TECHNICAL UNIVERSITY OF MOMBASA

Faculty of Engineering and Technology
Department of Mechanical & Automotive Engineering
UNIVERSITY EXAMINATION FOR:
BSc. Mechanical Engineering
EMG 2412 : VIBRATIONS
END OF SEMESTER EXAMINATION
SERIES: DECEMBER2016
TIME: 2 HOURS
DATE: Pick Date**Dec2016**

Instruction to Candidates:

You should have the following for this examination

- *Answer booklet*
- *Non-Programmable scientific calculator*

This paper consists of **FIVE** questions.
Question **ONE** is **COMPULSORY**
Attempt any other **TWO** questions.
Maximum marks for each part of a question are as shown.
Do not write on the question paper.
Mobile phones are not allowed in the examination room.

Question ONE (COMPULSORY: 30 Marks)

a) Define the terms:
   i) Cycle (1 Mark)
   ii) Amplitude (1 Mark)
   iii) Phase angle (1 Mark)
   iv) Linear frequency (1 Mark)
   v) Period (1 Mark)
   vi) Natural frequency (1 Mark)

b) A spring mass system has a natural period of 0.21 sec. What will be the new period if the spring constant is:
   i) Increased by 50 % (5 Marks)
   ii) Decreased by 50 % (5 Marks)

c) A locomotive car of mass 2000 kg travelling at a velocity, v, of 10 m/s is stopped at the end of the tracks by a spring damper system as shown in Figure Q1 c). If the stiffness of the spring is k = 40 N/mm and the damping constant is C = 20N-s/mm, determine:

i) The maximum displacement of the car after engaging the springs and the damper, and (7 Marks)

ii) The time taken to reach the maximum displacement. (7 Marks)

Question TWO (20 Marks)

a) What is the difference between free and forced vibrations? (4 Marks)

b) What is the difference between a single degree of freedom (SDOF) system and a multiple degree of freedom (MDOF) system? (4 Marks)

c) A 54 kg mass is supported by three springs as shown in Figure Q2 c). The initial displacement is 7.0 cm downward from the equilibrium position. No external forces act of the mass after it is released. What is the maximum velocity and acceleration? (12 Marks)

Question THREE (20 Marks)

a) A mass of 5 kg hangs from a spring and makes damped oscillations. The time of 50 complete oscillations is found to be 20 seconds, and the ratio of the first downward displacement to the sixth is found to be 2.25. Find the stiffness of the spring and the damping force. (10 Marks)

b) A body of mass 6 kg is hung on a spring of stiffness 1 kN/m. It is pulled down 50 mm below its static equilibrium position and released. There is a frictional resistance which is proportional to the velocity, and which is 36 N when the velocity is 1 m/s.

i) Write down the differential equation of the motion, and its solution, evaluating the constants. (7 Marks)

ii) Calculate the time which elapses, and the distance which the body moves, from the instant of release until it is again at rest at the highest part of its travel. (3 Marks)

Question FOUR (20 Marks)

a) The time of free vibration of a mass hung from the end of a helical spring is 0.8 seconds. When the mass is stationary, the upper end is able to move upwards with a displacement y mm such that $y = 45\sin 2\pi t$, where t is the time in seconds measured from the beginning of the motion. Neglecting the mass of the spring

and any damping effects, determine the vertical distance through which the mass is moved in the first 0.3 seconds. (10 Marks)

b) A spring mass system has a natural frequency of 10 Hz. When the spring constant is reduced by 800 N/m, the frequency is altered by 45%. Find the mass and spring constant of the original system. (10 Marks)

Question FIVE (20 Marks)

a) A mass of 18 kg is carried on a spring of stiffness 7500 N/m from a support which has a vertical harmonic motion of amplitude ± 4 mm at a frequency of 4 Hz. The motion of the mass is opposed by a force proportional to its absolute velocity, and of amount 75 N s/m. Calculate the amplitude of the steady motion of the mass and its phase relative to the motion of the support. Find also the maximum instantaneous extension of the spring. (12 Marks)

b) A periodic torque, having a maximum value of 0.5 Nm at a frequency corresponding to 4 rad/sec, is impressed on a flywheel suspended from a wire. The wheel has a moment of inertia of 0.12 kgm^2 and the wire has a stiffness of 1 Nm/rad. A viscous dash-pot applies a damping couple of 0.4 Nm at an angular velocity of 1 rad/sec. Calculate:

i) The maximum angular displacement from the rest position (6 Marks)

ii) The maximum couple applied to the dash-pot. (2 Marks)

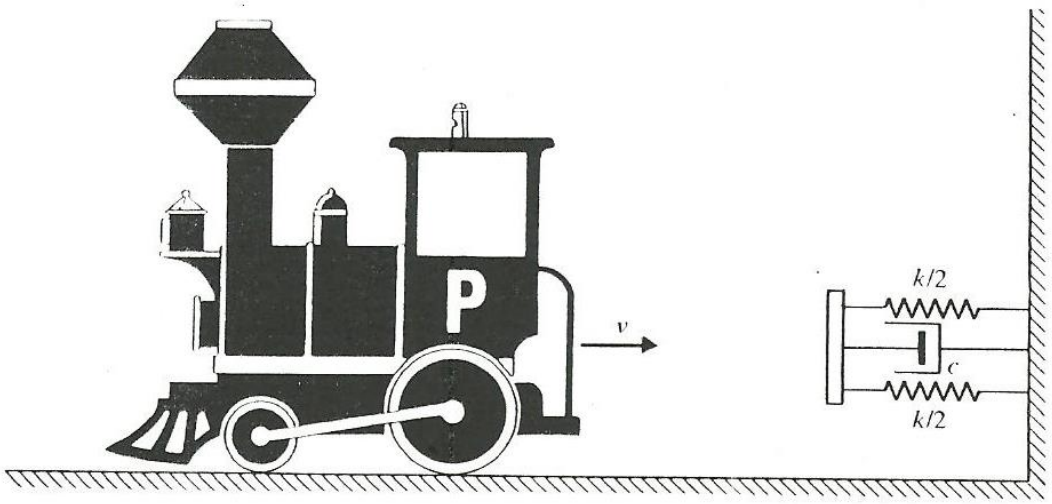

FIGURE Q1 C)

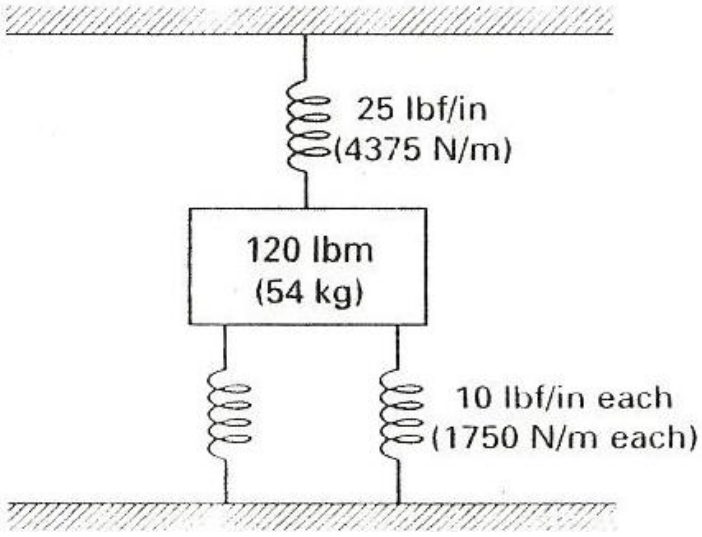

FIGURE Q2 C)