MACHAKOS UNIVERSITY

University Examinations 2016/2017

SCHOOL OF ENGINEERING AND TECHNOLOGY

DEPARTMENT OF MECHANICAL AND MANUFACTURING ENGINEERING

SECOND YEAR SECOND SEMESTER EXAMINATION FOR DEGREE IN BACHELOR OF SCIENCE IN MECHANICAL ENGINEERING

EMM 211: ENGINEERING MECHANICS II.

DATE: 14/6/2017 **TIME: 8:30 – 10:30 AM**

INSTRUCTIONS

1. *You should have the following for this examination*
   Answer booklet
   Scientific calculator
2. *This paper contains Five questions.*
3. *Answer **Question ONE** compulsory and carries 30 marks.*
4. *Answer any **TWO** questions from the remaining Four. All carry 20 marks each*

QUESTION ONE COMPULSORY (30 MARKS)

a) Define Newton's second law of motion (2 marks)

b) State D'Alembert's principle (3 marks)

c) With the aid of a sketch illustrate dynamic equilibrium for a particle acted upon by two forces. (4 marks)

d) A block of mass 50kg resting on a horizontal plane on which the coefficient of kinetic friction is 0.4 as shown in figure 1. The block is subjected to a towing force of P Newton as shown and accelerating at $2m/s^2$. Applying the equations of dynamic equilibrium for a body, determine;

   i. The magnitude of force P.

   ii. Velocity of the block after 5 seconds starting from rest. (8 marks)

e) A vehicle accelerates a glider of mass 125kg from rest to a speed of 50km/h. Secondly upon application of brakes, its velocity reduces to 20km/h. Calculate work done on the glider by the vehicle and the change in kinetic energy after braking. (4 marks)

f) From first principles, show that the centripetal acceleration of a particle moving with uniform angular velocity on a circular path is given by;

$$a^2 = \omega^2 r = \frac{v^2}{r}$$ (9 marks)

QUESTION TWO (20 MARKS)

a) Explain the following.

i. Principle of conservation of angular momentum

ii. Principle of conservation of energy. (3 marks)

b) A body of mass ***m*** kg and mass moment of inertia ***I*** about its centre of gravity has a combined motion of translation and rotation. If the centre of gravity is moving with linear velocity ***v*** m/s and rotating with angular velocity ***ω*** rad/s about its centre of gravity, Show that the rate of change of kinetic energy is equal to the work done in unit time. (10 marks)

c) A flywheel of mass 1tonne and radius of gyration 0.4m is fitted on the crank shaft of a steam engine. If the angular acceleration of the flywheel is 4.06m/s^2. Determine the starting torque and the kinetic energy of the flywheel after 10 seconds from the start. (7 marks)

QUESTION THREE (20 MARKS)

a) State the equations of kinetic energy of a body under translation and rotation motions. (2 marks)

b) State the parallel axis theorem? (2 marks)

c) Show that for a solid cylinder of radius, R and length, L the mass moment of inertia about axial axis is given by; $I = \frac{1}{2}mR^2$ (5 marks)

d) A rod of mass 6 kg and 2.4m length is pivoted about an axis perpendicular to its length passing through one of its ends. Calculate;

i The mass moment of inertia of the rod.

ii The mass moment of inertia for an axis 100mm from the end.

iii If the section was a hollow circular section, explain the effect on the mass moment of inertia. (11 marks)

QUESTION FOUR (20 MARKS)

The crank of a steam engine makes an angle of 45° with the horizontal and rotates at 100rpm. The lengths of crank and connecting rod are 20mm long and 80mm respectively. Graphically locate the instantaneous centre for the connecting rod at the given crank position and determine;

i. The velocity of the piston

ii. Angular velocity of connecting rod and the crank.

iii. The velocity of a point P located on the connecting rod at a position ratio 2:3 from crank end. (20 marks)

QUESTION FIVE (20 MARKS)

a) State the significance of the following

i. Area moment of inertia

ii. Polar moment of inertia. (4 marks)

b) Using Newton's second law, show that torque is equal to the product of mass moment of inertia and angular velocity. (4 marks)

c) Figure 2 shows a composite section of L – section.

i. Locate the COG (2 marks)

ii. Determine the moment of inertia about an axis I_{NN} which is 100mm away from the area as shown. (10 marks)

[Note; Dimensions in mm.]

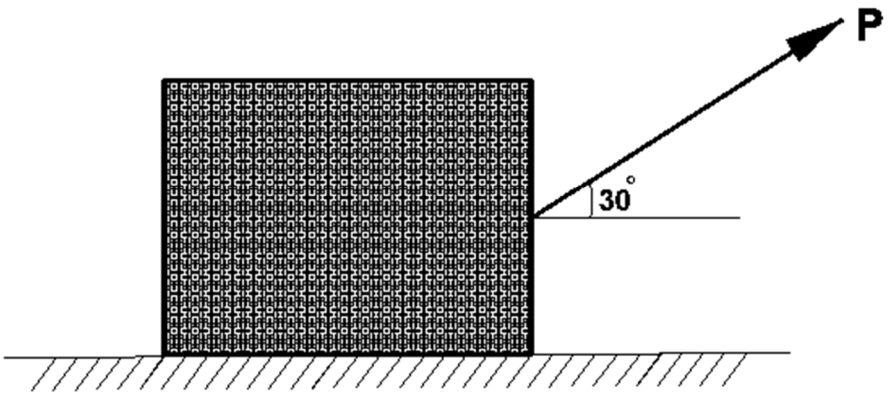

Figure 1

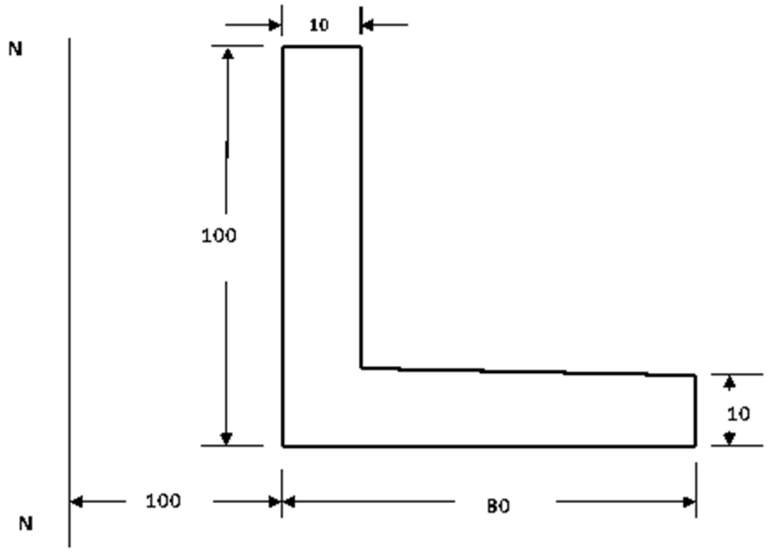

Figure 2