Reg. No.										

MANIPAL INSTITUTE OF TECHNOLOGY

MANIPAL

A Constituent Institution of Manipal University

VII SEMESTER B.TECH. (AERONAUTICAL ENGINEERING)

END SEMESTER EXAMINATIONS, NOV/DEC 2016

SUBJECT: THEORY OF VIBRATIONS [AAE 401]

REVISED CREDIT SYSTEM
(23/11/2016)

Time: 3 Hours MAX. MARKS: 50

Instructions to Candidates:

- Answer **ANY FIVE FULL** questions.
- Missing data may be suitable assumed.

1A. A harmonic motion has an amplitude of 0.05 m and a frequency of 25 Hz. Find the time-period, maximum velocity and maximum acceleration. Also, find the average values of displacement, velocity and acceleration. **(03)**

1B. A steel wire (E=1.96x10^{11} N/m^2) is of diameter 2 mm and 30 m long. It is fixed at the upper end and carries M kg at its lower end. Find M so that the frequency of longitudinal vibrations is 4 cycles/second. **(05)**

1C. Derive the natural frequency of a spring-mass SDOF system using Rayleigh's energy method. **(02)**

2A. Show that for finding the natural frequency of a spring-mass system, the mass of the spring can be considered by adding one-third of its mass to the main mass. **(05)**

2B. Given $x(t) = X\cos(100t + \phi)$ mm. The initial conditions are $x(0) = 4$ mm and $\dot{x}(0) = 1$ mm/s. Find the constants X and ϕ. **(03)**

2C. Explain the phenomenon of beats analytically. **(02)**

3A. To save space, two large pipes are shipped one stacked inside the other as indicated in figure-1. Calculate the natural frequency of vibration of the smaller pipe (of radius r) rolling back and forth inside the larger pipe (of radius R). Assume small angle oscillations. Use Newton's laws method and assume that the inside pipe rolls without slipping and has a mass m. **(05)**

3B. Briefly explain the principle Frahm's Reed tachometer. **(02)**

3C. Briefly explain the interfacial damping technique. **(03)**

4A. Under force-vibration conditions, what is the condition for effective isolation? **(02)**

4B. Between a solid mass of 10kg and the floor are kept two slabs of isolators, natural rubber and felt in series. The natural rubber slab has a stiffness of 3000 N/m and an equivalent viscous damping coefficient of 100 N-sec/m. The felt slab has a stiffness of 12000 N/m and an equivalent viscous damping coefficient of 330 N-sec/m. Determine the undamped and damped natural frequencies of the system. Neglect the mass of isolators. **(05)**

4C. Briefly explain the concept of acceleration measurement of an oscillating system. **(03)**

5A. State Maxwell's reciprocal theorem. What are flexibility coefficients? **(02)**

5B. Determine the natural frequencies of the MDOF system by Holzer's method shown in figure-2. Determine the first two natural frequencies. **(05)**

5C. Determine the natural frequencies of the 2DOF system shown in figure-3. **(03)**

6A. Determine the flexibility matrix of the system shown in figure-4 using influence coefficient method **(03)**

6B. Determine the third natural frequency of the system using matrix iteration method. Do three iterations only. **(05)**

6C. Briefly explain the method of Eigen value and Eigen vector approach of determining the natural frequency of MDOF systems **(02)**

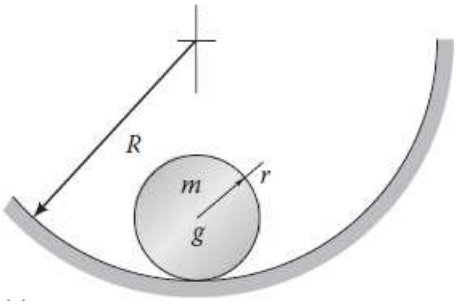

Figure1

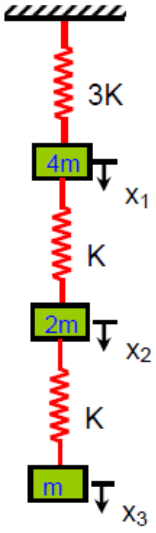

Figure 2

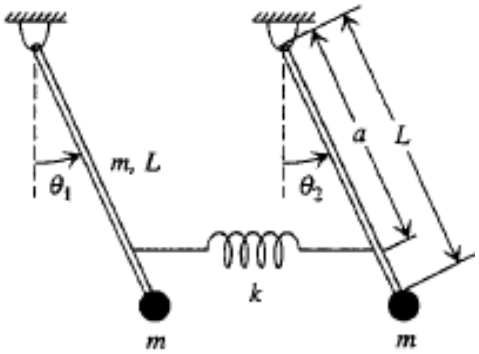

Figure 3

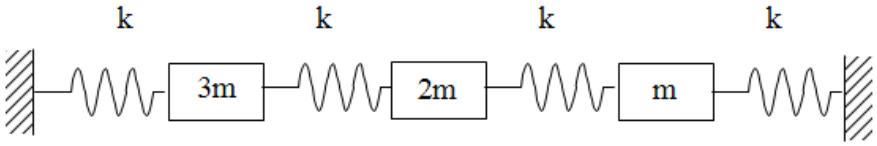

Figure 4

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