EGERTON UNIVERSITY

UNIVERSITY EXAMINATIONS

NJORO CAMPUS

FIRST SEMESTER 2012/2013

SECOND YEAR EXAMINIATION FOR THE DEGREE OF BACHELOR OF SCIENCE IN AGRICULTURAL/INSTRUMENTATION/MANUFACTURING ENGINEERING

MENT 222: MECHANICS OF MACHINES I

STREAM: **TIME:** 2½ HOURS

DAY: MONDAY, 3.00 – 5.00 P.M **DATE:** 21/01/2013

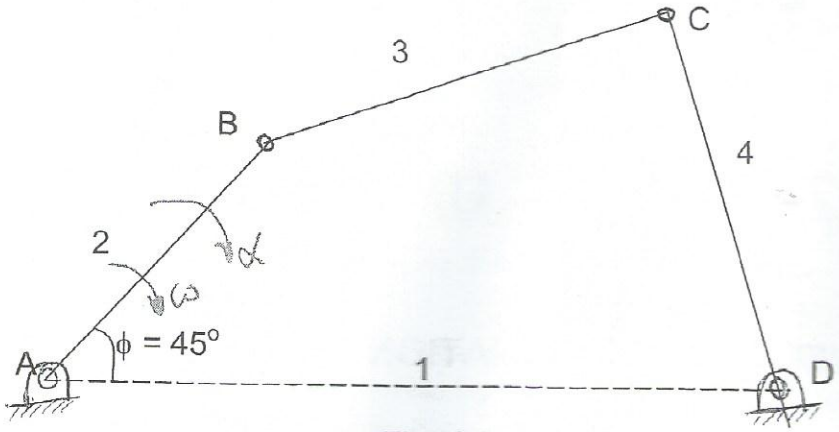
INSTRUCTIONS

1. ***Answer any FOUR questions***
2. ***All questions carry EQUAL maximum marks***
3. ***All symbols have their usual meaning unless specified otherwise***

QUESTION ONE

a) Briefly explain the following terms as used with mechanisms:
   i. A resistant body
   ii. A lower kinematic pair
   iii. A higher kinematic pair and
   iv. A kinematic chain (8 marks)

b) For the Four-Bar mechanism shown in Fig Q1, knowing that AB = 250 mm, BC = 305 mm, CD = 305 mm, AD = 572 mm, ω_2= 20 rads^{-1} and α_2=160 rads^{-2}.
   i. Draw the configuration and velocity diagrams for the mechanism (8 marks)
   ii. Draw the acceleration diagram and hence determine the acceleration of point C. (9 marks)



AB = 250 mm = 5cm
BC = 305 mm 6.1cm
AD = 572 mm 11.4cm
CD = 305 mm 6.1 cm
$\omega_2 = 20 rad\,s^{-1}$
$\alpha_2 = 160 rad\,s^{-2}$

Fig. Q1

QUESTION TWO

a) Show that in a slider-crank mechanism, the acceleration of the slider is given by the expression.

$$a_p \approx r\omega^2\left[\cos\theta + \frac{\cos 2\theta}{n}\right]$$

Where r = radius of the crank

n = l/r i.e Ratio of the length of the connecting rod to that of the crank

ω = uniform angular velocity of the crank and

θ = inclination of the crank to the line of stroke (10 marks)

b) The crank of a reciprocating engine is 230mm long, the connecting rod is 920 mm long and the r.p.m are 150. Determine analytically the velocity and acceleration of the piston and the angular velocity and angular acceleration of the connecting rod when the angle which the crank makes with the line of stroke is 30^0. (15 marks)

QUESTION THREE

a) With the aid of labeled sketches show the important elements of the following types of thread forms.

i. Square

ii. ACME (6 marks)

b) Show from the first principles that the torque developed by a square thread is given by

$$T = \frac{Fd_m}{2}\left[\frac{l + \mu\pi d_m}{\pi d_m - \mu l}\right]$$

Where:

I = lead of the thread

μ = coefficient of friction

d_m = mean diameter and

F = load lifted

(8 marks)

c) A single start square thread is to be used for lifting steel sluice gate weighing 70 KN. The screw thread has a major diameter of 60mm and a pitch of 5mm. The coefficients of friction for the thread and collar are 0.075 and 0.085 respectively.
If the collar mean diameter is 72 mm, find:

i. Torque to lift the sluice gate (4 marks)

ii. Torque to lower the gate (4 marks)

iii. Efficiency of this lifting mechanism (3 marks)

QUESTION FOUR

a) Explain two conditions under which friction clutches are most widely used. (6 marks)

b) Show that the maximum torque that can be transmitted from a new disc clutch is given by the expression

$$T = \frac{F\mu}{3}\left[\frac{D^3 - d^3}{D^2 - d^2}\right]$$

Where:

F is the actuating force

μ is the coefficient of friction

D is the external diameter and

d is the internal diameter of the friction surfaces (8 marks)

c) A disc clutch has four pairs of mating friction surfaces is 125mm outside diameter by 75mm inside diameter and has a coefficient of friction of 0.1

i. What actuating force is required for a pressure of 830 KN/m^2? (3 marks)

ii. What is the torque rating? (8 marks)
Use the uniform-pressure assumption

QUESTION FIVE

a) Briefly explain at least FOUR advantages of belt drives. (8 marks)

b) Determine the relationship that exists between the tight side and slack side tensions, T_1 and T_2 of a flat belt in terms of the coefficient of dry friction μ, between the belt and pulley surfaces, and the angle of lap θ on the smaller pulley. (6 marks)

c) A belt drive is used to transmit power to a machine pulley. The belt speed required is 20 ms^{-1} and the maximum allowable tension is 300N. The angle of lap of the belt over the pulley is 140^0 and the coefficient of friction between the belt and pulley is 0.25. Calculate the maximum power that can be transmitted using:

i. A flat belt (5 marks)

ii. A vee-belt of a groove of 40^0. (6 marks)

F = 300 N
belt speed = 20 m s^-1
angle of lap = 140°

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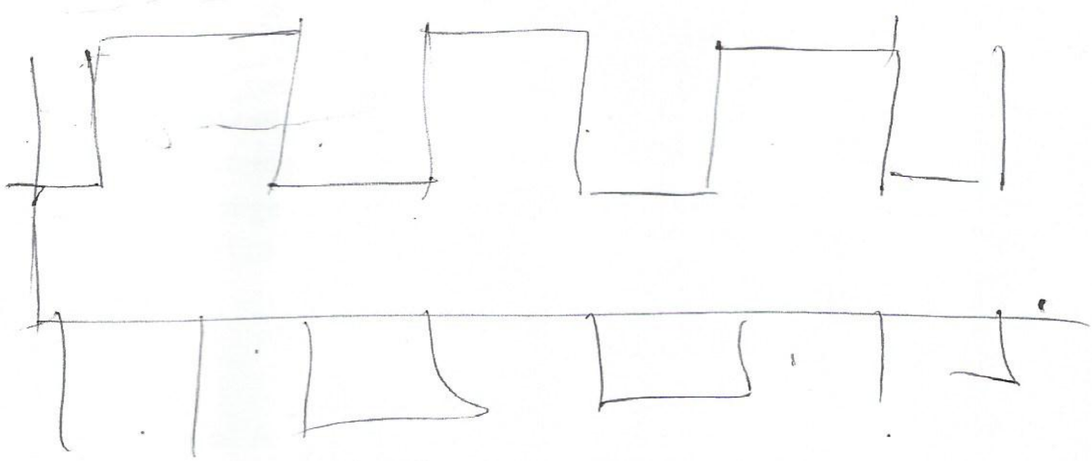
Coeff = 0.25

Maximum power which can be transmitted



acceleration of piston

ap =