Reg. No.										

MANIPAL INSTITUTE OF TECHNOLOGY

MANIPAL

A Constituent Institution of Manipal University

VII SEMESTER B.TECH (MECHATRONICS ENGINEERING)
END SEMESTER EXAMINATIONS, JAN 2017

SUBJECT: MECHANICAL VIBRATIONS [MME 469]

REVISED CREDIT SYSTEM
(06/01/2017)

Time: 3 Hours MAX. MARKS: 50

Instructions to Candidates:

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

1A. For the system shown in ***Fig. Q.1a***) below. $k_1 = 2000\frac{N}{m}, k_2 = 1500\frac{N}{m}, k_3 = 3000\frac{N}{m}$ *and* $k_4 = k_5 = 500\frac{N}{m}$. Find m such that the system has a natural frequency of 10 Hz. **04**

1B. Explain the following: **03**
i) Over damping
ii) Critical damping
iii) Under damping

1C. ***Fig. Q.1c)*** shows a mass of 5 kg suspended in a box by a spring. The box is placed on a platform having vibration y = 10 sin 10t mm. The stiffness of the spring is 10000N/m. Determine the absolute amplitude of the mass. **03**

2A. State and prove Maxwell Reciprocal Theorem. **04**

2B. Two degrees of freedom vibrating system is shown in ***Fig. Q.2b***). Determine, **06**
a) The two natural frequencies of vibrations
b) Ratio of amplitudes of motion of m_1 and m_2 for the two modes of vibration.
c) Locate the nodes for each mode of vibration.

Given: m_1 = 2 kg; m_2 = 1 kg; k_1 = 40 N/m and k_2 = 20 N/m

3A. A single cylinder vertical petrol engine of total mass 320 kg is mounted upon a steel chasis frame and causes a vertical deflection of 0.002 m. The reciprocating parts of the engine have a mass of 24 kg and moves through a vertical stroke of 0.15 m with simple harmonic motion. A dashpot is provided, the damping resistance of which is directly proportional to the velocity and amounts to 490 N at 0.3 m/sec. Determine **04**
i) The speed of driving shaft at which resonance will occur.
ii) Amplitude of steady state forced vibrations when driving shaft of the engine rotates at 480 rpm.

3B. Find the lowest natural frequency of the system shown in ***Fig. 3b)*** by Stodola method. **06**

4A. A shock absorber is to be designed so that its overshoot is 10% of the initial displacement when released. Determine damping factor. If damping factor is made equal to half of the original damping factor what will be the overshoot? **04**

4B. Calculate the influence coefficients for the system shown in ***Fig. Q. 4b).*** **06**

5A. The equation $2\ddot{x} + 12\dot{x} + 50x = 8\sin 10t$ describes a single degree of **05**

forced vibration system. Determine

i) Natural frequency
ii) Damped natural frequency
iii) Damping factor
iv) Amplitude of steady state vibration and phase angle.
v) Ratio of any two successive amplitudes.

5B. Prove that for a compound pendulum of undamped single degree of freedom system is given as $\omega_n = \sqrt{\frac{g\,h}{k^2 + h^2}}$ rad/sec **05**

6A. A U tube manometer has a uniform box of cross section ***A***. If a column of length ***l*** and density $\boldsymbol{\rho}$ is set into motion, find the frequency of the resulting motion. **04**

6B. The support of a spring mass system is vibrating with amplitude of 5 mm and a frequency of 1150 cycles/min. If the mass is 0.9 kg and the spring has a stiffness of 1960 N/m, determine the amplitude of vibration of the mass. What amplitude will result if a damping factor of 0.2 is included in the system? **04**

6C Differentiate between free and forced vibrations. **02**

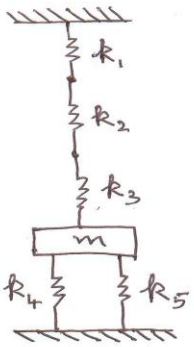

FIG Q. 1a)

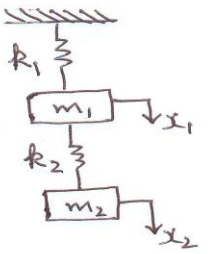

FIG Q. 2b)

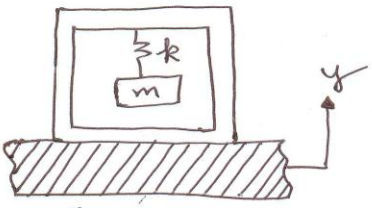

FIG Q. 1c)

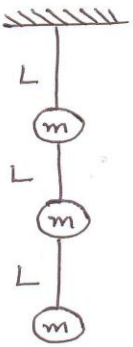

FIG. Q. 4b)

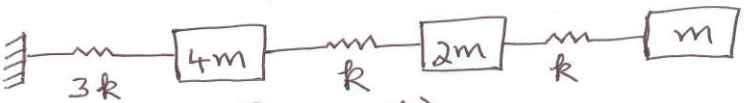

FIG. Q. 3b)