULTY OF ENGINEERING

DEPARTMENT OF MECHANICAL AND AUTOMOTIVE ENGINEERING

BACHELOR OF SCIENCE IN MECHANICAL ENGINEERING

EMG 2203 ENGINEERING MECHANICS YEAR II

SEMESTER I EXAMS

SERIES APRIL 2010

TIME 3 HRS

INSTRUCTION TO CANDIDATES

You should have the following for this examination

- **Drawing instruments**
- **Scientific Calculator**

This paper consists of FIVE questions ,

ANSWER QUESTION ONE AND ANY OTHER TWO QUESTIONS

Maximum marks for each part of a question are as shown.

Q 1

a) Describe the following idealizations used in engineering mechanics:
   i. Particle
   ii. Rigid body
   iii. Concentrated force

(6 marks)

b) Using Newton's law of gravitational attraction, explain how the weight of a body located on the surface of the earth is determined.

(6 marks)

c) Represent each of the following combinations of units in the correct S.I. form using an appropriate prefix:
   i. m/ms
   ii. μkm
   iii. ks/mg
   iv. km·μN

(8 marks)

Q 2

a) State the differences between vectors and scalars.

(2 marks)

b) Using the cosine and sine laws describe how to the forces F_1, F_2, F_3 and angles γ, β, α in figure 1 are interconnected.

(4 marks)

c) Use figure 2 to answer the following questions:
   i. Determine the design angle θ ($0^o \leq \theta \geq 90^o$) for strut AB so that the 400 N horizontal force has a component of 500 N directed from A towards C. Find the component of the force acting along AB. Take $\varphi = 40^o$.

(8 marks)

   ii. Determine the design angle φ ($0^o \leq \theta \geq 90^o$) between struts AB and AC so that the 400 N horizontal force has a component of 600 N which acts up to the left, in the same direction as from B towards A. Take $\theta = 30^o$

(6 marks)

Q 3

a) Use figure 3 to answer the following questions:
   i. A log is being towed by two tractors A and B as shown in the figure. Determine the magnitude of the two towing forces F_A and F_B, if it is required that the resultant force have a magnitude F_R=10 kN and be directed along the x axis. Take θ=15º.

(5 marks)

ii. If the resultant of the two forces acting on the log is to be directed along the positive x axis and have a magnitude of 10 kN, determine the angle θ of the cable attached to B such that the force F_B in this cable is minimum and the force in each cable for this situation.

(5 marks)

b) The three concurrent forces acting on the post in figure 4 produce a resultant force $F_R=0$. If $F_2=0.5F_1$ and F_1 is to be 90º from F_2, determine the required magnitude F_3 expressed in terms of F_1 and the angle θ.

(10 marks)

Q 4

a) Use figure 5 to answer the following questions:

i. The mast in figure is subjected to three forces F_1 and F_2 and F_3 as shown. Determine the coordinate direction angles γ_1, β_1, α_1 of F_1 so that the resultant force acting on the mast is zero.

(5 marks)

ii. Determine the coordinate direction angles γ_1, β_1, α_1 of F_1 so that the resultant force acting on the mast is $F_R = \{350\ i\}$ N

(5 marks)

b) The two forces F_1 and F_2 acting at A in figure 6 have a resultant force of $F_R=\{-100k\}$ N. determine the magnitude and coordinate direction angles of F_2

(10 marks)

Q 5

a) The pole in figure 7 is subjected to a force F which has components F_x =1.5 kN and F_z=1.25 kN. If β=75ºn determine the magnitude of F and F_y.

(8 marks)

b) Express force F in figure 8 as a Cartesian vector and determine its coordinate direction angles.

(12 marks)

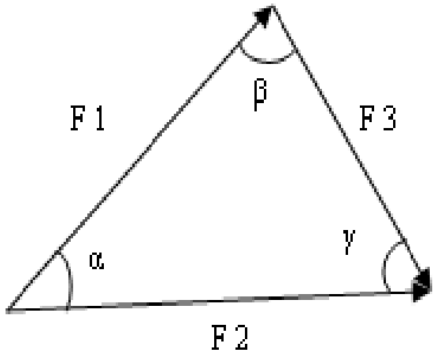

Figure 1

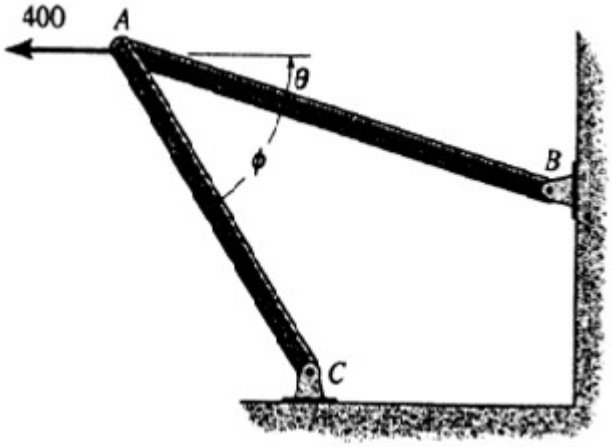

Figure 2

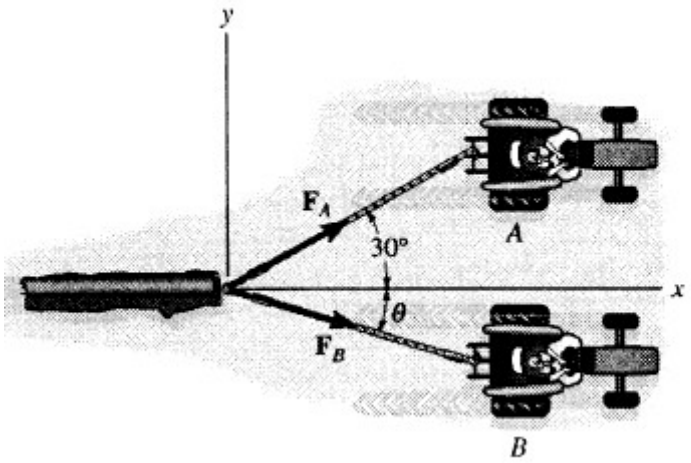

Figure 3

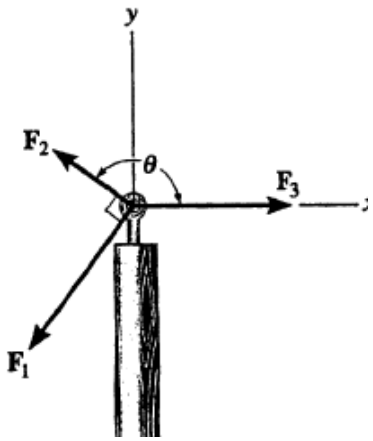

Figure 4

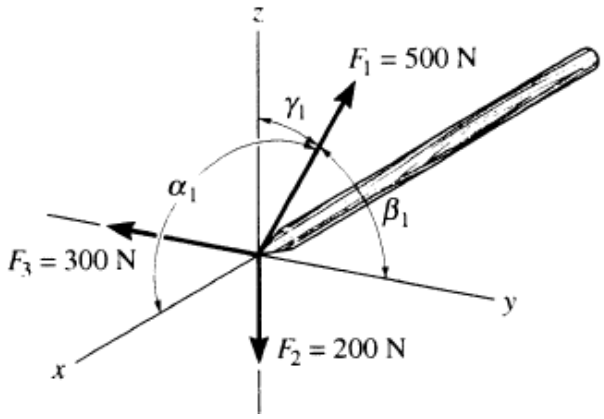

Figure 5

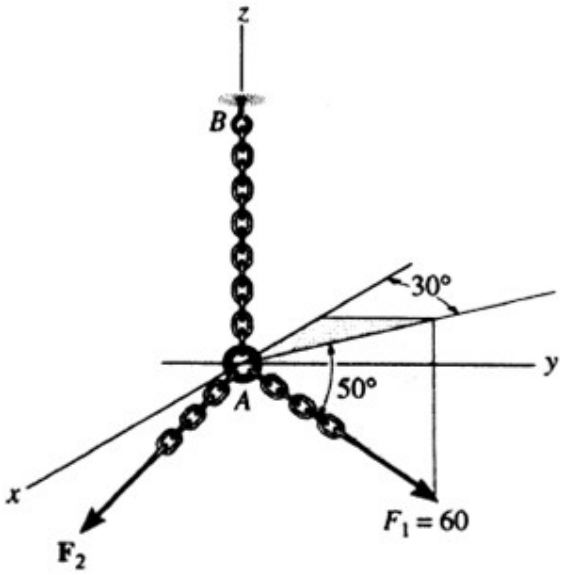

Figure 6

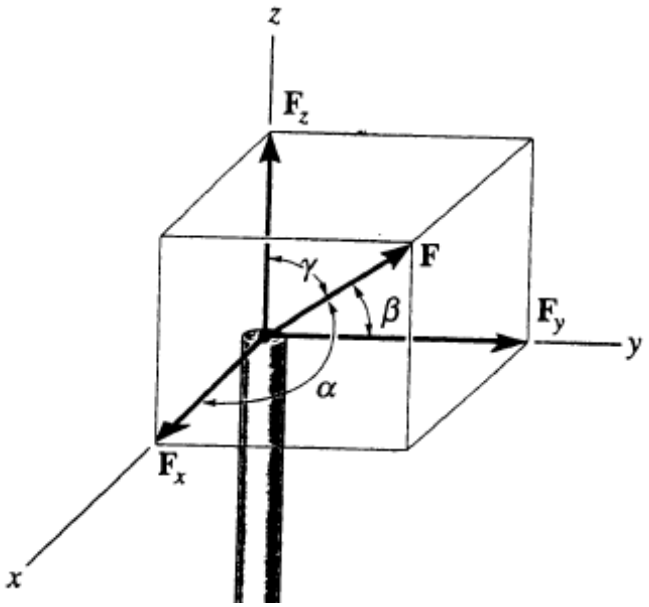

Figure 7

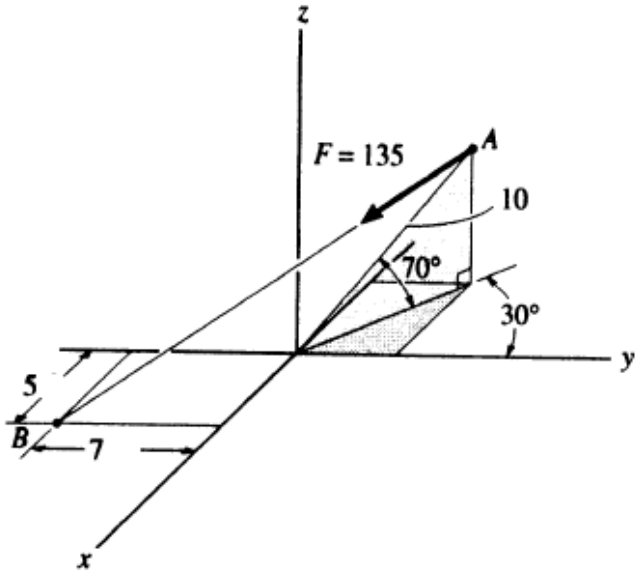

Figure 8