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**University Examinations 2015/2016**

SECOND YEAR FIRST SEMESTER EXAMINATION

FOR THE DEGREE OF

BACHELOR OF TECHNOLOGY IN MECHANICAL ENGINEERING

**EMT 3256: ENGINEERING MECHANICS II**

**DATE: APRIL 2016 TIME: 2 HOURS**

**INSTRUCTIONS:** *Answer question* ***one*** *and any other* ***two*** *questions*

**QUESTION ONE (30 MARKS)**

1. Define the following terms
2. Kirematics (1 mark)
3. Rectilinear motion (1 mark)
4. Curvilinear motion (1 mark)
5. Radius of gyration (1 mark)
6. Moment of momentum (1 mark)
7. State Newton’s Second Law of motion as applied to rotating bodies (1 mark)
8. Using the mathematical expression of this law, show that the torque developed by rotating bodies is given by:



Where T = Torgue

I = Moment of invential of the votating body

 = Angular acceleration of the votaling body. (3 marks)

1. A body falls freely from a height h. Show that the velocity, V, with which it hits the ground is given by:

 (3 marks)

1. An impulsive torque acts on two gears rotating at 1200 r.p.m and 1500 r.p.m, until they both rotate at speeds corresponding to their velocity ratios. If the moment of inertia for each gear is 0.5 kg/m2, determine the magnitude of impulsive torque applied in 5 seconds. (4 marks)
2. State the parallel axes theorem and write it in form of an equation, defining all the terms used. (4 marks)
3. A thin disc of mass m=2kg has a radius r=1.5m. Determine the following
4. Mass moment of inertia of the disc through its centre of gravity and perpendicular to the plane of the disc. (2 marks)
5. Mass moment of inertial of the disc about the diameter (2 marks)
6. Figure (iii) below shows an equivalent dynamical system where a large mass m with centre of gravity G has been replaced by two smaller masses m1 and m2 at a and b metres form the centre of gravity G respectively. Using the three conditions for an equivalent dynamical, system, show that

ab=k2

where K is the radius of gyration of the mass m (6 marks)

**QUESTION TWO (20 MARKS)**

1. The motion of a particle is given by , where a is the acceleration in m/s2 and t is the time in seconds. The velocity of the particle at t=1 second is 2.7m/s , and the displacement is 10m. Calculate:
2. Velocity at t=2 seconds (4 marks)
3. Displacement at t=2 seconds (4 marks)
4. A body moves along a circular path from A to B as shown in figure 1 below where:

r = Radius of the circular path

 = Angular displacement in radius

s = Linear displacement

v = Linear velocity

a = Linear acceleration

 = Angular acceleration

Show that the linear acceleration is given by

 (4 marks)

1. A horizontal bar 2m long and of small cross-section rotates about vertical axis through one end. If it accelerated uniformly form 1500 r.p.m to 1800 r.p.m in an interval of 5 seconds.
2. What is the linear velocity at the beginning and end of the interval? (4 marks)
3. What are the normal and tangential components of the acceleration of midpoint of the bar after 5 seconds after the acceleration begins? (4 marks)

**QUESTION THREE (20 MARKS)**

1. Each of the four wheels of a car weighs 10kg. When the vehicle moves at a speed of 36km/h, the wheel rotates at 1200 r.p.m. Calculate the total kinetic energy of each wheel if the radius of gyration is 1.5 m. (6 marks)
2. The flywheel of a steam engine has a radius of gyration of 1.5m and mass 2600kg. The starting torque of the steam engine is 1800 Nm and may be assume constant. Determine:
3. Angular acceleration of the flywheel (5 marks)
4. Kinetic energy of the flywheel after 15 seconds from the start. (5 marks)
5. Define impulse and show that it is equal to change of linear momentum (4 marks)

**QUESTION FOUR (20 MARKS)**

1. A mass M of 80kg is hung form a rope wrapped round a drum of effective radius of 0.25m, which is keyed to shaft A (figure 1). The shaft A is geared to shaft B which runs at 8 times the speed of shaft A. The total mass moment of inertia of the masses attached to shaft A is 120 kgm2 and that of shaft B is 5kgm2

Find the acceleration of mass M if:

1. It is allowed to fall freely (6 marks)
2. When the efficiency of the gearing system is 80%. (6 marks)
3. The motor shaft A exerts a constant torque of 120Nm and is geared to shaft B as shown in the figure 2 below. The moments of inertia of the parts attached to the motor shaft A is 4 kgm2 and that of the parts attached to other shaft B is 40 kgm2. Find the gear ratio which gives the maximum angular acceleration of shaft B and the corresponding angular acceleration of each shaft (8 marks)