10ME72

Seventh Semester B.E. Degree Examination, Dec.2016/Jan.2017
Mechanical Vibrations

Time: 3 hrs.   Max. Marks:100

Note: *1. Answer FIVE full questions, selecting*
at least TWO questions from each part.
2. Missing data may be suitably assumed.

PART – A

1 a. Add the following harmonic motions analytically and check the solution graphically:
$x_1 = 4 \cos(wt + 10°)$, $x_2 = 6 \sin(wt + 60°)$. **(10 Marks)**

b. Represent the periodic motion given in the Fig.Q.1(b) by harmonic series. **(10 Marks)**
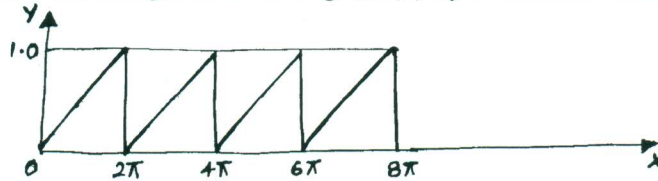

Fig.Q.1(b)

2 a. Determine the natural frequency of spring-mass system taking the mass of the spring in to account. **(10 Marks)**

b. Using energy method find the natural frequency of the system shown in the Fig.Q.2(b). **(10 Marks)**
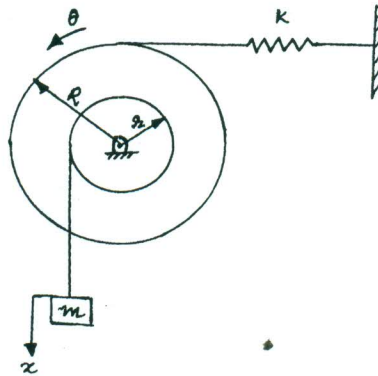

Fig.Q.2(b)

3 a. Obtain the response of viscous damped system for critically damped case. **(10 Marks)**

b. The disc of a torsional pendulum has a moment of inertia of 0.06kg m^2 and is immersed in a viscous fluid. The brass shaft attached to it is of 100mm diameter and 400mm long when the pendulum is vibrating. The observed amplitude on the same side of neutral position for the successive cycles are 9°, 6° and 4°. Determine:
i)   Logarithmic decrement.
ii)   Damping torque at unit velocity.
iii)   Periodic time of vibration.
iv)   The frequency if the pendulum is removed from the viscous fluid.
Assume for brass shaft G = 4.4×10^{10} N/m². **(10 Marks)**

4 a. Show that for a spring mass damped system the peak amplitude occurs at a frequency ratio given by the expression $\frac{W}{W_n} = \sqrt{1 - 2\xi^2}$, when the system is excited by a harmonic force.

Also determine the expressions for peak amplitude and the corresponding phase angle.

(10 Marks)

b. A machine of mass one tonne is acted upon by an external force of 2450N at a frequency of 1500 rpm. To reduce the effects of vibration isolator of rubber having a static deflection of 2mm under the machine load and an estimated damping factor of 0.2 are used. Determine:
   i)   Force transmitted to the foundation.
   ii)   Amplitude of vibration of the machine.
   iii) Phase lag of the transmitted force with respect to the external force.   (10 Marks)

PART – B

5 a. Explain Frahm's reed tachometer.   (05 Marks)

b. Explain Vibrometer.   (05 Marks)

c. A horizontal shaft of 25mm diameter carries a mass of 12kg mounted midway. The shaft is supported at the ends by two bearings. The span between the bearings is 900mm. The mass centre is 0.02mm from the axis of the shaft. Determine the amplitude of steady state vibrations and the dynamic force on the bearings when the shaft rotates at 3000 rpm. Take E = 200GPa. Neglect damping and mass of shaft.   (10 Marks)

6 a. What is a "Semi definite system"? Explain.   (08 Marks)

b. Determine the natural frequencies of the system as shown in the Fig.Q.6(b) if $k_1 = 4c \times 10^3$ N/m, $k_2 = 50 \times 10^3$ N/m, $k_3 = 60 \times 10^3$ N/m, $m_1 = 10$kg, $m_2 = 12$kg, $r_1 = 0.10$m and $r_2 = 0.11$m.   (12 Marks)
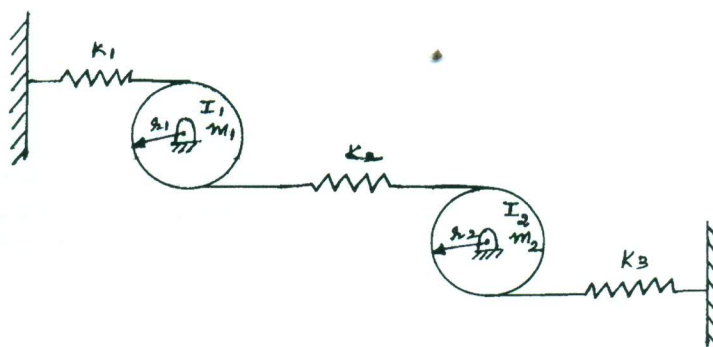

Fig.Q.6(b)

7 a. Using Stodala's method find the natural frequencies of the four mass system as shown in Fig.Q.7(a) if k = 1 N/m and m = 1kg. **(15 Marks)**
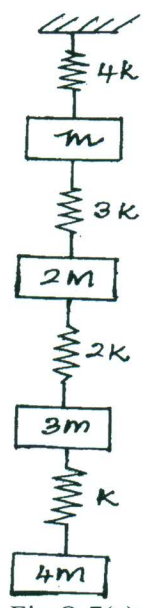

Fig.Q.7(a)

b. Use Dunkerley method to find the fundamental natural frequency of transverse vibration for the system shown in Fig.Q.7(b). **(05 Marks)**
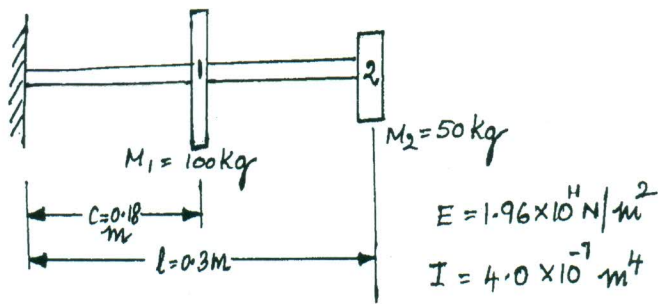

$M_1 = 100 kg$

$M_2 = 50 kg$

$C = 0.18 m$

$l = 0.3 M$

$E = 1.96 \times 10^{11} N/m^2$

$I = 4.0 \times 10^{-7} m^4$

Fig.Q.7(b)

8 a. Briefly explain the hardware of an equipment necessary for experimental modal analysis. **(10 Marks)**

b. Explain machine condition monitoring techniques. **(10 Marks)**

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