



**MASINDE MULIRO UNIVERSITY OF
SCIENCE AND TECHNOLOGY
(MMUST)
MAIN CAMPUS
UNIVERSITY EXAMINATIONS
2021/2022 ACADEMIC YEAR
FOURTH YEAR FIRST SEMESTER EXAMINATIONS
FOR THE DEGREE
OF
BACHELOR OF TECHNOLOGY EDUCATION
(MECHANICAL OPTION)**

COURSE CODE: TEM 441

COURSE TITLE: MECHANICS OF MACHINES I

DATE: 26/4/2022

TIME: 3.00-5.00PM

INSTRUCTIONS TO CANDIDATES

This paper contains **FOUR** Questions
Answer **question ONE (1)** and any **OTHER TWO** questions

TIME: 2 Hours

MMUST observes ZERO tolerance to examination cheating

This Paper Consists of 3 Printed Pages. Please Turn Over. 

1. (a) (i) Explain two mechanical elements or situations where friction is disastrous in Engineering applications (2 marks)
- (ii) Give two circumstances in which relative slip in belt drive would be desirable. (2 marks)
- (b) (i) What is a screw jack?. Explain why you need a less force in lowering/reversing a screw jack than raising the load. (4 marks)
- (ii) Name any two mechanical drives used in power transfer systems (2 marks)
- (c) A pull of 25 N at 30° to the horizontal is necessary to move a block of wood on a horizontal table. Draw a free body diagram to show the forces acting on the block. If the coefficient of friction between block and the table is 0.2, what is the weight of the block? (6 marks)
- (d) A single-start thread has a mean diameter of 80 mm and a pitch of 12 mm. The section of thread is V-shaped with included angle of $2\beta = 30^\circ$ between the faces. If the coefficient of friction is 0.5, find (i) the torque necessary to overcome an axial load of 2 kN and (ii) the efficiency of thread. (8 marks)
- (e) A steel cylinder of 500 mm outside and 200 mm inside diameters respectively is set in rotation about its axis. If the cylinder is 900 mm long of density $7,800 \text{ kg/m}^3$, calculate the torque required to give it an angular acceleration of 0.5 rads/s^2 (6 marks)
2. (a) A machine weighing 1500 N is supported by two chains attached to some point on the machine. One of these chains goes to the eye bolt in the wall and is inclined at 30° to the horizontal and the other goes to the hook in the ceiling and is inclined at 45° to the horizontal. Find the tensions in the two chains (6 marks)
- (b) (i) state two disadvantages of Flat belts (2 marks)
- (ii) A flat belt 7.5 mm thick and 100 mm wide transmits power between two pulleys, running at 1500 r.p.m. The mass of the belt is 0.9 kg/m. The angle of lap on the smaller pulley is 165° and the coefficient of friction between the belt and pulleys is 0.3. If the maximum permissible stress in the belt is 3 MN/m^2 , find (i) The tight side tension T_1 ; (ii) the slack side tension T_2 ; (ii) the maximum power transmitted and the diameter of the smaller pulley.
(Consider centrifugal tension) (12 marks)

3. (a) A vehicle has a wheelbase of 3.6 m and is driven along a level road by a torque applied to the **front** wheels. The center of gravity is 0.8 m above the ground level and 1.6 m behind the front axle. The coefficient of friction between the wheels and the road is 0.5. Determine: -

a) the maximum acceleration of the vehicle if the wheels are not to slip

b) the maximum retardation of the vehicle when brake is applied to the **rear** wheels only

(10 marks)

(b) An electrically driven road vehicle of mass 450 kg has four wheels, of effective diameter 400 mm, radius of gyration 125mm, and mass 9 kg. The armature of the electric motor has a mass of 65 kg, a radius of gyration of 100 mm, and rotates at 4 times the speed of the road wheels. The rolling resistance to motion of the vehicle is to be assumed constant at 250 N. Determine the acceleration of vehicle if it is allowed to run freely down a slope whose inclination to the horizontal is $\sin^{-1}0.2$.

(10 marks)

4. (a) A torsional pendulum consists of a wire 0.56 m long, 10 mm diameter, fixed at its upper end and attached at its lower end to a heavy disc having a moment of inertia of 0.06 kgm². The modulus of rigidity of the wire is 44 GN/m². Find the frequency torsional oscillation of the disc. If the maximum displacement to one side of the rest position is 5°, find the maximum angular velocity and acceleration of the disc. (Hint $q = GJ/l$)

(6 marks)

(b) A winding drum raises a cage of mass 500 kg through a height of 120 m. The winding drum has a mass of 250 kg and an effective radius of 0.5m and a radius of gyration of 0.36m. The mass of the rope is 3 kg/m. The cage has at first an acceleration of 1.5 m/s² until a velocity of 9m/s is reached, after which the velocity is constant until the cage nears the top when the final retardation is 6 m/s² Find:

(14 marks)

a. The time taken for the cage to reach the top

b. The torque which must be applied to the drum at starting

c. The power at the end of acceleration period

