

INSTRUCTIONS:

1. The question paper contains 5 questions each of 5 marks and total 25 marks.
2. Attempt all questions.
3. The missing data, if any, may be assumed suitably.
4. Tables/Data handbook/Graph paper etc., if applicable, will be supplied to the candidates

- Q.1 A helical spring of stiffness k is cut into two halves, and a mass m is connected to the two halves as shown in Fig. Q.1(a). The time period of this single-DOF system is found to be 0.5 s. If an identical spring is cut so that one part is one-fourth and the other part three-fourths of the original length, and the mass m is connected to the two parts as shown in Fig. Q.1(b), what would be the time period of the system?

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[5] 1 5

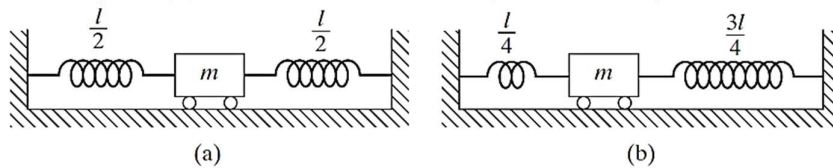


Fig. Q.1

- Q.2 A damped single degree-of-freedom system has $m = 5$ kg, $c = 500$ N-s/m, and $k = 5000$ N/m. Determine the undamped and damped natural frequencies of vibration and the damping ratio of the system. Based on the computed damping ratio, comment on the damping condition of the system, i.e., underdamped or critically damped or overdamped condition.

[5] 1 3

- Q.3(a) Find the natural frequencies of the 2-DOF system shown in Fig. Q3.

[3] 2 3

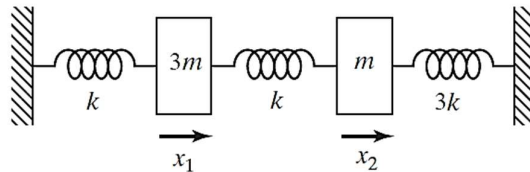


Fig. Q.3

- Q.3(b) For a 2-DOF spring-mass system, describe why identifying the “first” natural frequency of a 2-DOF system is often more crucial than the “second” one from a designer perspective.

[2] 2 2

- Q.4 Find the steady-state response of the system shown in Fig. Q.4 when the mass m_1 is excited by the force $F_1 = F_0 \cos \omega t$. Also, plot its frequency-response curve.

[5] 2 4

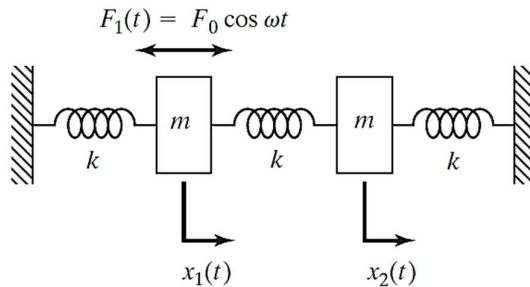


Fig. Q.4

- Q.5 Derive the equations of motion of a generalized multi-degree-of-freedom system in matrix form. For free vibrating undamped multi-degree-of-freedom system, show how the equations of motion can be converted into an eigenvalue problem.

[5] 3 3