TECHNICAL UNIVERSITY OF MOMBASA

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EMG 2412: VIBRATIONS

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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) Define the following terms:
Resonance, Natural Frequency, Damping, Phase Angle, Time period (5 Marks)

b) A spring mass system has spring constant of K N/m and weight of W N. The natural frequency is 12 Hz. When an extra 24.525N weight is added to W the natural frequency reduces by 2 Hz. Find the mass M and the spring constant K. (5 Marks)

c) A cylinder of mass m and radius r rolls without slipping on a circular surface of radius R as shown in Figure 1. Find the natural frequency of the cylinder assuming the oscillations are small about the equilibrium point A. Use Energy Method. (10 Marks)

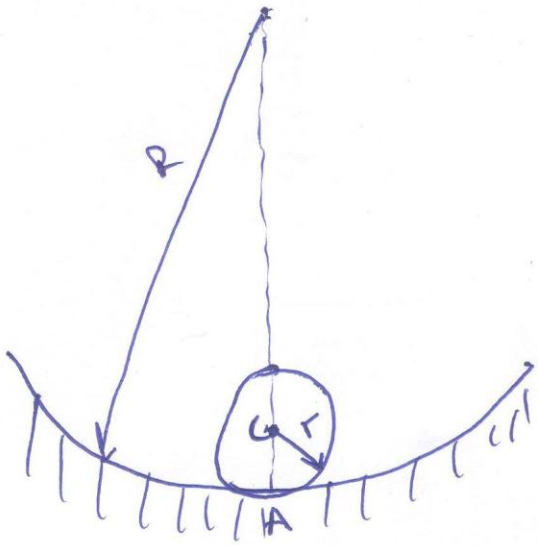

Figure 1

Question TWO

a) A vehicle is modeled as a single – degree of freedom system vibrating in the vertical direction. It is driven along a road whose profile varies sinusoidally. The distance from peak to trough is 0.2 m and distance along the road between peaks is 70 m. If the natural frequency of the vehicle is 2 Hz and damping ratio of the shock absorber is 0.15. Determine;
   i. The amplitude of vibration at a speed of 120 Km/h (10 marks)
   ii. If the speed of the vehicle is varied, find the most unfavorable speed for the passenger. (10 marks)

Question THREE

a) A reciprocating pump weighing 1000 kg is runs at 300 rpm. The forces transmitted to the rigid foundation, on which it is bolted are found the too high. It is desired to reduce these forces to one – tenth of their present values by mounting the pump on springs of negligible damping at each of the four corners of the plate. Assume the weight are equally distributed on the four springs. Determine the spring constant. (10 marks)

b) A shaft, carrying a rotor weighing 500N and eccentricity of 3mm, rotates at 12000rpm. Let the stiffness of the shaft stiffness K = 40 x 10^6 N/m and external damping ratio $\zeta = 0.1$ Determine;

   i) The steady state whirling amplitude (7 Marks)

ii) The maximum whirling amplitude during start up condition. (3 Marks)

Question FOUR

a) Find the natural frequency and amplitude ratio of the system shown in Figure 2. Let *K = 1000 N/m M = 20 kg* (10 Marks)

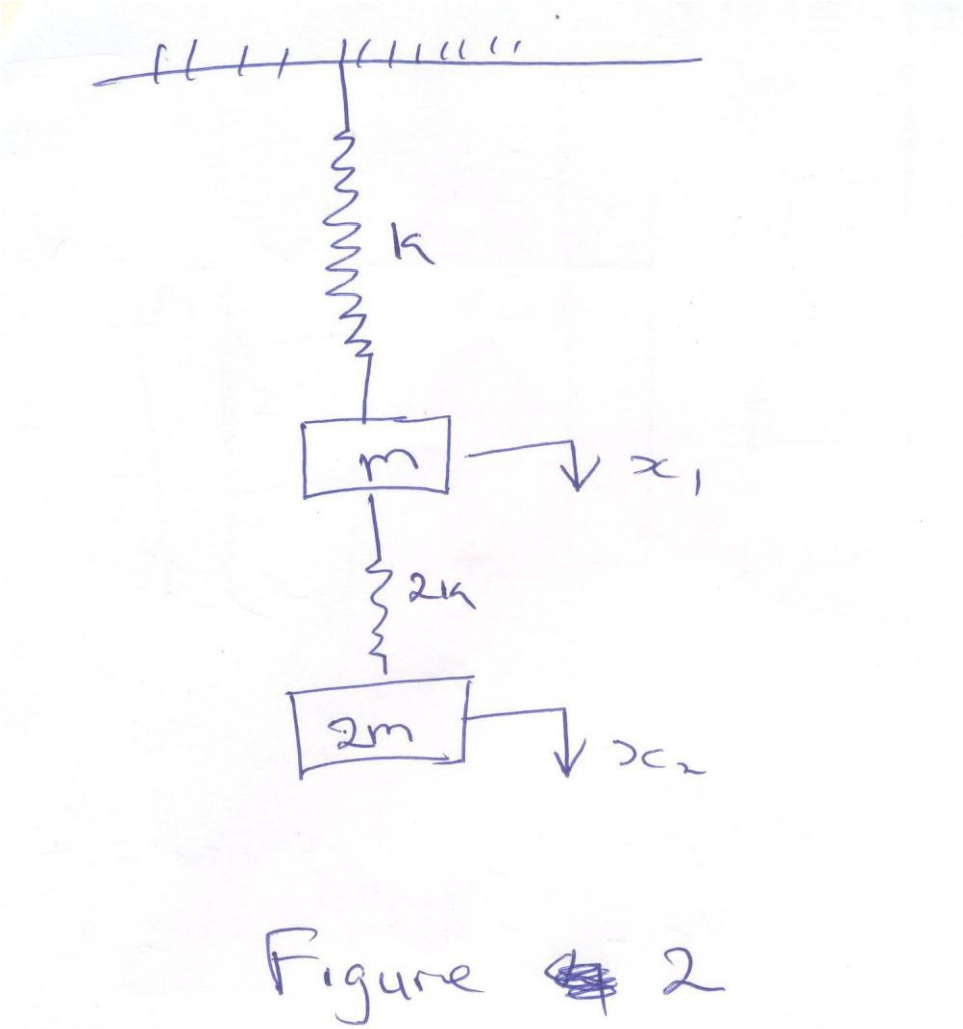

Figure 2

b) An air compressor of mass 300kg is found to have large amplitude of vibration while running at 1500 rpm. Determine the mass and spring constant of the absorber to be added if the natural frequencies of the system are to be atleast 15% from the impressed frequency (10 Marks)

Question FIVE

a) Find the natural frequency for the geared system as shown in Figure 3. The shaft A is 0.8m in length and a diameter of 0.04 m. Shaft B has a diameter 0.03 m and a length 1 m. Take the modulus of rigidity for the shaft material as 80 GPa, I_A = 24 Nm^2, I_B = 10 Nm^2. Neglect the inertia for the gears. (10 Marks)

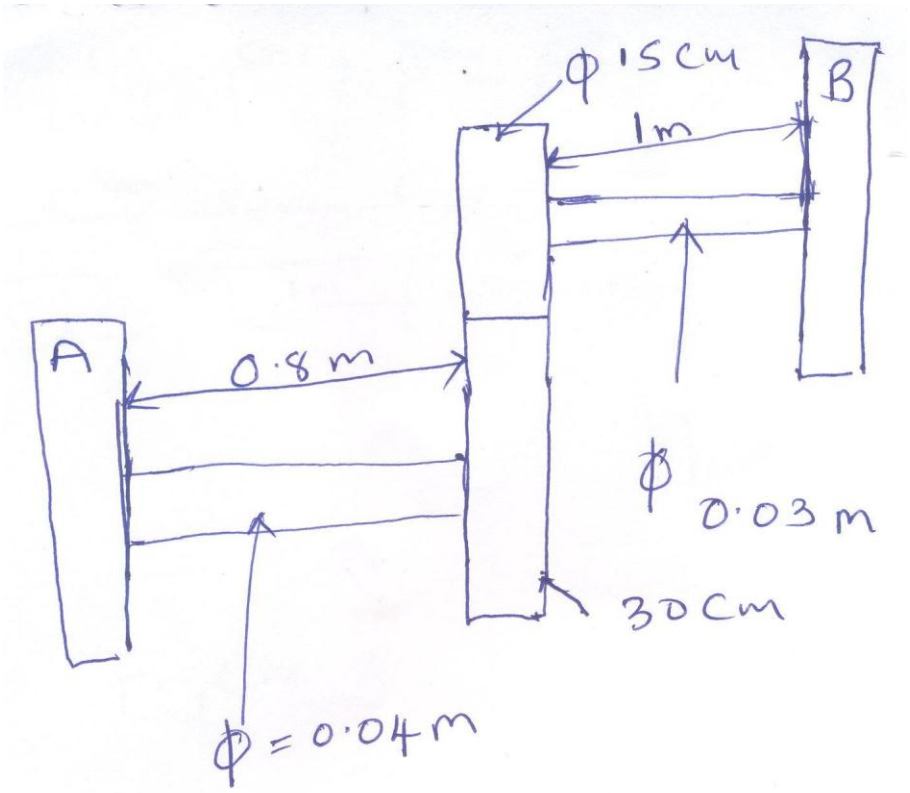

Figure 3

b) A shaft of negligible weight having a length of 5 m is simply supported at the ends and carries four weights of 50 kg each at equal intervals of the length of shaft as shown in Figure 4. Find the frequency of vibration using Dunkerley method. (10 Marks)

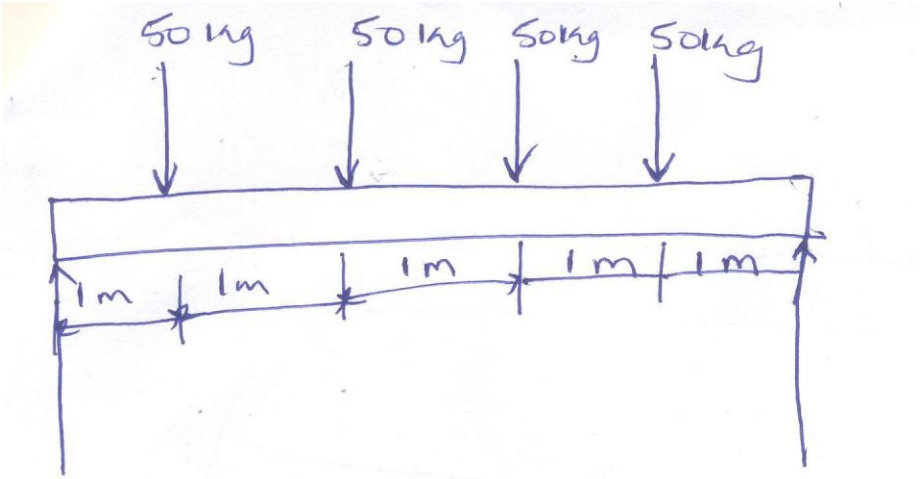

Figure 4