Exam Date & Time: 18-Jun-2024 (02:30 PM - 05:30 PM)



# **MANIPAL ACADEMY OF HIGHER EDUCATION**

## B.TECH MAKE UP EXAMINATIONS THEORY OF VIBRATIONS [AAE 3254]

#### Marks: 50

#### **Duration: 180 mins.**

(4)

A

### Answer all the questions.

Instructions to Candidates: Answer ALL questions Missing data may be suitably assumed

1) A body is subjected to the following 2 harmonics

 $X_1 = 15 \cos(wt + pi/6)$ 

A)  $X_2 = 8 \cos(wt + pi/3)$ 

What extra motion should be given to the body to bring it to static equilibrium?

- B) An instrument has a natural frequency of 10 Hz. It can stand a maximum acceleration of 10 m/sec<sup>2</sup>. Find the amplitude. (3)
- C) Determine the natural frequency of the following system shown in figure 1 considering (3) very small displacements.



Figure 1

- A tightly wound helical spring is made of 18 mm diameter bar spring steel (G=80 GPa). The spring has 80 active coils with a coil diameter of 16 cm. What is the change in length of spring when it vertically hangs with one end fixed and other is loaded with 200 (3)
  A) kg weight?
  - B) Elucidate the working principle of Frahm Reed Tachometer.

(3)

- C) A spring mass dashpot system consists of spring of stiffness 343 N/m and the mass is 3.43 kg. The mass is displaced by 2cm beyond the equilibrium position and released. Find the equations of motion of the system if the damping coefficient of the system is 137.2 Ns/m and 68.6 Ns/m.
- A mass of 100kg is supported on an isolator having spring scale of 19600N/m and viscous damping of constant 98 Ns/m It is acted upon by a harmonic force of 39.2 N at the undamped natural frequency. Determine the undamped natural frequency and the (3) amplitude of vibration of the mass.
  - B) A system of beams supports a motor of mass 1200 kg. The unbalance in the motor weighs 1 kg located at 6cm radius. The resonance occurs at 2210 rpm. What is the amplitude of vibration at 1440 rpm if the damping is assumed to be less than 0.1? (3)
  - C) A 1000 kg machine is supported on 4 isolators of total spring constant 1.96x10^6 N/m and having negligible damping. The machine is subjected to a harmonic force of amplitude 490 N at 180 rpm. Determine the amplitude of motion of the machine and maximum force transmitted to the foundation. (4)
- 4) Determine the natural frequencies of system shown in figure 2 below.

A)



Figure 2

B) Draw the mode shapes of the system shown in figure 2.

(2)

C) Determine the flexibility coefficient matrix of the system shown in figure 3 by influence (4) coefficient method. Consider  $k_{1}=k$ ,  $K_{2}=2k$ ,  $k_{3}=3k$  and  $k_{4}=4k$ . Take  $m_{1}=3m$ ,  $m_{2}=2m$  and  $m_{3}=m$ .



Figure 3

- 5) Explain how it possible to compute the natural frequencies of the system shown in figure 3 by making use of Holzer's method. (3)
  - A)
  - B) Determine the 1<sup>st</sup> natural frequency of the system shown in figure 3 by Method of matrix iteration and consider the first approximation for displacements as 1:2:3. (5)
  - C) Assess the significance of flexibility influence coefficient in computing the natural frequency of Multi degree freedom systems (2)

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