B. Tech.
(SEM. VIII) EXAMINATION, 2006-07
MECHANICAL VIBRATIONS

Time : 3 Hours] [Total Marks : 100

Note : Attempt all questions.

1. Attempt any two parts of the following :

   (a) A gun barrel with mass 600 kg has a recoil spring of 350 kN/m. If the barrel recoils one meter on firing, find :

      (i) initial recoil velocity of the gun.

      (ii) the critical damping coefficient of a dashpot which is engaged at the end of the recoil stroke.

   (b) A refrigeration unit operating at 600 rpm and mass 35 kg is to be supported by 3 springs of kN/m. If only 10% (percent) of the shaking force of the unit is to be transmitted to this structure, what should be the value of k. Assume damping coefficient as 0.05.

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(c) Explain the resonance curve method of measurement of damping in a system.

2 Attempt any two parts of the following:

(a) Describe the principle of dynamic vibration absorber and derive necessary condition.

(b) Considering appropriate example, derive the necessary expressions for response of two degree of freedom far coupled undamped system using influence coefficient method.

(c) A motor drives a pulley mounted overhanging on a shaft as shown in Fig. 1. Determine the critical speeds of the motor pulley system.

Fig. 1
Attempt any four parts of the following:

(a) Explain the principle of mode shapes.

(b) Derive the relation for degenerated system using modal analysis.

(c) Referring to Fig. 2, prove that modal vectors are orthogonal with respect to mass matrix and stiffness matrix and then determine the decoupled equations.

\[ m_2 = 500 \text{ kg}, \]
\[ k_2 = 15 \text{ MN/m}, \]
\[ m_1 = 15 \text{ Tonnes}, \]
\[ k_1 = 9 \text{ MN/m}. \]

Fig. 2
(d) What is proportional damping? Discuss modal analysis for multi degree of freedom damped system with proportional damping.

(e) For a motor-pulley system if motor develops an unbalance of 0.025 kgm, determine amplitudes of rotor and pulley at an operating speed of 500 rpm by the method of modal analysis. Refer Fig. 3.

\[ m_1 = 55 \text{ kg} \]
\[ m_2 = 15 \text{ kg} \]
\[ l = 0.4 \]
\[ d = 3 \text{ cm} \]
\[ EI \text{ (shaft)} = 8400 \text{ N/m}^2 \]

Fig. 3
(f) Describe impedance method to determine response of a multi degree of freedom system.

4 Attempt any four parts of the following:

(a) Derive the Dunkerley's equation to find out fundamental frequency of structure.

(b) Explain the method of transfer function with some suitable example.

(c) A steam turbine blade of length $l$, can be considered as a uniform cantilever beam mass $m$ per unit length, with a tip mass $M$ as shown in Fig. 4. The flexural rigidity of the blade is $EI$. Determine the fundamental frequency by Rayleigh's method. In fundamental mode, assume the mode shape as $y(x, t) = \hat{y}(x) \cos pt$ where

$$\hat{y}(x) = A \left(1 - \cos \frac{\pi x}{2l}\right).$$
(d) Write short notes on:
   
   (i) Self excited vibrations
   
   (ii) Secondary critical speed.

(e) Analyse the system shown in Fig. 5 (a) by Laplace transform. The excitation is shown in Fig. 5 (b).
Fig. 5 (b)

$m = 40 \text{ kg, } k = 100 \text{ kg/m, } F_1 = 10 \text{ kg.}$

(f) Discuss in detail the Raileigh-Ritz method.