



MACHAKOS UNIVERSITY

University Examinations 2018/2019

SCHOOL OF ENGINEERING AND TECHNOLOGY

DEPARTMENT OF MECHANICAL AND MANUFACTURING ENGINEERING

THIRD YEAR SPECIAL/SUPPLEMENTARY EXAMINATION FOR

BACHELOR OF SCIENCE IN MECHANICAL ENGINEERING

EMM 301: MECHANICS OF MACHINES 1

DATE: 2/8/2019

TIME: 8.30-10.30 AM

INSTRUCTIONS:

Answer Question One and Any Other Two Questions

QUESTION ONE (30 MARKS)

- a) Define the following terms (4 marks)
 - i. Kinematic pair
 - ii. Mechanism
 - iii. Body closure
 - iv. Force closure
- b) List 3 limitations of using belt drives to transmit power (3 marks)
- c) Using sketches, describe the three types of gear trains (3 marks)
- d) A slider-crank mechanism has a crank radius of 160 mm, and a connecting link 500 mm long. The crank rotates at a steady speed of 4500 rev/min. Find the velocity of a point on the connecting link 360 mm from the slider, when the crank has turned through an angle of 40° measured from the position where the slider is furthest from the crank axis (outer dead-centre position) (5 marks)
- e) Show that the torque of a plate clutch operating under uniform pressure is given by:

$$T = \frac{2}{3} \mu W \frac{r_1^3 - r_2^3}{r_1^2 - r_2^2} \quad (10 \text{ marks})$$

- f) An electric motor driven power screw moves a nut against a force of 75 kN at an angular speed of 50 rpm. The screw has a single square thread of pitch 6 mm on a mean diameter of 37 mm. The coefficient of friction at the screw thread is 0.1. Calculate the power of the motor. (5 marks)

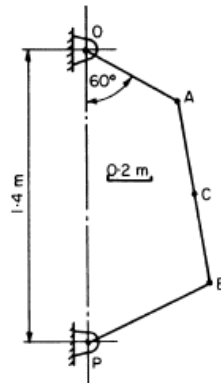
QUESTION TWO (20 MARKS)

- a) With the aid of sketches, describe the three types of belts used to transmit power (6 marks)
- b) Find the power transmitted by a belt running over a pulley of 600 mm diameter at 200 rpm. The coefficient of friction between the belt and the pulley is 0.25, angle of lap 160° and maximum tension in the belt is 2500 N. (14 marks)

QUESTION THREE (20 MARKS)

For the four-bar chain of figure 2.13a find the velocity and acceleration of point C, and the angular velocity and acceleration of link PB. $AC = CB = 0.45 \text{ m}$, $OA = 0.5 \text{ m}$, $PB = 0.65 \text{ m}$ and crank OA rotates clockwise with an angular velocity of 2.6 rad/s which is decreasing at 4.5 rad/s^2 .

(20 marks)



QUESTION FOUR (20 MARKS)

- (a) Derive the equation for the maximum efficiency of a power screw thread (10 marks)
- (b) A vertical screw with single start square threads 50 mm mean diameter and 12.5 mm pitch is raised against a load of 10 kN by means of a hand wheel, the boss of which is threaded to act as a nut. The axial load is taken up by a thrust collar which supports the wheel boss and has a

mean diameter of 60 mm. If the coefficient of friction is 0.15 for the screw and 0.18 for the collar and the tangential force applied by each hand to the wheel is 100 N ; find suitable diameter of the hand wheel. (10 marks)

QUESTION FIVE (20 MARKS)

- (a) Derive the equation for torque transmitted by a plate clutch undergoing uniform wear (10 marks)
- (b) A plate clutch has 3 discs on the driving shaft and 2 discs on the driven shaft, providing four pairs of contact surfaces, each of 240 mm external diameter and 120 mm internal diameter. Assuming uniform pressure, find the total spring load pressing the plates together to transmit 25 kW at 1575 rev/min. Take $\mu = 0.3$.
- If there are 6 springs each of stiffness 13 kN/m and each of the contact surfaces has worn away by 1.25 mm, what is the maximum power that can be transmitted at the same rev/min, assuming uniform wear and the same coefficient of friction?