(b) Prove that it is a case of underdamping

(c) Derive the response for this system.

4. Consider a single degree of freedom system with mass m = 10 kg, spring of k = 4000 N/m, and damping C = 20 N-s/m. An external force of $F(t) = F_0 \cos \omega t$ acts on the system with F_0 = 100 N and ω = 10 rad/s.

(a) Derive the governing equation system for the forced vibration.

(b) Determine the response of the system in terms of frequency ratio and damping ratio. **5+10=15**

Unit III

5. For the given two-degree freedom system in fig 3 :

(a) Derive its governing equations

(b) Determine the natural frequency and mode shape of the system

BB-83

M. Tech. EXAMINATION, Dec. 2018

(Second Semester)

(B. Scheme) (Re-appear Only)

(ME)

MED506B

VIBRATION AND CONDITION MONITORING

Time : 3 *Hours*] [*Maximum Marks* : 75

Before answering the question-paper candidates should ensure that they have been supplied to correct and complete question-paper. No complaint, in this regard, will be entertained after the examination.

Note : Attempt *Five* questions in all, selecting at least *one* question from each Unit. All questions carry equal marks.

Unit I

1. (a) Explain, why mass is necessary for mechanical vibration to take place.

   (b) A sledgehammer strikes an anvil with a velocity of 15 m/s. The hammer and the anvil weigh 6 kg and 50 kg respectively. The anvil is supported on Four springs, each of stiffness $k = 2 \times 10^4$ N/m. Derive the governing equations of the motions and the response of the anvil for two situations :

   (i) The hammer remains in contact with the anvil

   (ii) The hammer does not remain in contact with the anvil after the initial impact. **5+10=15**

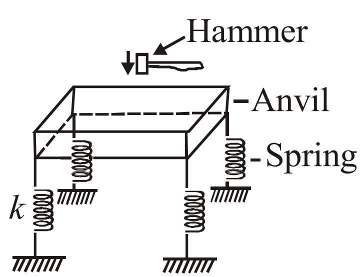


Fig. 1

2. Determine the natural frequency of the vibratory system : **15**

   (a) When only k_1 is present.

   (b) When both k_1 and k_2 are present.

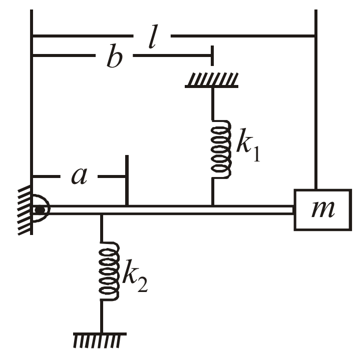


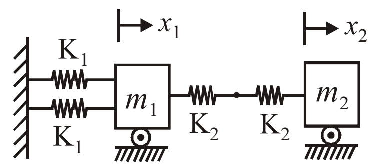
Fig. 2

Unit II

3. Consider a single degree of freedom system with mass m = 10 kg, spring of k = 4000 N/m, and damping C = 20 N-s/m : **5×3=15**

   (a) Derive the governing equation system for free vibration.

(c) Write the general response of the system for initial conditions of $x_1(0) = 1$, $v_1(0) = x_2(0) = v_2(0) = 0$. **5×3=15**



$m_1 = 10$ kg $K_1 = 15$ N/m
$m_2 = 10$ kg $K_2 = 10$ N/m

6. (a) Derive the governing equation in matrix form for a multi-degree far coupled system and prove that it reduces to an eigen value problem.

(b) In order to determine the natural frequency of a structure, it is excited by an electro-dynamic shaker and a sweep test is carried out. The mass of the moving member of the exciter is 13.5 kg and the natural frequency of the system is bound to be 10.2 Hz. An additional mass of 10 kg is attached to the moving member of the shaker and the measured natural frequency is 9.3 Hz. Determine the true natural frequency of the structure using Dunkerley's method. **10+5=15**

Unit IV

7. (a) Explain the working principle of an accelerometer and seismometer.

   (b) Giving the experimental set up for RAP test, explain how you determine the natural frequency and damping ratio of a vibratory system.

   (c) The rotor of a machine is rotating at a speed of 6000 RPM. The first natural frequency of the machine is found to be 50 Hz. Prove that the machine is operating above first critical. Determine the frequency of 1X, 2X, 3X vibration signals. **5×3=15**

8. (a) Let f is periodic function of time $f(t) = f(t + T)$. Write Fourier series of the function. If the time period T = 0.002 second, calculate the fundamental harmonic.

   (b) A vibratory system has a response as $x(t) = 10 \sin \omega_1 t + 10 \sin \omega_2 t$; where $\omega_1 = 10$ rad/s and $\omega_2 = 20$ rad/s. Depict this response in time domain and frequency domain. **7+8=15**