Machakos University

(University Examinations 2022/2023)

SCHOOL OF ENGINEERING

DEPARTMENT OF MECHANICAL AND MANUFACTURING ENGINEERING

FIRST SEMESTER EXAMINATION FOR DIPLOMA (II) IN MECHANICAL ENGINEERING (PLANT, PRODUCTION AND AUTOMOTIVE)

MECHANICS OF MACHINES

2502/202/MM

DATE: 23/3/2023 **TIME: 8:30 – 11:30 AM**

INSTRUCTIONS

Answer all questions

QUESTION ONE

(a) Define the following terms,
- (i) Momentum.
- (ii) Inertia.
- (iii) Impulse.
- (iv) Coefficient of restitution.
- (v) Force. (5 marks)

(b) A planning machine table of mass 450kg attains a speed of 0.6m/s in a distance of 500mm from rest, with uniform acceleration. The coefficient of friction between table and bed is 0.1, calculate the effort applied to the table. (5 marks)

(c) The motion of a particle is given by $a = t^3 - 3t^2 + 5$, where a is the acceleration in m/s^2 and t is the time in seconds. The velocity of the particle at $t = 1$ second is $6.25\ m/s$, and the displacement is $8.30\ metres$. Calculate the displacement and the velocity at $t = 2$ seconds. (10 marks)

QUESTION TWO

Two parallel shafts 3 m apart are to be connected by a belt running over the pulleys of diameter 500 mm and 100 mm respectively.

a) If the belt is to be crossed,
   i. Determine the length of belt required and the angle of contacts between belt and each pulley. (5 marks)
   ii. What power can be transferred if the larger pulley rotates at 220 revolutions per minute. (5 marks)

b) If the belt is parallel connected,
   i. Find angle of contact between belt and each pulley and the length of belt required. (5 marks)
   ii. Find the minimum power that can be transmitted if the larger pulley rotates at 220 revolutions per minute. (5 marks)

(Given: Maximum permissible tension in the belt = 1 kN and coefficient of friction between the belt and the pulley is 0.25.)

QUESTION THREE

a) Show that the mass moment of inertia of a solid cylinder of mass m, radius r and length l about an axis through the centre perpendicular to the length is given by

$$I = m\left(\frac{r^2}{4} + \frac{l^2}{12}\right)$$ (10 marks)

b) A steel cylinder of 500 mm outside diameter and 250mm inside diameter is set in rotation about its axis. If the cylinder is 900 mm length and of $density\ \rho = 7800\ kg/m^3$, calculate the torque to give it an angular acceleration of $0.5\ rad/s^2$ and K, the radius of gyration. (10 marks)

QUESTION FOUR

a) From first principles, show that the radius of gyration for a hollow cylinder of uniform thickness is given by;

$$K = \frac{d_1^2 + d_2^2}{8}$$ (15 marks)

b) A steel cylinder of 500mm outside diameter and 200mm inside diameter is set in rotation about its axis. If the cylinder is 900mm long and of density 7800kg/m^3. Calculate the torque to give it an angular acceleration of 0.5 and k, the radius of gyration. (5 marks)

QUESTION FIVE

a) With the aid of a diagram, establish a formula for the torque transmitted by a single plate clutch of outer, inner and mean radii r_1, r_2 and R respectively. Let T be the torque transmitted by the clutch and p the intensity of pressure between the contact surfaces. Take the limiting coefficient of friction as μ. Assume the pressure is uniform over the contact surface. (12 marks)

b) A single plate clutch, with both sides effective, has outer and inner diameters 300 mm and 200 mm respectively. The maximum intensity of pressure at any point in the contact surface is not to exceed 0.1 N/mm^2. If the coefficient of friction is 0.3, determine the power transmitted by a clutch at a speed 2500 *rpm*. (8 marks)