Reg. No.

Manipal Institute of Technology, Manipal

(A Constituent Institute of Manipal University)

VII SEMESTER B.TECH (MECHATRONICS ENGINEERING)

END SEMESTER EXAMINATIONS, NOV/DEC 2015

SUBJECT: MECHANICAL VIBRATIONS [MME 469]

Time: 3 Hours MAX. MARKS: 50

Instructions to Candidates:

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

1A. Derive an expression for the natural frequency and time period of a spring mass system taking the mass of the spring into consideration. **04**

1B. Explain the following: **03**

i) Over damping
ii) Critical damping
iii) Under damping

1C. Obtain the equation of motion and determine the natural frequency of the spring-mass-pulley system shown in ***Fig. Q.1c.*** Assume the cord to be inextensible and no slip between the pulley and cord. **03**

2A. Define logarithmic decrement. Derive expressions for logarithmic decrement in terms of damping ratio. **04**

2B. Calculate all the influence coefficients of the triple pendulum shown in ***Fig. Q.2b.*** **06**

3A. The equation $2\ddot{x} + 12\dot{x} + 50x = 8\sin 10t$ describes a single degree of forced vibration system. Determine **05**

a) Natural frequency
b) Damped natural frequency
c) Damping factor
d) Amplitude of steady state vibration and phase angle.
e) Ratio of any two successive amplitudes.

3B. A section of pipe pertaining to a certain machine vibrates with large amplitude at a compressor speed of 220 rpm. For analyzing this system, a spring – mass system was suspended from the pipe to act as an absorber. A 1 kg absorber mass tuned to 220 cpm resulted in 2 resonant frequencies of 188 and 258 cpm. What must be the mass and the spring stiffness of the absorber if the resonant frequencies are to lie outside the range of 150 to 310 cpm. **03**

3C. Prove that an undamped measuring instrument will show a true response for frequency ratio $\omega/\omega_n = 1/\sqrt{2}$ **02**

4A. What is magnification factor? Derive an expression for the same, sketch and discuss its variation with frequency ratio. **05**

4B. Using the matrix iteration method, determine the lowest natural frequency for the system shown in the ***Fig. Q. 4*** **05**

5A. A mass attached to a spring of 500 N/m stiffness has a viscous damping device. When the mass was displaced and released, the period of vibrations was found to be 1.8 seconds and the ratio of consecutive amplitude was 4:1. Determine the amplitude and phase angle of vibrations when a force F = 20 cos 3t acts on the system. **04**

5B. State and prove Maxwell's reciprocal theorem. **03**

5C. When a system was subjected to damped vibration test the measured frequency was 10 Hz. When the same system was subjected to constant excitation force, the measured peak frequency was 9.6 Hz. Then what is the natural frequency and damping factor of the system? **03**

6A. A spring – mass – damper system has a natural frequency of vibration 10 rad/sec and a damping ratio of 0.5. The system is disturbed from its equilibrium position by giving an initial velocity of 0.1 m/sec. **04**

i) Obtain an expression for the system response.
ii) What will be its displacement when the time elapsed is 2 seconds?

6B. ***Fig. Q.6b*** 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**

6C. 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 **03**

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.

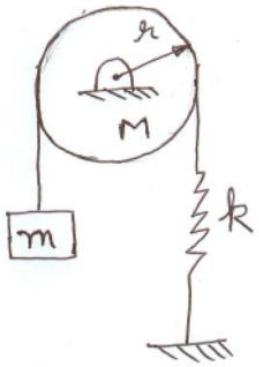

FIG. Q. 1c

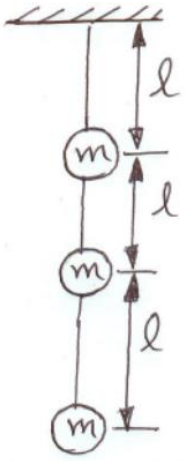

FIG. Q. 2b

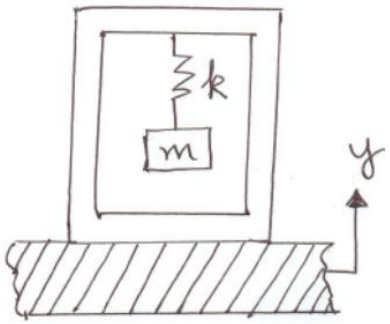

FIG. Q. 6b

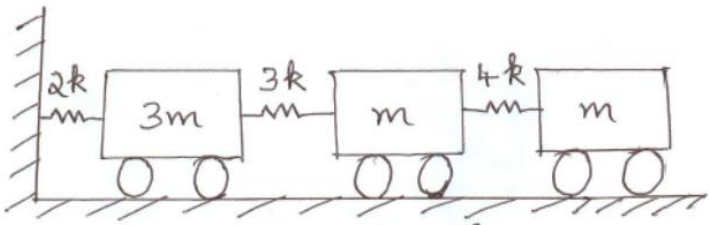

FIG. Q. 4b