TECHNICAL UNIVERSITY OF MOMBASA

FACULTY OF ENGINEERING AND TECHNOLOGY

DEPARTMENT OF MECHANICAL & AUTOMOTIVE ENGINEERING

UNIVERSITY EXAMINATION FOR:

BACHELOR OF SCIENCE IN MECHANICAL ENGINEERING

EMG 2412: VIBRATIONS

END OF SEMESTER EXAMINATION

SERIES:APRIL2016

TIME:2HOURS

DATE: Pick DateMay2016

Instructions to Candidates

You should have the following for this examination

-*Answer Booklet, examination pass and student ID*

This paper consists of **FIVE** questions. Attempt **any THREE questions**.

Do not write on the question paper.

Question ONE

a) List FIVE ways of classifying vibration (5 Marks)

b) A harmonic motion has an amplitude of 0.15 m and a frequency of 30 Hz. Find the time period, maximum velocity and maximum acceleration. (10 marks)

c) A cylinder of mass *m* and radius *r* is connected by a spring of stiffness *k* on an inclined plane as shown in figure 1. It is free to roll on the surface without slipping. Develop the expression for determining the natural frequency. Use energy method. (10 Marks)

Figure 1

Question TWO

a) The mass of spring – mass – dashpot system is displaced by a distance of 0.05 m from the equilibrium position and released. Find the equation of motion for the system for the cases when
   i. $\zeta = 1.3$ (5 Marks)
   ii. $\zeta = 1$ (5 Marks)

b) A spring mass damper system has a mass of 5 kg, spring stiffness of 150 N/m and damping coefficient of 5 N s/m. Determine; (10 Marks)
   i. The critical damping constant
   ii. Damping ratio
   iii. Frequency of damped oscillation
   iv. Logarithmic decrement
   v. No of cycles after which the initial amplitude is reduced to 10%.

Question THREE

a) The seat of a helicopter, with the pilot weighs 1200N and is found to have a static deflection of 10 mm under self weight. The vibration of the rotor is transmitted to the base of the seat as a harmonic motion with a frequency of 4Hz and amplitude of 0.2 mm. Determine;
   i. The amplitude felt by the pilot (6 marks)
   ii. The velocity felt by the pilot (2 marks)
   iii. The acceleration felt by the pilot (2 marks)

b) A rotor of mass 15 kg is mounted in the middle of a 25 mm diameter shaft supported at the ends by two bearings. The bearing span is 450 mm. Because of certain manufacturing inaccuracies, the centre of gravity of the disc is 0.05 mm away from the geometrical centre of the rotor. If the shaft rotates at 2450 rpm, find the amplitude of steady state vibration and the dynamic force transmitted to the bearings. Let $E = 2 \times 10^5\ N/mm^2$ (10 marks)

Question FOUR

a) Determine the frequency equation for the system shown in Figure 2. (10 marks)
b) A two wheeled trailer is drawn over a rough unpaved road in such a way that the vertical motion of the tyre may be regarded as sinusoidal, the pitch of the unpaved road being 5m. The combined stiffness of the tyres is 185kN/m and that of the main spring is 75kN/m; the axle and the attached parts have a mass of 400 kg and the mass of the body is 500 kg. Find;

   i. The critical speed of the trailer in km/h. (5 marks)
   ii. The amplitude of the trailer body vibration when it is drawn at 50 km/h and the amplitude of the unpaved is 0.1 m. (5 marks)

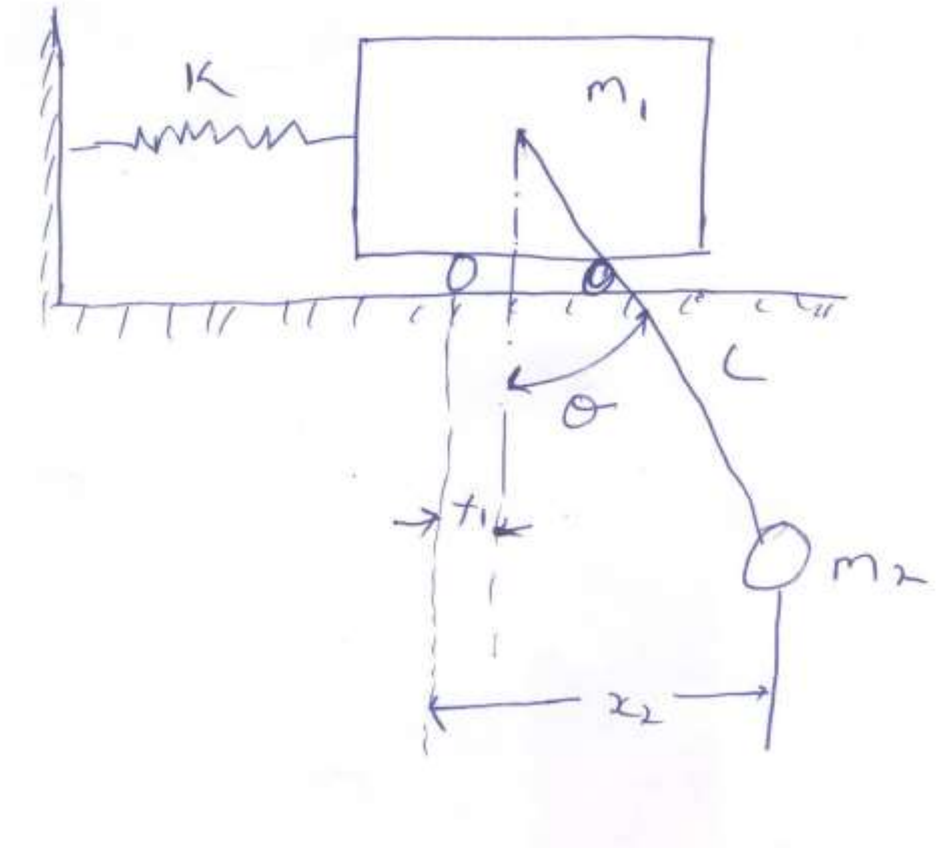

Figure 2

Question FIVE

a) Determine the natural frequency of system shown in Figure 3. (10 marks)

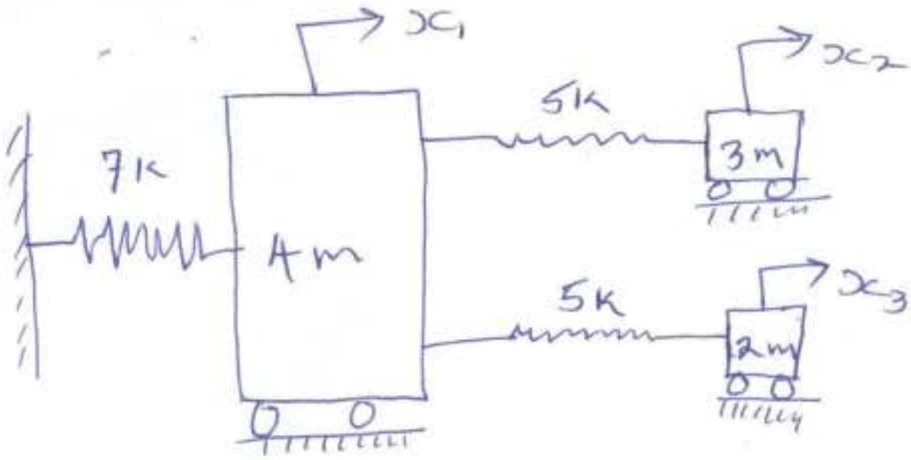

Figure 3

b) Find the fundamental natural frequency of Figure 4 using Dunkerley method. Let $E = 196 \times 10^{9}\ N/m^{2}$ and $I = 4 \times 10^{-7}\ m^{4}$. (marks)

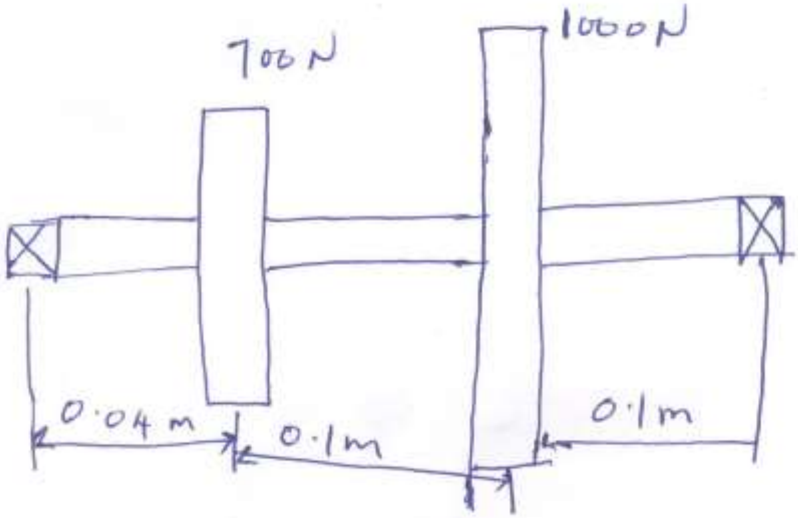

Figure 4