

**TECHNICAL UNIVERSITY OF MOMBASA**

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FACULTY OF ENGINEERING AND TECHNOLOGY  
DEPARTMENT OF MECHANICAL & AUTOMOTIVE  
ENGINEERING

BACHELOR OF SCIENCE IN MECHANICAL ENGINEERING

EMG 2208: MECHANICS OF MACHINES I

END OF SEMESTER II YEAR II EXAMINATION

**SERIES: APRIL 2016**

**TIME: 2 HOURS**

**DATE:** Pick Date Select Month Pick Year

TIME: 2 HOURS

INSTRUCTIONS TO CANDIDATES

1. You are required to have the following for this examination:
  - Examination Booklet, Examination pass and student ID.
  - Drawing instruments
  - Scientific calculator
2. This paper consists of **FIVE** Questions.
3. Answer **ANY THREE** Questions.
4. Maximum marks for each part of a question are shown.
5. Take gravitational acceleration,  $g = 9.81\text{m/s}^2$  where applicable.
6. Show all your working on the answer booklet
7. **Do not write on the question paper**

### QUESTION ONE

In the mechanism shown in Figure Q1 below, the link AB rotates with a uniform angular velocity of 30 rad/s. The length of the various links are, AB=100mm, BC=300mm, BD=150mm, DE=250mm, EF=200mm, DG=167mm and angle CAB=30°. For the configuration shown, draw the velocity and acceleration diagrams and hence determine the velocity and acceleration of G.

(20 Marks)

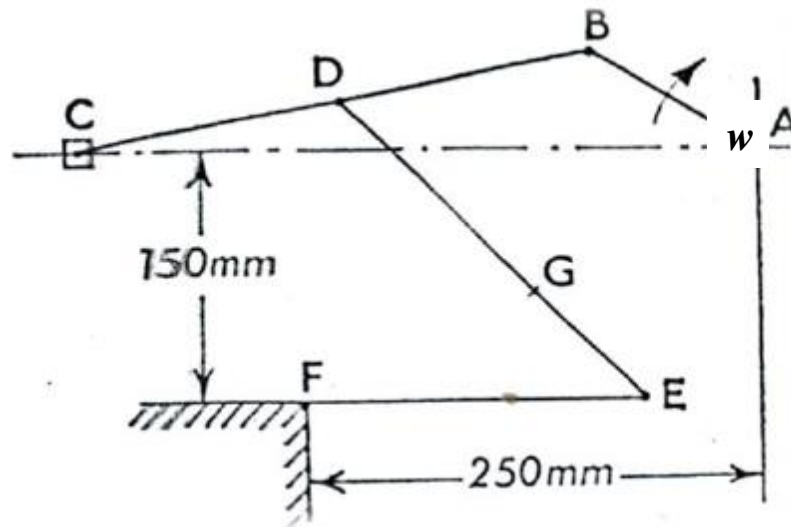


Figure Q1

### QUESTION TWO

From the epicyclic gear train shown in Figure Q2,  $S_1$  is the driver. The number of teeth on the gears are  $S_1=40$ ,  $A_1=120$ ,  $S_2=30$ ,  $A_2=100$  and the sun wheel  $S_2$  is fixed. Determine:

- (a) The velocity ratio of the two co-axial shafts.

(16 Marks)

- (b) The magnitude and direction of the torque required to fix  $S_2$ , if a torque of 300Nm is applied in a clockwise direction to  $S_1$ .

(4 Marks)

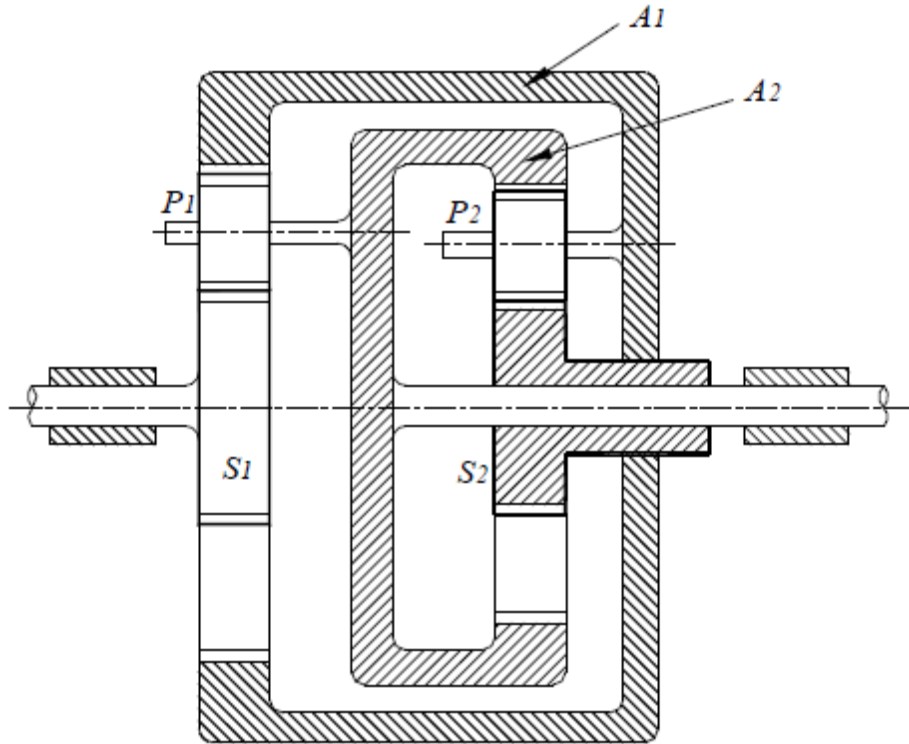


Figure Q2

### QUESTION THREE

- (a) A single clutch is to have an internal and external radii,  $r_1$  and  $r_2$  respectively. If the limiting coefficient of friction is  $\mu$  and the axial spring loading is  $W$ , show that the maximum torque transmitted by the clutch is given by:

(i)  $\frac{2}{3} \mu W \left[ \frac{r_2^3 - r_1^3}{r_2^2 - r_1^2} \right]$ ; assuming uniform pressure intensity on the contact surfaces

(ii)  $\mu W \left[ \frac{r_2 + r_1}{2} \right]$ ; assuming uniform wear of contact surfaces.

(12 arks)

- (b) A multi-plate clutch has four plates with friction surfaces on each side. Each spring used provides a spring force of 300N, and the assembly has six springs in it. The internal radius of the plates is 40mm and the external radius is 100mm. The coefficient of friction between the contact surfaces is 0.45. For both the constant pressure approach and the constant wear approach, determine the power that this clutch could transmit when running at 2400rev/min.

(8 Marks)

#### QUESTION FOUR

- (a) With the aid of a neat diagram, show that the power transmitted by a flat belt drive is given by:

$$T_1 \left( 1 - \frac{1}{e^{\mu\theta}} \right) V$$

Where:

$T_1$  – Tight tension in the belt

$\mu$  – Coefficient of friction

$\theta$  – Angle of lap

(7 Marks)

- (b) Two pulleys are 100mm and 150mm in diameter and their centres are 400mm apart. If the coefficient of friction between the materials is 0.3, and the maximum tensile force in the belt is 2000N, determine the power that can be transmitted for a belt speed of 24m/s if:

i) The belt is flat.

ii) The belt is a “V-type” with an included angle of 40°

(6 Marks)

- (c) A crossed belt drive is to transmit 7.5 KW at 1000rev/min of the smaller pulley. The smaller pulley has a diameter of 250mm, the velocity ratio is 2 and the centre distance is 1.25m. It is desired to use a flat belt 6mm thick with an expected coefficient of friction of 0.3. If the maximum allowable stress in the belt is 1.7MN/m<sup>2</sup> and the belt has a density of 970 Kg/m<sup>3</sup>, determine the necessary belt width.

(7 Marks)

#### QUESTION FIVE

- (a) Show that the torque (T) required to raise a given load and also to overcome any frictional forces using a power screw is given by:

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

Where:

$d_m$  – mean thread diameter

$l$  – lead of the screw

$\mu$  – coefficient of friction between screw and nut thread

$\mu_c$  – coefficient of friction at collar

$d_c$  – effective friction diameter of collar

(8 Marks)

(b) The C-clamp shown in Figure Q5 uses a 10mm screw with a pitch of 2mm. the coefficient of friction is 0.15 for both the threads and the collar. The collar has a frictional diameter of 16mm. The capacity of the clamp is 700N. Determine:

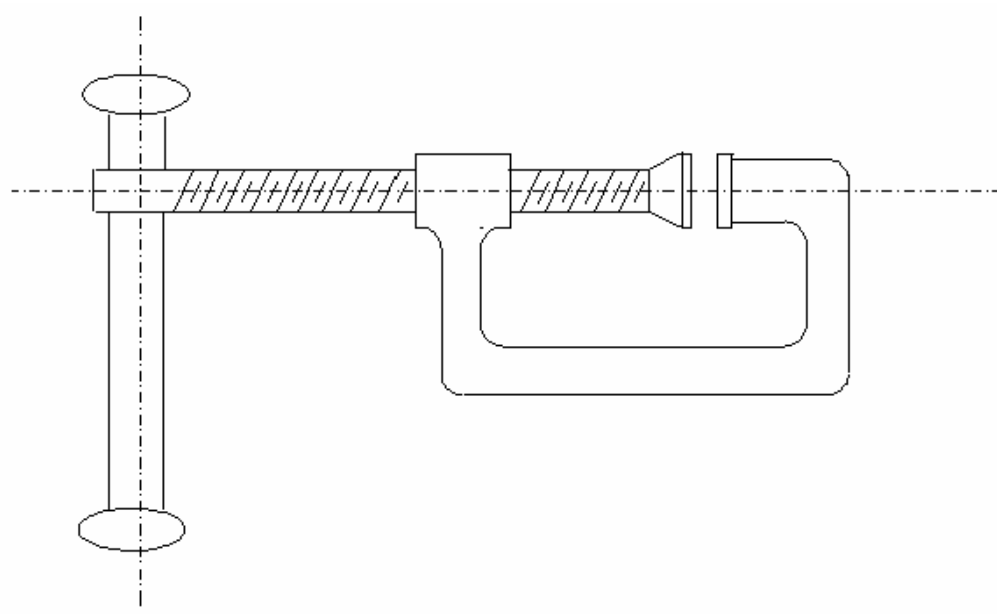
- i) The torque required to tighten the clamp to full capacity
- ii) The length of the handle if the operator is to exert a force of 15N at the end of the handle.

(6 Marks)

(c) A single square thread power screw is to raise a load of 50KN. A screw thread of major diameter 34mm and a pitch of 6mm is used. The coefficient of friction at the thread and collar is 0.15 and 0.1 respectively. If the collar frictional diameter is 100mm and the screw turns at a speed of 1rev/s, determine:

- i) The power input to the screw
- ii) The combined efficiency of the screw and collar

(6 Mark)



**Figure Q5**