Exam Date & Time: 02-May-2024 (02:30 PM - 05:30 PM)

MANIPAL ACADEMY OF HIGHER EDUCATION

End Semester Examination

THEORY OF VIBRATIONS [AAE 3254]

Marks: 50 **Duration: 180 mins.**

Descriptive Questions

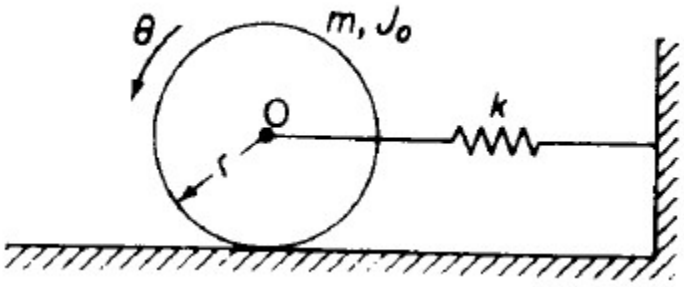
Answer all the questions. Section Duration: 180 mins

1) Show that the sum of 2 harmonics with same frequency but with different phase angles is also a harmonic function of same frequency (3)

A)

B) The motion of a particle is represented by the equation x=4 sin (2*pi*t). Roughly sketch the plots of variation of displacement, velocity and acceleration with time (3)

C) Determine the natural frequency of the following system shown in figure 1 for small displacement.



(4)

Figure 1

2) Calculate the effective spring stiffness of the system shown in figure 2 (m= 25 kg; k_1=500 N/m, k_2=k_3=800 N/m) and also compute the natural frequency

A)

(3)

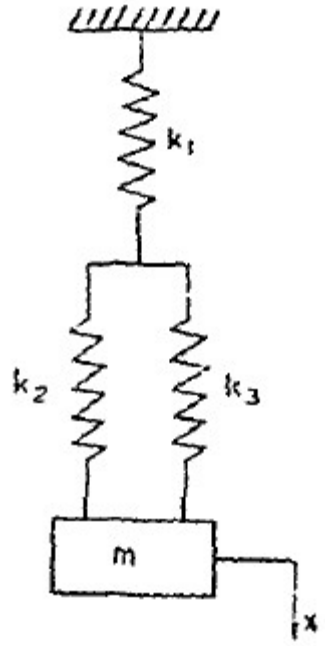


Figure 2

B) A vibrating system consisting of mass 4.534 kg, a spring of stiffness of 35 N/cm and a dashpot with a damping coefficient of 0.1243 N/cm/s. Find (a) damping ratio, (b) logarithmic decrement and (c) the ratio of any 2 successive amplitudes. (3)

C) A mass of 40 kg is suspended form a spring of stiffness 20,000 N/m. The vertical motion of the mass is subjected to coulomb friction of magnitude 100 N. If the spring is initially displaced downwards by 6 cm from the static equilibrium position, determine (a) the time elapsed before the mass comes to rest and (b) the final extension of the spring. (4)

3) When a 20 kg recording device is mounted on an isolator, the deflection of the isolator is 50 mm. An unbalanced force of 20 N is produced when the recording device is operated at 20 rad/sec, and the amplitude of the vibrating system is 2 mm. Determine the damping

A) ratio of the system. (4)

B) Analyse the influence of damping ratio on the working of displacement pick up. (2)

C) A machine of mass 100 kg is mounted on sprigs of total stiffness 50,000 N/m and a damping ratio of 0.2. A harmonic force F= 500 sin (13.2*t*) acts on the mass. Determine (a) the amplitude of motion of the machine, (b) the phase lag, (c) the transmissibility and (d) Maximum dynamic force transmitted to the foundation. (4)

4) Derive the differential equation of motion of the double pendulum and the natural frequencies shown in figure3. (4)

A)

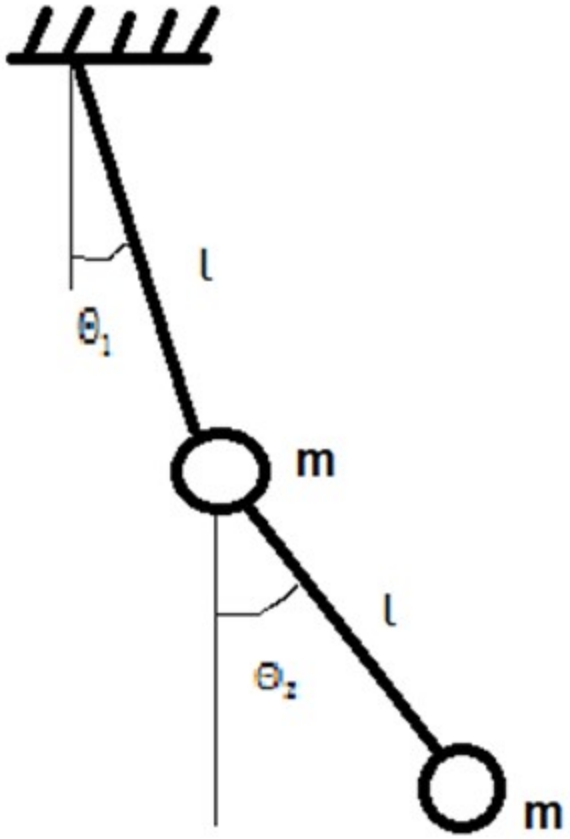
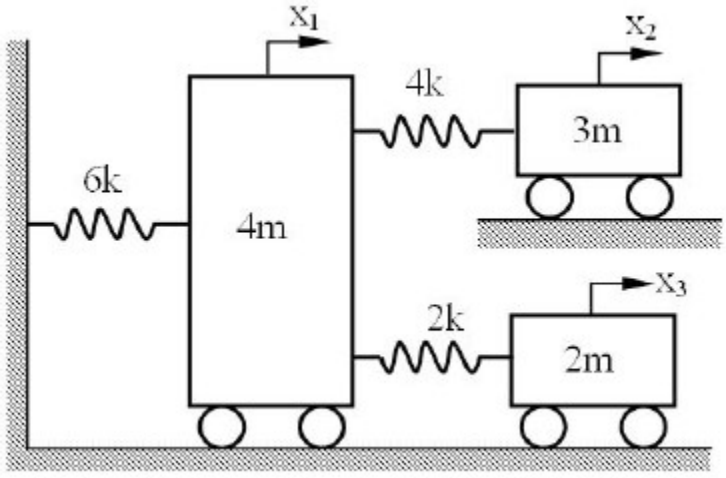


Figure 3

B) Compute the flexibility coefficient of the system shown in figure 4.



(4)

Figure 4

C) Compute the natural frequency of the system shown in figure 4 by Dunkerly's method. (2)

5) Find out the natural frequencies of the system shown in figure 5 by method of matrix iteration (perform 3 iterations and take the staring amplitude as 1:2:3). (5)

A)

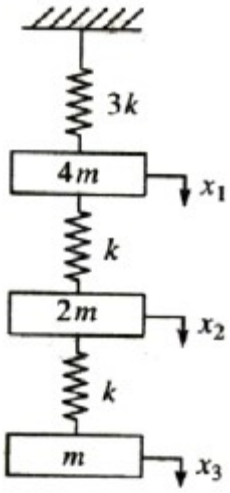


Figure 5

B) Determine the stiffness matrix of the system shown in figure 5 by influence coefficient method. (3)

C) Briefly discuss the Rayleigh's method of computing the first natural frequency of a multi-degree freedom system by considering Lumped parameter modeling of the system. (2)

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