# MACHAKOS UNIVERSITY

**University Examinations 2018/2019**
**SCHOOL OF ENGINEERING AND TECHNOLOGY**
**DEPARTMENT OF MECHANICAL AND MANUFACTURING ENGINEERING**
**THIRD YEAR SPECIAL/SUPPLEMENTARY EXAMINATION FOR**
**BACHELOR OF SCIENCE IN MECHANICAL ENGINEERING**
**EMM 311: MECHANICS OF MACHINES 11**

**DATE: 26/9/2019** **TIME: 11.00-1.00 PM**

**INSTRUCTIONS:**

**Answer Question One and Any Other Two Questions**

**QUESTION ONE (30 MARKS)**

a) Define the following terms
   i. Amplitude
   ii. Periodic time
   iii. Frequency (3 marks)

b) 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)

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)

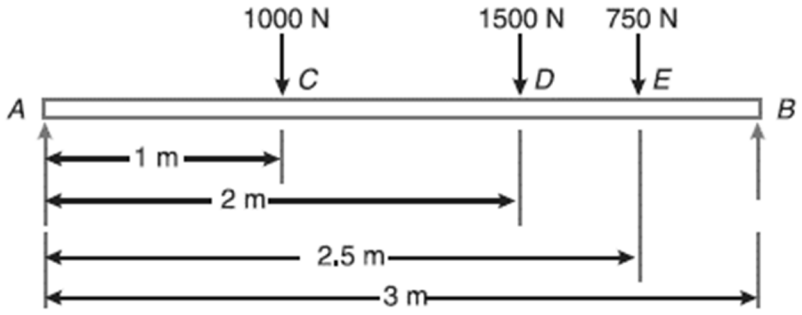
f) A helical spring, of negligible mass, and which is found to extend 0.25 mm under a mass of 1.5 kg, is made to support a mass of 60 kg. The spring and the mass system is displaced

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 vibrating system consists of a mass of 200 kg, a spring of stiffness 80000 N/m and a damper with damping coefficient of 800 N/m/s. Determine the frequency of vibration of the system. (8 marks)

b) A shaft 50 mm diameter and 3 metres long is simply supported at the ends and carries three loads of 1000 N, 1500 N and 750 N at 1 m, 2 m and 2.5 m from the left support. The Young's modulus for shaft material is 200 GN/m2. Find the frequency of transverse vibration Hint: ( $\delta = \frac{Wa^2b^2}{3EIL}$ $and$ $\delta = \delta_1 + \delta_1 + \delta_1$) (12 marks)




**QUESTION THREE (20 MARKS)**

a) A vertical shaft of 60 mm diameter and 1.8 m long is made from a metal whose modulus of rigidity, $G = 90\ Gpa$. The shaft has a flywheel of moment of inertia, $I = 70\ kgm^2$ mounted on the end. Determine the frequency of the torsional oscillations. (7 marks)

b) A piston, moving with a simple harmonic motion, has a velocity of 8 m/s, when it is 1 metre from the centre position and a velocity of 4 m/s, when it is 2 metres from the centre. Find :

i. Amplitude (7 marks)

ii. Periodic time (2 marks)

iii. Maximum velocity (2 marks)

iv. Maximum acceleration (2 marks)

**QUESTION FOUR (20 MARKS)**

Four masses *A*, *B*, *C* and *D* are attached to a shaft and revolve in the same plane. The masses are 12kg, 10 kg, 18 kg and 15 kg respectively and their radii of rotations are 40 mm, 50 mm, 60 mm and 30 mm. The angular position of the masses *B*, *C* and *D* are 60°, 135° and 270° from the mass *A*. Find the magnitude and position of the balancing mass at a radius of 100 mm:

a) Using the graphical method (10 marks)

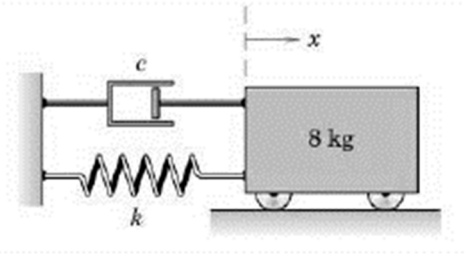
b) Using the analytical method (10 marks)

**QUESTION FIVE (20 MARKS)**

a) An 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 = 3s (8 marks)




b) Using sketches, describe the 4 types of roller bearings (8 marks)