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
(26/12/2016)

Time: 3 Hours MAX. MARKS: 50

Instructions to Candidates:

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

1A. A body is subjected to 2 harmonics as shown below. **(03)**

$x_1 = 15\cos(\omega t + \pi/6)$

$x_2 = 8\cos(\omega t + \pi/3)$

What extra harmonic motion is required to bring the body to equilibrium?

1B. Determine the natural frequency of the system shown in figure-1 using energy method. **(05)**

1C. Show that when 2 springs of spring constant "k" are connected in series, the effective spring stiffens of the system is halved. **(02)**

2A. Derive the equations of motion of a spring-mass-dashpot system and find the solution when the system is underdamped. Plot the Displacement-time plots for different damping ratios. **(05)**

2B. Find the algebraic sum of the 2 harmonics **(03)**

$x_1 = 2\cos(\omega t + \pi/3)$

$x_2 = 3\cos(\omega t + 2\pi/3)$

2C. Determine the natural frequency of a torsional pendulum. **(02)**

3A. Determine the natural frequency for small angular displacement of the system shown in figure-2 using Newtonian approach. **(05)**

3B. Briefly explain the principle of accelerometer. **(02)**

3C. Explain the principle of structural damping. **(03)**

4A. Under what conditions a system will become aperiodic? **(02)**

4B. An instrument of 50 kg mass is in an airplane cabin which vibrates at 2000 cpm with an amplitude of 0.1 mm. Determine the stiffness of the four steel springs required as supports for the instruments to reduce its amplitude to 0.005 mm. Also, calculate the maximum total load for which each spring must be designed. **(05)**

4C. Derive the expression of amplitude of vibrations when the system under forced vibration conditions with coulomb damping. **(03)**

5A. Explain how a 2DOF system behaves when the masses are given equal displacement in same direction and unequal displacements in opposite direction? **(02)**

5B. Express the system shown in figure-3 in matrix form in terms of flexibility coefficients **(03)**

5C. Determine the natural frequencies of the MDOF system by Stodola method shown in figure3. Perform at least three iterations. **(05)**

6A. Explain the concept of Dunkerley's approximation method of finding the natural frequency of a MDOF system and find the natural frequency of the system in figure-3 using the same. **(05)**

6B. Explain the principle of centrifugal pendulum absorber **(03)**

6C. What are mode shapes of system? Explain how would you find the mode shape of MDOF using matrix iteration method. **(02)**

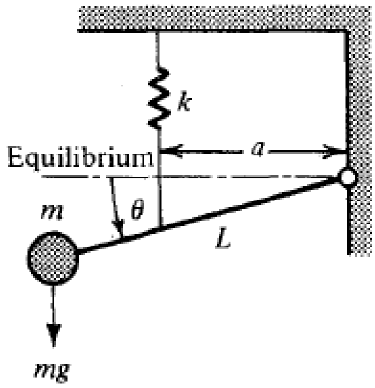

Figure1

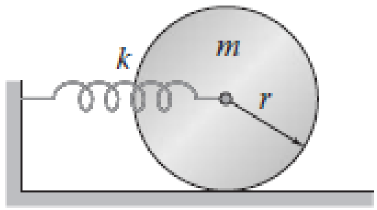

Figure2

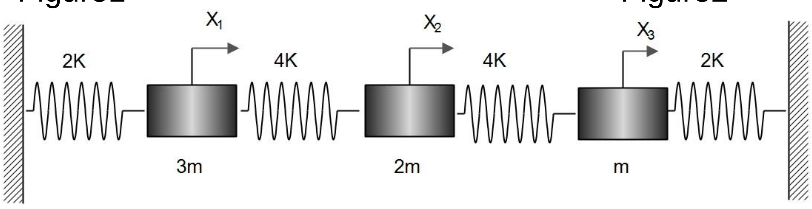

Figure 3

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