B Total Pages **4**

Register No: .... Name: ....

SAINTGITS COLLEGE OF ENGINEERING
KOTTAYAM, KERALA

(AN AUTONOMOUS COLLEGE AFFILIATED TO
APJ ABDUL KALAM TECHNOLOGICAL UNIVERSITY, THIRUVANANTHAPURAM)

FIRST SEMESTER M.TECH. DEGREE EXAMINATION(R), MARCH 2021

(MACHINE DESIGN)

Course Code: 20MEMDT103

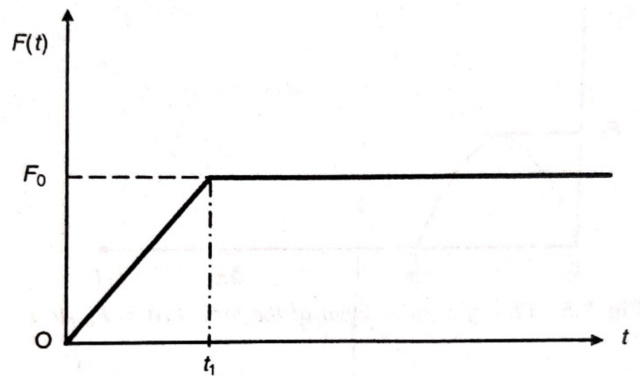
Course Name: THEORY OF VIBRATIONS

Max. Marks: **60** **Duration:** **3 Hours**

PART A

(Answer all questions. Each question carries 3 marks)

1. Deduce the torsional equation of motion of a rotor connected to a shaft.
2. Explain critical damping coefficient and damping ratio.
3. Obtain the response to a reciprocating unbalance.
4. Derive the response of a spring mass damper system to a general periodic forcing function F(t).
5. Determine the forced response of the undamped SDOF system subjected to the rising time forcing function as shown in the figure.



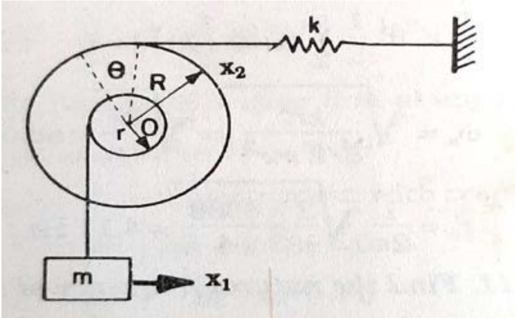
6. Derive the expression for the response to an impulse excitation.
7. Briefly explain coordinate coupling.
8. Briefly explain a semi-definite system.

PART B

(Answer one full question from each module, each question carries 6 marks)

MODULE I

9. Determine the natural frequency of the system shown in the figure. (6)

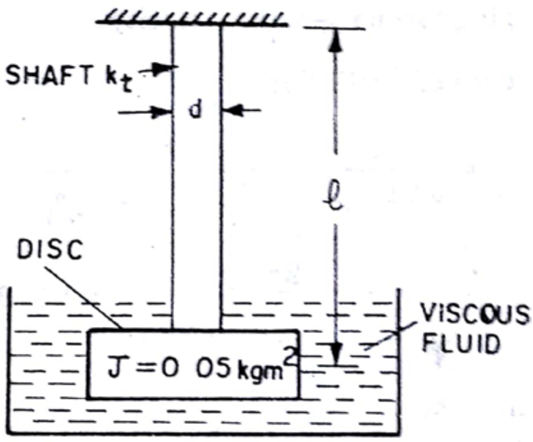


OR

10. A block of mass 0.0647 Kg is suspended from a spring having stiffness of 50 N/m. The block is displaced downwards from its equilibrium position through a distance of 2cm and released with an upward velocity of 3cm/s. Determine (i) the natural frequency (ii) the period of oscillation (iii) the maximum velocity (iv) the maximum acceleration and (v) the phase angle. (6)

MODULE II

11. The torsional pendulum with a disc of moment of inertia J = 0.05 Kgm^2 immersed in a viscous fluid as shown in the figure. During vibrations of the pendulum, it is observed that the amplitudes on same side of the neutral axis for successive cycles are found to decay by 50% of the initial value. Determine (i) logarithmic decrement, (ii) damping torque per unit velocity, (iii) periodic time of vibration, and (iv) the frequency when the disc is removed from the fluid. Assume G = 4.5 x 1010 N/m^2 for the material of the shaft, d = 0.10m, l = 0.50m, M.I. of the disc = 0.05 kgm^2. (6)



OR

12. A weight of 50N is suspended from a spring of stiffness 5000 N/m and is subjected to a harmonic force of amplitude 40N and frequency of 4 Hz. Find the (i) extension of (6)

the spring due to the suspended weight (ii) the static displacement of the spring due to the maximum applied force and (iii) the amplitude of the forced motion of the weight.

MODULE III

13. A machine of mass one tonne is acted upon b an external force of 2450 N at a frequency of 1500 rpm. To reduce the effects of vibration an isolator of rubber having a static deflection of 2 mm under the machine load and an estimated damping ratio of 0.2 are used. Determine (i) the force transmitted to the foundation (ii) the amplitude of vibration of machine, and (iii) the phase lag. (6)

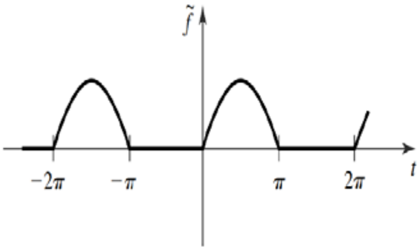
OR

14. A 50 Kg mass is attached to a base through a spring in parallel with a damper. The base undergoes harmonic excitation of *y(t)* = 0.20 sin30t. The stiffness of the spring is 30000 N/m and the damping constant is 200 Ns/m. Determine the amplitude of the absolute displacement of the mass and the amplitude of its displacement relative to its base. (6)

MODULE IV

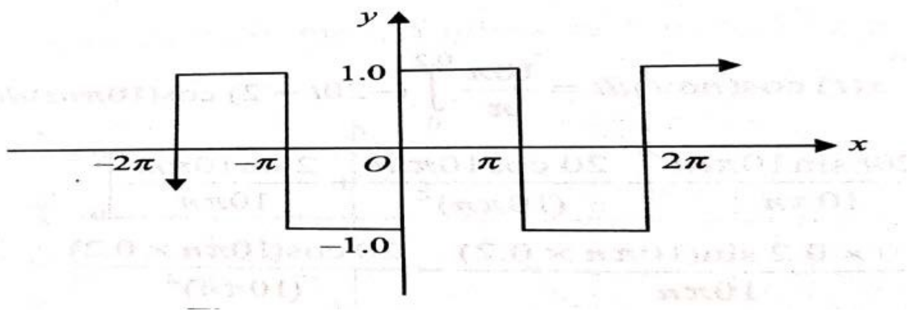
15. Derive the equivalent harmonic series for the function given by (6)

$$f(t) = \begin{cases} \sin t, & 0 \le t \le \pi \\ 0, & \pi \le t \le 2\pi \end{cases}$$



OR

16. Represent the periodic signal as the sum of harmonic series. (6)

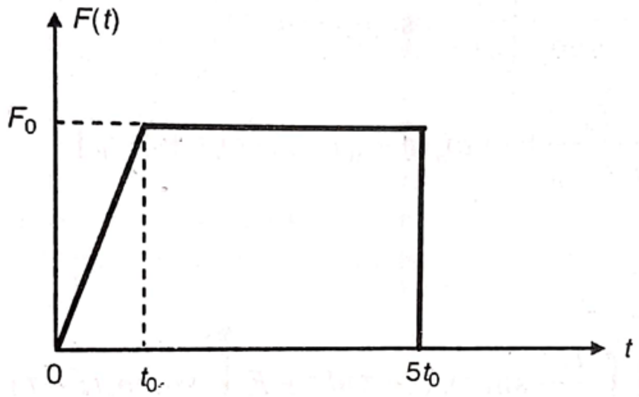


MODULE V

17. Determine the equation of motion of a spring mass damper system for free vibration. Solve using Laplace Transform and obtain the solution given: *m*= 10Kg, *k* = 1000 N/m, *c* = 100Ns/m, *x(0)* =0.001m, *v(0)* = 0.10 m/s. (6)

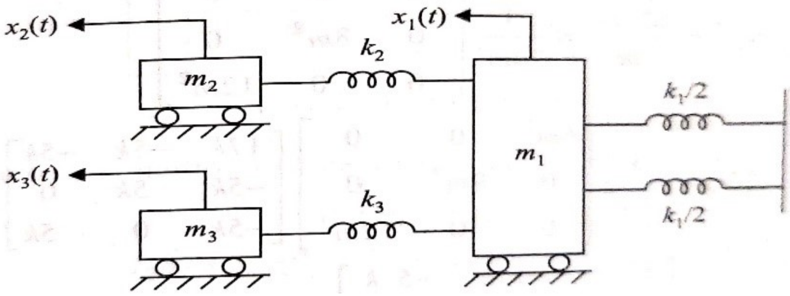
OR

18. Find the response of an undamped, single degree of freedom system subjected to a forcing function given by (6)



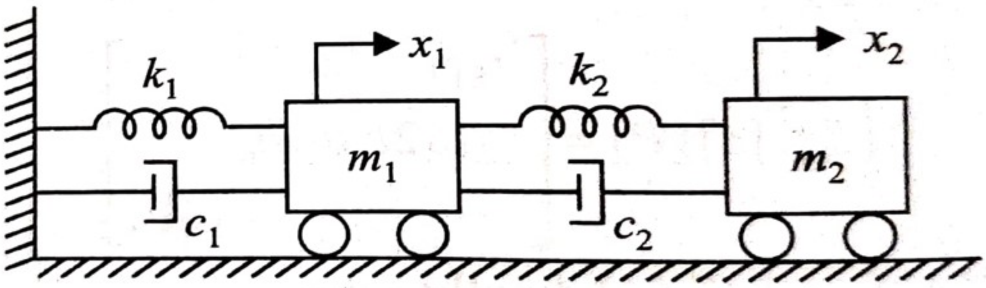
MODULE VI

19. Analyze the lowest natural frequency of the system shown in figure. Assume $k_1 = 7k$, $k_2 = 5k$, $k_3 = 5k$ and $m_1 = 4m$, $m_2 = 3m$, $m_3 = 2m$ (6)



OR

20. For the damped two degree of freedom system shown in the figure, analyze the vibratory response of the masses for the initial condition $(x_1)_{t=0} = 1$, $(x_2)_{t=0} = 2$ and $(v_1)_{t=0} = 0$, $(v_2)_{t=0} = 0$. Take $m_1 = m_2 = m$ and $k_1 = k_2 = k$. (6)



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