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*Total No. of Questions :8]* *[Total No. of Printed Pages :3*

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# MMPD-104

## M.E./M.Tech., I Semester

Examination, June 2016

## Theory of Vibration

***Time : Three Hours***

***Maximum Marks : 70***

***Note :*** i) Attempt any five questions.
ii) All questions carry equal marks.

1. a) Show that for finding the natural frequency of torsional oscillations of a shaft and disc system, the inertia of the shaft can be taken into account by adding one-third the inertia of the shaft to that of the disc. 7

   b) Two dashpots of coefficients $C_1$ and $C_2$ are connected in (i) series (ii) parallel. Find their equivalent damping coefficients from first principles. 7

2. a) Derive the differential equation characterising the motion of an oscillation system subject to viscous damping and no periodic external force. 7

   b) The measurements on a mechanical vibrating system. Show that it has a mass of 8 kg and that the springs can be combined to give an equivalent spring of stiffness 5.4 N/mm. If the vibrating system have a dashpot attached which exerts a force of 40 N when the mass has a velocity of 1 m/sec, find : 7

   i) Critical damping coefficient

   ii) Damping factor



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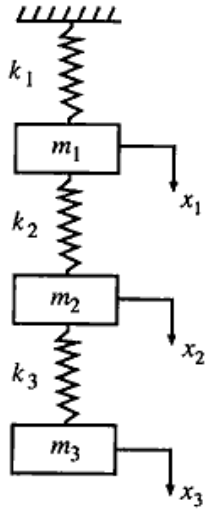
3. For the system shown below :




a) Write three differential equations of motion by Newton's second law of motion and put them in matrix form. 7

b) Find flexibility matrix and write the differential equation of motion in terms of flexibility matrix. 7

4. a) For a simply supported beam of length '$l$' and of uniform cross-section, find the first natural frequency of transverse vibration by Rayleigh's method. 7

b) Explain Stodola's method. 7

5. a) Prove that the principle of superposition does not hold good for non-linear differential equation. Take a specific differential equation. 7

b) Explain Jump Phenomenon. 7



Contd...




6. Take the case of an overdamped single degree of freedom system with $\omega_n = 10$ and $\zeta = 2$. Sketch the phase-plane plot by the method of isoclines for a set of initial conditions that makes the mass cross the equilibrium position from positive '$x$' to negative '$x$'. Assume any other data necessary. 14

7. Three stationary processes are defined as written $X(t) = \sin(wt + n)$, $Y(t) = \cos^2(wt + y)$ and $Z(t) = X(t) + Y(t)$, in which $x$ and $y$ are random phase angles with a uniform joint distribution between $\{-\pi \le x \le \pi\}$ and $\{-\pi \le y \le \pi\}$ calculate :

i) Expected value of $X(t)$, $Y(t)$ and $Z(t)$.

ii) Auto and cross-correlation functions of $X(t)$, $Y(t)$ and $Z(t)$.

iii) Show that these processes are ergodic.

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8. Explain the following (any three) : 14

a) Self excited vibrations

b) Narrow band and wide band random process

c) Maxwell's reciprocal theorem

d) Vibration isolation and transmissibility

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