Reg. No.										

MANIPAL INSTITUTE OF TECHNOLOGY

MANIPAL

(A constituent unit of MAHE, Manipal)

I SEMESTER M.TECH. (AUTOMOBILE ENGINEERING)

END SEMESTER EXAMINATIONS, FEBRUARY 2021

SUBJECT: VIBRATIONS AND ACOUSTICS [AAE -5174]

REVISED CREDIT SYSTEM

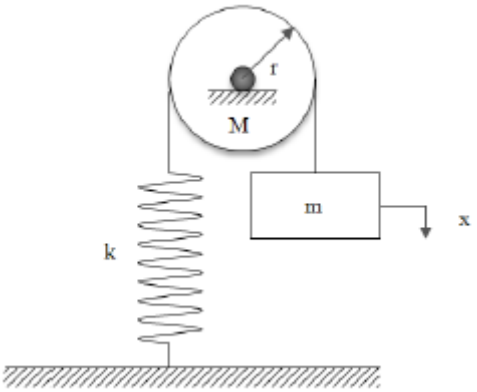
(24/02/2021)

Time: 3 Hours MAX. MARKS: 50

Instructions to Candidates:

- Answer **ALL** the questions.
- Missing data may be suitably assumed.

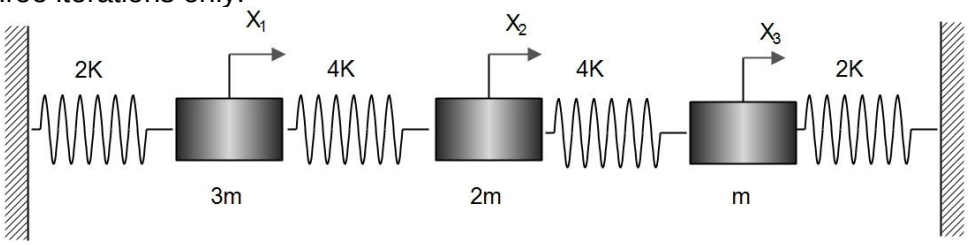
1A. Determine the natural frequency of the following system for small oscillations. **(03)**



1B. A vibrating system has a mass of 4.534 kg and a spring of stiffness 35 N/cm and a dashpot of coefficient 0.1243 N-cm/sec. Find the natural frequency, damping ratio, logarithmic decrement, and the ratio of any 2 successive amplitudes. **(05)**

1C. Discuss the influence of damping on the working principle of displacement pick-up. **(02)**

2A. Determine the third natural frequency of the system using matrix iteration method. Do three iterations only. **(06)**



2B. Derive the standard equation for the vibration of a string fixed between 2 end points **(04)**

3A. With suitable example explain spring hardening and softening phenomenon with respect to non-linear vibrations. **(03)**

3B. The equation of motion of a SDOF system is $2\ddot{x}+0.8\dot{x}+1.6x=0$. The initial conditions are displacement and velocity at *t*=0 is -1 and 2, respectively. Plot a **(05)**

trajectory in phase plane.

3C. A 4 kg rotor is mounted midway between on a shaft of dia 0.012 m and bearing span is 0.5 m. There is an eccentricity of 0.015mm in the system. If the shaft rotates at 1440 rpm, find the amplitude of steady state vibrations. Take *E* as 210 GPa. **(02)**

4A. A K-M system is excited by a force of F_0 Sin (ωt). At resonance, the amplitude was measured to 0.58 cm and at 0.8-time resonance, an amplitude of 0.46 cm was recorded. Determine the damping ratio. **(02)**

4B. A 100 kg centrifugal compressor is supported on isolators of damping factor 0.2. It runs at a constant speed of 1500 rpm and has a rotating unbalance of 0.1 kgm. What should be the stiffness of the isolator if the force transmitted to the foundation is to be less than 10% of the unbalance force? **(05)**

4C. A viscous damped system has a spring of stiffness 525 N/m. When the weight is displaced and released, the time of oscillations was found to be 1.8 sec. and the ratio of successive amplitudes was 4.2 to 1. Determine the amplitude and phase when a force of F= 2Cos 3t acts on it. **(03)**

5A. Briefly explain the necessity of acoustic exciter and calibrators. **(03)**

5B. Derive the equation of sound wave propagation in 3-D **(04)**

5C What is frequency domain analysis and how it is useful in analysis of dynamic systems? **(03)**

For systems with harmonic excitation $$MF = \frac{X}{X_{st}} = \frac{1}{\sqrt{\left[1-\left(\frac{\omega}{\omega_n}\right)^2\right]^2 + \left(\frac{2\xi\omega}{\omega_n}\right)^2}}$$

For systems with rotating unbalance $$MF = \frac{X}{\left(\frac{m_o e}{m}\right)} = \frac{\left(\frac{\omega}{\omega_n}\right)^2}{\sqrt{\left[1-\left(\frac{\omega}{\omega_n}\right)^2\right]^2 + \left(\frac{2\xi\omega}{\omega_n}\right)^2}}$$