Time: 3 Hours **Marks: 80**

Note:

1. **Question No. 1 is compulsory.**
2. **Solve ANY THREE questions from the remaining five questions.**
3. **Assume suitable data wherever required, but justify the same.**

Q.1 Solve ANY FOUR questions from the following: **(20)**

a) Explain the sources of industrial vibration.
b) Discuss Skyhook damping.
c) Explain the significance of material selection in vibration isolation.
d) Explain dynamic vibration neutralizers.
e) Write a note on semi-active isolation.

Q.2 a) A precision machine used for the manufacture of integrated circuits, having a mass of 50 kg, is placed on a work bench (as base). The ground vibration transmitted by a nearby internal combustion engine causes the base (all four corners of the bench) to vibrate at a frequency of 1800 rpm. Helical springs, with a damping ratio of 0.01 and a relationship of bilinear load (P) to deflection (x) given by

$$P = \begin{cases} 50{,}000x; & 0 \le x \le 8 \times 10^{-3} \\ 10^5 x - 4 \times 10^5; & 8 \times 10^{-3} \le x \le 13 \times 10^{-3} \end{cases}$$

where, P in N and x in m are available for use as isolators at the four corners of the base. If no more than 10 percent of the vibration of the base is to be transmitted to the precision machine, determine a method of achieving the isolation. **(12)**

b) Differentiate between classical control and optimal control. **(08)**

Q.3 a) Discuss ground hook control method for Semi-Active tuned vibration absorber. **(10)**

b) Write a short note on Magnetorheological (MR) fluids and explain its different models in dampers. **(10)**

Q.4 a) Explain vibration isolation system with base motion. **(08)**

b) A precision electronic system supported on an elastic pad (with no damping) has a mass of 15 kg and a natural frequency of 20 rad/s. It is estimated that the system requires a damping ratio of 0.85 to control the vibration. Assume that the available dashpots can provide damping constants only in the range 0 to 400 N-s/m. Suggest whether passive vibration control will satisfy the requirements. If not, what would be required damping constant for the active vibration control system? **(12)**

Q.5 a) A structure supporting a rotating machine is found to vibrate excessively at an excitation frequency of 18 Hz. It is proposed to attach a vibration neutralizer tuned to this frequency. What should be the mass and stiffness of the neutralizer so that the resulting two natural frequencies are at least 25% away from the excitation frequency? The supporting structure has an effective mass of 1000 kg and a natural frequency of 15 Hz. **(12)**

b) Discuss the transmissibility characteristics of different types of isolators. **(08)**

Q.6 a) Derive the stiffness of a single acting air spring. **(10)**

b) Discuss the Quarter-Car model of a Vehicle Suspension. **(10)**

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