TECHNICAL UNIVERSITY OF MOMBASA

Faculty of Engineering & Technology

DEPARTMENT OF MECHANICAL & AUTOMOTIVE ENGINEERING

UNIVERSITY EXAMINATIONS FOR DEGREE IN

BACHELOR OF SCIENCE IN MECHANICAL ENGINEERING

EMG 2304: MECHANICS OF MACHINES II

END OF SEMESTER EXAMINATIONS

SERIES: APRIL 2015

TIME: 2 HOURS

INSTRUCTIONS:

- You should have; Answer booklet; Drawing instruments and scientific calculator
- This paper consists of FIVE questions.
- Answer any THREE questions.

This paper consists of Three printed pages

QUESTION 1

a) Define the following terms associated with oscillatory motion:
   i) Natural frequency
   ii) Resonance
   iii) Degree of freedom **(3 marks)**

b) A torsional pendulum consists of a wire 0.5m long, 10mm diameter, fixed at its upper end and attached at its lower end to a heavy disc having a moment of inertia of 0.06kg-m^2. The modulus of rigidity of the wire is 44GN/M^2. If the maximum displacement to one side of the rest position is 5^0, determine:-
   i) The periodic time
   ii) The maximum angular velocity and
   iii) The maximum angular acceleration of the disc. **(17 marks)**

QUESTION 2

a) For a damped oscillation described by equation:

$x = e^{-(3wnt)} \ (P\cos \mu t + Q\,sin \ \mu t)$

Show that the logarithmic decrement is given by

$$\ln\left(\frac{x_1}{x_2}\right) = \frac{2®^{3}}{\sqrt{(1-5^{2})}}$$

Where x is the deflection, is damping ratio, is the natural frequency. **(6 marks)**

b) A mass suspended from a spring is subjected to a viscous damping and oscillates with a damped frequency of 1.8 Hz with an amplitude which decreases by 40% in three complete oscillations. Determine:

i) The damping factor

ii) The frequency of the undamped oscillation. **(14 marks)**

QUESTION 3

Three rotating masses, A = 14Kg, B = 11Kg and C = 21Kg, are carried on a shaft, with centres of mass 275mm, 400mm and 150mm respectively from the shaft axis. The angular positions of B and C are 60^0 and 135^0 respectively from A, measured in the same direction. The distance between the planes of rotation of A and B is 1.35m and between those of A and C is 3.6m, B and C being on the same side of A.

Two balance masses are to be fitted, each with its centre of mass 225mm from the shaft axis, in planes midway between those of A and B and of B and C. Determine the magnitude and angular position with respect to A and of each balance mass. **(20 marks)**

QUESTION 4

a) A governor of the Hartnets type, with dimensions as shown in figure Q. 4 (a), runs at a mean speed of 300 rev/min, each ball has a mass of 2.3Kg and 3% reduction in speed causes a sleeve movement of 6mm.

If the ball arm is vertical at the mean speed, and gravitational effects are ignored determine the spring stiffness. **(9 marks)**

b) A porter governor has 300mm arms and the rotating balls each have a mass of 1.8Kg. At the mean speed of 120 rev/min, the arm make 30^0 to the vertical if the sleeve movement is $\pm 25mm$, determine:

i) The central dead load and

ii) The sensitivity of the governor. **(11 marks)**

QUESTION 5

a) Distinguish the following:
   i) Spinning and processional motion
   ii) Gyroscopic couple and reaction couple. **(4 marks)**

b) Explain the effect of a gyroscopic couple on
   i) A car rounding a curve
   ii) The rolling of a ship. **(6 marks)**

c) A generator on a ship has its rotor with its axis parallel to the central axis of the ship. The rotor has a moment of inertia of 200Kg – m^2 and revolves at 360 rev/min. when the ship is steaming at 10m/s round a curve of 200m radius determine the gyroscopic couple transmitted to the ship. **(4 marks)**

d) A flywheel of mass 40Kg and radius of gyration 300mm rotates about its horizontal axis with an angular velocity of 100 rev/min. the horizontal shaft of the flywheel is supported on the bearings 1.3m apart. The flywheel axis is then made to rotate about a vertical axis through the centre of the wheel at an angular velocity of 80 rev/min. Determine the load on the bearings of the wheel. **(6 marks)**