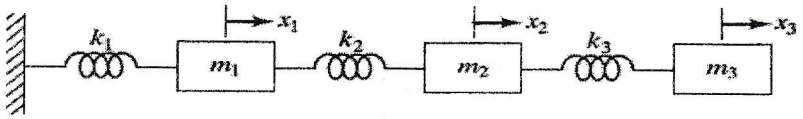
30/11/2018

ME Sem I / Mech / Choice base / Second half 2018

(03 Hours) [Total Marks: 80]

N.B. : (1) Attempt any FOUR Questions.
(2) Answers to the questions showed to be grouped & Written together.
(3) Assume suitable Data wherever necessary, with suitable justification.
(4) Illustrate the answers with sketches, if necessary.

Q1) A. Find the natural frequencies and mode shapes of the system shown in figure for $k_1 = k_2 = k_3 = k$ and $m_1 = m_2 = m_3 = m$.



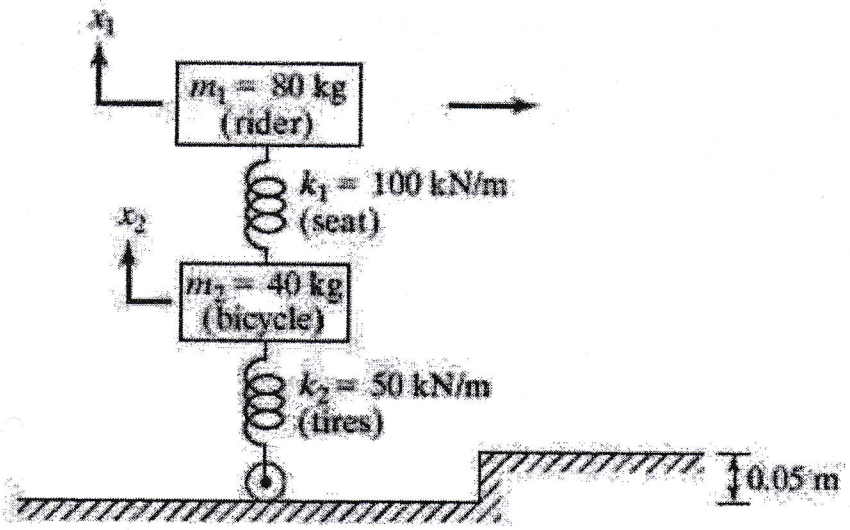
(10 Marks)

B. Washing machine of mass 50 kg operates at 1200 rpm. Find the maximum stiffness of the isolator that provides 75% isolation in transmitted force. Assume that damping ratio of the isolator is 7%. (10 Marks)

Q2) A. Explain Experimental Modal Analysis ? Why is experimental model analysis considered as one of the most important steps required in resolving the vibration related problems ? (10 Marks)

B. Give an iterative procedure for obtaining displacement response and natural frequency of system represented by Duffing's equation $\ddot{x} + \omega_0^2 x \pm \alpha x^3 = f\cos(\omega t)$ assuming small nonlinearity. (10 Marks)

Q3) A. A simplified model of a bicycle with its rider is shown in Figure. Find the vertical motion of the rider when the bicycle hits an elevated road, as shown in the figure.

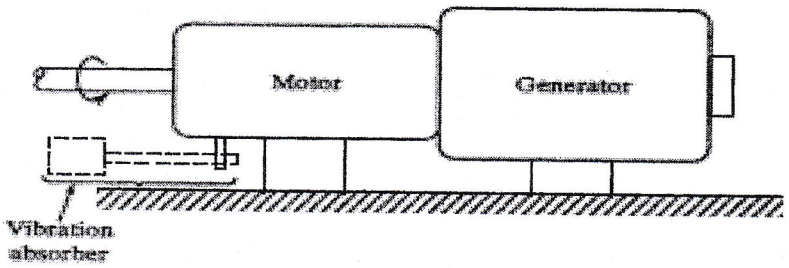


(10 Marks)

B. Write a note on Condition Monitoring and Fault,Diagnosis

(10 Marks)

Q4) A. A motor-generator set, shown in Fig. below is designed to operate in the speed range of 2000 to 4000 rpm. However, the set is found to vibrate violently at a speed of 3000 rpm due to a slight unbalance in the rotor. It is proposed to attach a cantilever mounted lumped-mass absorber system to eliminate the problem. When a cantilever carrying a trial mass of 2 kg tuned to 3000 rpm is attached to the set, the resulting natural frequencies of the system are found to be 2500 rpm and 3500 rpm. Design the absorber to be attached (by specifying its mass and stiffness) so that the natural frequencies of the total system fall outside the operating-speed range of the motor-generator set.



(10 marks)

B. What is the source of nonlinearity in Duffing's equation? What is the difference between hard spring and soft spring? Explain Jump Phenomenon. (10 marks)

Q5) A. What are the principles on which a vibrometers and an accelerometer are based? What should be the range of natural frequencies for a vibrometers and for an accelerometer for a frequency of vibration and of acceleration respectively? (10 marks)

B. A flywheel of mass 10 kg and radius of gyration 0.3 m, makes torsional rotations under a torsion spring of stiffness 5 Nm/rad. A viscous damper is fitted and it is found that the amplitude is reduced by factor 100 over any two complete cycles. Find

a) Damping factor
b) Damping Coefficient
c) Periodic time of damping oscillations (10 marks)

Q6) A. Using modal analysis, determine the free-vibration response of a two-degree-of-freedom system with equations of motion

$$2\begin{bmatrix}1 & 0\\ 0 & 1\end{bmatrix}\ddot{x}(t)+8\begin{bmatrix}2 & -1\\ -1 & 2\end{bmatrix}x(t)=0$$

With initial conditions

$$x(0)=\begin{Bmatrix}1\\ 0\end{Bmatrix}\quad \dot{x}(0)=\begin{Bmatrix}0\\ 1\end{Bmatrix}$$ (10 marks)

B. Explain the phase plane techniques and Perturbation method. (10 marks)

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