Registration No: | | | | | | | | | | |

Total Number of Pages: 03 **M.TECH**

P2MDCC11

2^{nd} Semester Regular Examination 2016-17
MACHINE VIBRATION
BRANCH: MACHINE DESIGN, MECH. SYSTEM DESIGN, SYSTEM DESIGN

Time: 3 Hours

Max Marks: 100

Q.CODE: Z971

Answer Question No.1 which is compulsory and any FOUR from the rest.
The figures in the right hand margin indicate marks.

Q1 **Answer the following questions:** ***Short answer type*** **(2 x 10)**

a) Differentiate between Lumped Parameter and Distributed Parameter Vibration System.

b) Two spring elements k_1 and k_2 are arranged in parallel and the combination is in series with a third spring k_3. What is the equivalent spring stiffness of the system ?

c) Draw and briefly explain the Frequency response in a single degree of freedom damped vibration system with a harmonic force excitation.

d) What do you mean by normal modes and orthogonality of normal modes.

e) What do you mean by whirling of rotating shaft and critical speed.

f) What do you mean by coulomb damping.

g) Define the flexibility and stiffness influence coefficients in vibration systems.

h) Briefly explain Coordinate coupling in vibrating systems.

i) Briefly explain Rayleigh's principle in vibrating systems

j) A harmonic motion has a frequency of 15 cycles/second and its maximum velocity is 5 m/s. Determine its amplitude, period and maximum acceleration.

Q2 **a)** Define (a) natural frequency and (b) resonance of a vibratory system. A circular cylinder of mass *m* and radius *r* is connected by a spring of modulus *k* as shown in Figure 1. If it is free to roll on the rough surface without slipping, find the equation of motion and its natural frequency. **(10)**

b) A single-degree-of-freedom viscously damped system is composed of a mass of 10 kg, a spring having a spring constant of 2000 N/m, and a dashpot having a damping constant of 50 N-s/m. The mass of the system is acted on by a harmonic force $F = F_0 \sin \omega t$ having a maximum value of 250 N and a frequency of 5 Hz. Determine the complete solution for the motion of the mass. **(10)**

Q3 a) Define viscous damping coefficient, damping factor and Logarithmic decrement. It is observed that the vibration amplitude of a damped single-degree-of-freedom system falls by 50 percent after five complete cycles. Assume that the system is viscously damped. Calculate the logarithmic decrement and the damping factor. **(10)**

b) What is transmissibility. A machine of a mass 100 kg is mounted on springs and a damper. The total spring stiffness is 50,000 N/m and the damping factor is 0.20. A harmonic force$F$ = 500 sin13.2$t$acts on the mass. For the sustained or steady-state vibration of the system, determine: (a) the amplitude of the motion of the machine (b) its phase with respect to the exciting force (c) the transmissibility (d) the maximum dynamic force transmitted to the foundation and the (e) the maximum velocity of the motion. **(10)**

Q4 a) With a neat schematic diagram, explain the principle of working of the vibration measuring instruments. Explain the working principle of vibrometers and accelerometers along with their difference. **(10)**

b) For the 2-degree of freedom vibratory system shown in Figure 2, with m_1 = m, m_2 = 2m, k_1 = k_2 = k, k_3 = 2k, evaluate the equations of motion, the natural frequencies and mode shapes. The vibration displacements are along the spring-mass orientation. x_1 is the displacement of mass m_1 and x_2 the displacement of mass m_2 . **(10)**

Q5 a) A cylinder of weight *w* and radius *r* rolls without slipping on a cylindrical surface of radius *R*, as shown in Figure 3. Determine the differential equation of motion for small oscillations about the lowest point and the natural frequency of oscillation. **(10)**

b) In the transverse vibration of a string, how the energy storage and release is ensured. Derive the equation of motion for the free transverse vibration of a taught string, whose mass per unit length is *m*(*x*), tension *T*, external distributed force per unit length *p*(*x*). **(10)**

Q6 a) Derive the general expressions for the equations of motion of a beam in transverse vibration and evaluate the expressions for frequency equation, natural frequencies and mode shape of a hinged-hinged beam in transverse vibration. **(10)**

b) For a 2-DOF system given by $\begin{bmatrix} 2m & 0 \\ 0 & m \end{bmatrix}\begin{Bmatrix} \ddot{x}_1 \\ \ddot{x}_2 \end{Bmatrix} + \begin{bmatrix} 3k & -k \\ -k & k \end{bmatrix}\begin{Bmatrix} x_1 \\ x_2 \end{Bmatrix} = \begin{Bmatrix} 0 \\ 0 \end{Bmatrix}$, evaluate the characteristic equation, natural frequencies and mode shapes. **(10)**

Q7 a) Explain the steps involved in the Matrix Iteration Method used in machine vibration illustrating with an example. **(10)**

b) Find out the equation of motion of the damped forced system by Lagrange’s method (Figure 4). The intermediate bar is rigid and massless. **(10)**

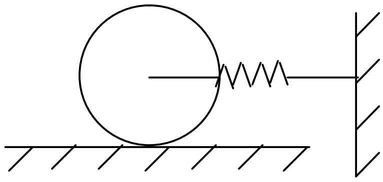

Figure 1

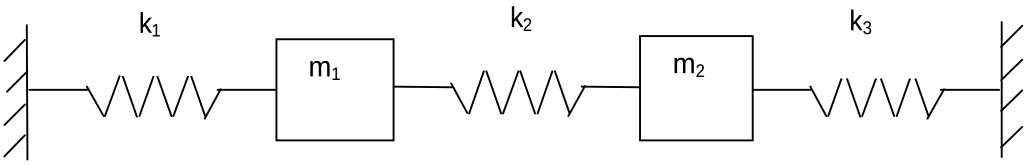

Figure 2

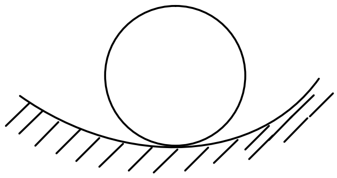

Figure 3

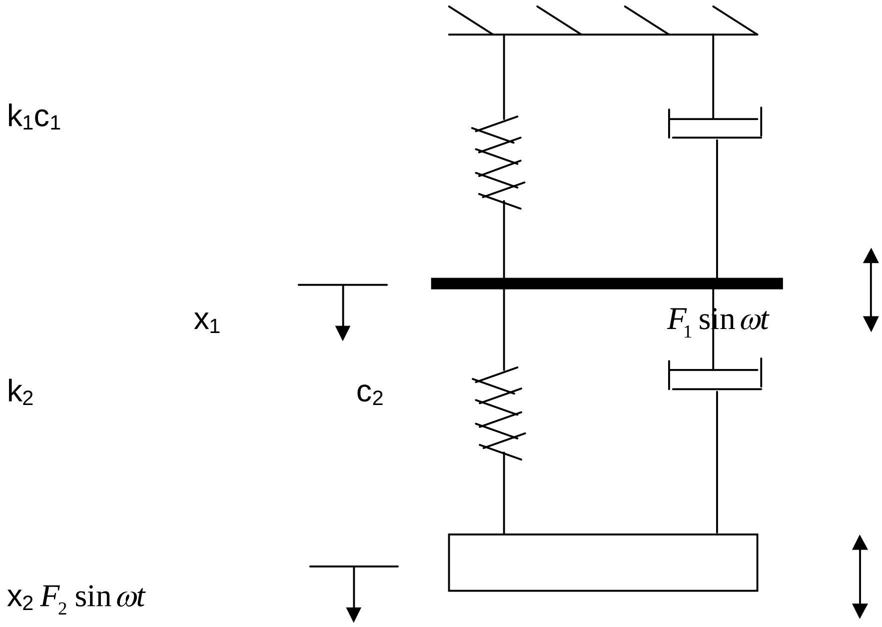

Figure 4