INDIAN INSTITUTE OF TECHNOLOGY KHARAGPUR

Department of Mechanical Engineering

Autumn Semester (End Term) Examination 2018- 2019

Number of Students: 68 Date of Examination: 19.11.2018

Subject No.ME60403 Name: VIBRATION ANALYSIS

Time : Three Hours Full Marks. 50

Specializations : DDME3, ME3, Ph.D.

Answer all questions. Figure numbers correspond to problem numbers.

1(a). Apply Rayleigh's method to obtain an estimate of the fundamental natural frequency of transverse vibration of a string of length L fixed at both ends and subjected to a constant tension T. Assume that T does not vary during small deflection. [7]

1(b). A flexible string of length L is fixed at the upper end and is free to oscillate under the influence of gravity, as shown. Obtain the equation of lateral motion. Use only the coordinates shown in the figure. [7]

2(a). A jig is used to size coal contains a screen that reciprocates with a frequency of 600 cpm. The jig mass is 50 kg and has a fundamental frequency of 400cpm. If an absorber having a mass of 12.5 kg is to be installed to eliminate the vibration of the jig frame, determine the absorber spring stiffness. What will be the resulting two natural frequencies of the combined system? [5+2]

Fundamental Frequency 400 CPM

2(b). Given the two matrices

$$M = \begin{bmatrix} 2 & 0 \\ 0 & 1 \end{bmatrix},\ K = \begin{bmatrix} 4 & -1 \\ -1 & 2 \end{bmatrix}$$

of a two D.O.F. system, find the eigenvectors ***without finding the eigenvalues***. **Solution done by solving the standard eigenvalue problem carries no marks.** [5]

3(a). Derive the equation of motion of an Euler-Bernoulli beam for transverse vibration. State the assumptions clearly. Do not solve the equation. [5+2]

3(b). Obtain the expressions of natural frequencies and the mode shapes of a uniform beam pinned at both ends. [8]

4(a). Prove that the flexibility influence coefficient matrix is symmetric in an n-DOF system. [5]

4(b). Determine the damping matrix for the system shown and show that it is not proportional. [4]

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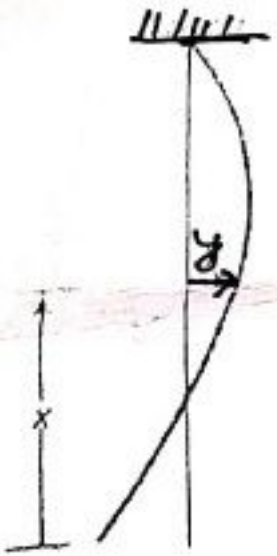

Fig. 1(b)

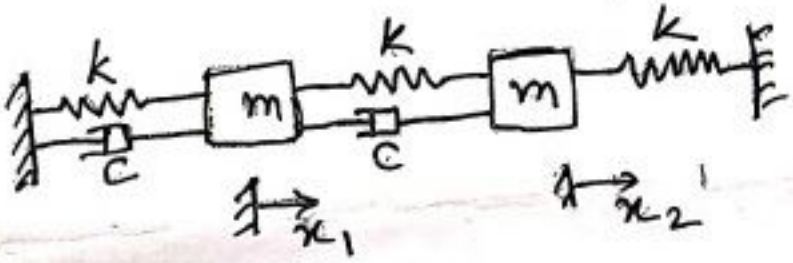

Fig. 4(b)

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