MACHAKOS UNIVERSITY

University Examinations for 2019/2020Academic Year

SCHOOL OF ENGINEERING AND TECHNOLOGY

DEPARTMENT OF MECHANICAL AND MANUFACTURING ENGINEERING

THIRD YEAR SECOND SEMESTER EXAMINATION FOR

BACHELOR OF SCIENCE IN MECHANICAL ENGINEERING

EMM 311: MECHANICS OF MACHINES 11

DATE: 30/11/2020 **TIME: 8.30-10.30 AM**

INSTRUCTIONS

This paper contains FIVE questions.
Question ONE is compulsory and carries 30 marks.
Four remaining questions carry 20 marks each.
Attempt question ONE and any other TWO.

QUESTION ONE (30 MARKS)

a) i State two conditions that must be met for a body to be said to be in simple harmonic motion (2 marks)

ii A particle, moving with simple harmonic motion, performs 10 complete oscillations per minute and its speed, when at a distance of 80 mm from the centre of oscillation is 3/5 of the maximum speed. Find the amplitude of the oscillation (6 marks)

b) Differentiate between longitudinal, transverse and torsional free vibrations (3 marks)

c) Show that the frequency of a simple pendulum is given by $n = \frac{1}{2\pi}\sqrt{\frac{g}{L}}$ (6 marks)

d) Differentiate between the source, the path and the receiver of a vibration (3 marks)

e) State 3 ways in which the life span of a bearing can be enhanced (3 marks)

f) A helical spring, of negligible mass, and which is found to extend 0.25 mm under a mass of 1.5 kg, is made to support a mass of 60 kg. The spring and the mass system are displaced vertically through 12.5 mm and released. Determine the frequency of natural vibration of the system and the velocity of the mass when it is 5 mm below its rest position. (7 marks)

QUESTION TWO (20 MARKS)

a) A composite spring has two springs A and B in series. A has a stiffness, $k_1 = 2000\ N/m$ and B has a stiffness, $k_2 = 800\ N/m$. The composite spring carries a mass of weight 50 N and oscillates freely in the vertical direction. Calculate the frequency of longitudinal oscillation (7 marks)

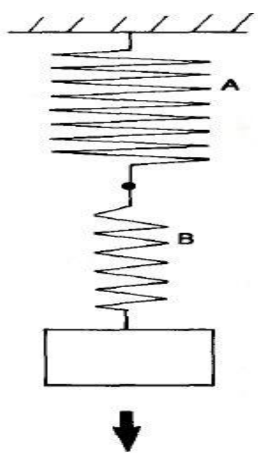

Figure Q2 (a)

b) A vertical shaft of 50 mm diameter and 1.2 m long is made from a metal whose modulus of rigidity, $G = 80\ Gpa$. The shaft has a flywheel of moment of inertia, $I = 50\ kgm^2$ mounted on the end. Determine the frequency of the torsional oscillations. (7 marks)

c) Explain how you would mount a bearing to support a radial load (6 marks)

QUESTION THREE (20 MARKS)

a) A 8 kg body is moved 0.2 m from the right of the equilibrium position and released from rest at a time t = 0. If the viscous damping coefficient, c = 20 Ns/m and the spring stiffness k = 32 N/m, Determine:

i. The damped natural frequency of the body (4 marks)

ii. The displacement of the body at t = 2s (8 marks)

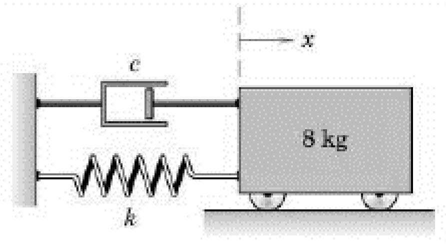

Figure Q3 (a)

b) i Show that the amplitude of a body undergoing undamped forced vibrations is given by: $X = \frac{F/m}{1-\left(\frac{\omega n}{\omega}\right)}$ (5 marks)

ii An 800g machine component mounted on springs is known to have a natural frequency of 25 rad/s and little damping (from observation of its natural vibration). Its base is expected to be vibrated at a frequency of 30 rad/s with amplitude 2 mm. Estimate the spring stiffness and the frequency ratio (3 marks)

QUESTION FOUR (20 MARKS)

Four masses m_1, m_2, m_3 and m_4 are 200 kg, 300 kg, 240 kg and 260 kg respectively. The corresponding radii of rotation are 0.2 m, 0.15 m, 0.25 m and 0.3 m respectively and the angles between successive masses are 45°, 75° and 135°. Find the position and magnitude of the balance mass required, if its radius of rotation is 0.2 m:

a) Using the analytical method (10 marks)

b) Using the graphical method (10 marks)

QUESTION FIVE (20 MARKS)

a) Name two benefits of using sliding-contact bearing over rolling contact bearings to support loads (2 marks)

b) Using sketches, describe 5 types of ball bearings (10 marks)

c) List 4 steps that you can take to ensure bearings achieve their theoretical life (2 marks)

d) Find the natural frequency of transverse vibration for the shaft shown in Figure Q5 (d). The modulus of elasticity of the shaft, $E = 200\ GPa$ and shaft diameter $= 50\ mm$.

(Hint: $\delta = \frac{Wa^2b^2}{3EIL}$) (6 marks)

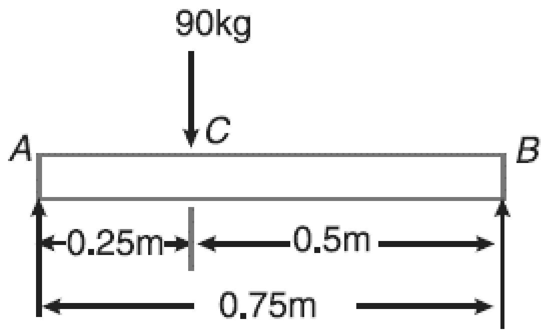

Figure Q5(d)