Question Bank

Subject – BTCVSS802E_Structural Dynamics

Module 1

1. Define the following terms
    a) Degrees of freedom,
    b) Undamped system,
    c) Frequency and Period
    d) Amplitude of motion
    e) Stiffness and Flexibility
    f) Damping
    g) Inelastic systems
2. Explain the assumptions considered for analytical or mathematical Model?
3. Draw and explain an analytical model for one degree freedom system? Also draw free body diagram of it?
4. Derive equations to calculate effective stiffness when springs are in series and in parallel.
5. Derive and explain the differential equation for a body vibrating along horizontal axis and for a body moving vertically as shown in Fig 5.1 and 5.2

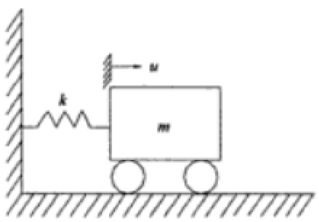


Fig. 5.1

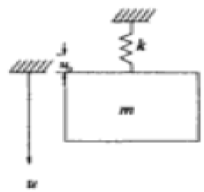


Fig. 5.2

6. Derive the equation of motion of the weight w suspended from a spring at the free end of the cantilever steel beam shown in Fig. 6.1 For steel, E = 29,000 ksi. Neglect the mass of the beam and spring

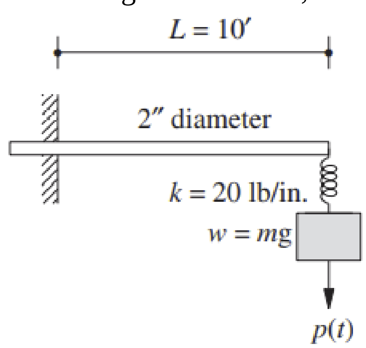


Fig 6.1

7. Derive the equation governing the free motion of a simple pendulum (Fig. 7.1), which consists of a point mass m suspended by a light string of length L.

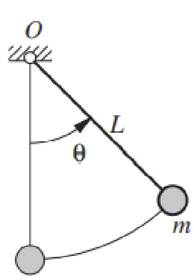


Fig 7.1

8. The system of Fig. 8.1 consists of a weight w attached to a rigid massless bar of length L joined to its support by a rotational spring of stiffness k. Derive the equation of motion. Neglect rotational inertia and assume small deflections. What is the buckling weight?
9. Derive the natural frequency of the beam spring system shown in fig 9.1 consisting of a weight of W = 50 N attached to a horizontal cantilever beam through the coil spring k_2 . The cantilever beam has a thickness h = ¼ inch, width b =1 inch. Modulus of elasticity E = 30 * 10^6 psi, and length 1250 mm. The coil spring has a stiffness k_2 = 100 N/mm.

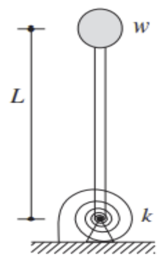


Fig 8.1

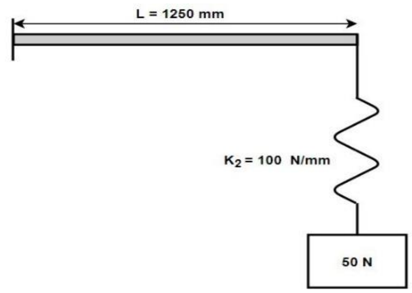


Fig. 9.1

10. An undamped SDOF System having mass 100 kg and stiffness 225 kN/m is given an initial displacement of 100 mm, and initial velocity of 125 mm/sec. Find the a) Natural Frequency, b) Period of vibration, c) amplitude of vibration.
11. A Water tank is set to vibrate freely. Amplitude of vibration reduces from 0.25 to 0.15 m in 8 cycles is 1.6 second. Find the damping of the system & damped natural period?
12. A free Vibration test is conducted on an empty elevated water tank. A Cable is attached to the tank applies a lateral force of 75 kN and pulls the tank horizontally by 5 cm. The cable is suddenly cut, and the resulting free vibration is recorded. At the end of 4 complete cycles, the time is 2 second and amplitude is 2.5 cm. Take acceleration due to gravity as 10 m/s^2.Calculate a) Damping ratio, b) Natural Period of undamped vibration
13. Consider SDOF System. It undergoes undamped free vibration. Mass = 40 kN and Stiffness = 3500 kN /m. If the initial displacement is 0.01m and initial velocity is 0.1 m/sec. Calculate a) Natural frequency, b) Natural period.
14. Consider a driver weighing 90 Kg at the end of a diving board that cantilevers out of a fixed support by 1 m. The driver oscillates at a frequency of 2 Hz. Calculate flexural rigidity of driving board?
15. Consider SDOF System having mass 5 kg, Damping 10 N-s/m, and Stiffness 20 N/m. What will be the undamped and undamped natural frequency?
16. For a system with damping ratio of 5 %, Find the Number of free vibration cycles required to reduce the displacement amplitude to 10% of the Initial amplitude?
17. Consider SDOF System having mass 5 kg, damping 10 N-s/m, and Stiffness 20 N/m. Identify the System?
18. Determine the effective stiffness of the combined spring and write the equation of motion for the spring–mass systems shown in 18.1.

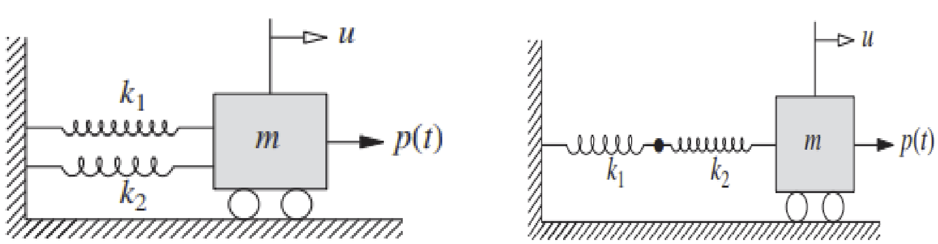


Fig. 18.1

Module 2

1. Explain undamped free vibration and derive an equation of motion for it.
2. Consider SDoF System. It undergoes undamped free vibration. Mass = 40 kN and stiffness = 3500 kN/m. Determine the a) Natural frequency, b) Natural period if the initial displacement is 0.01 m and initial velocity is 0.1 m/s.
3. A Portal frame supports a machine that exerts a sinusoidal force of 8.5 kN at a frequency of 1.75 Hz. The mass of the machine is 4000 kg and is added to that of the time of the frame. The mass of the frame at the floor level is 5000 kg and lateral stiffness of the frame is 4 x 10^{6} N/m. Calculate the applied force?
4. A Portal frame supports a machine that exerts a sinusoidal force of 8.5 kN at a frequency of 1.75 Hz. The mass of the machine is 4000 kg and is added to that of the time of the frame. The mass of the frame at the floor level is 5000 kg and lateral stiffness of the frame is 4 x 10^{6} N/m. Calculate the natural and forcing frequency of the system?
5. A Portal frame supports a machine that exerts a sinusoidal force of 8.5 kN at a frequency of 1.75 Hz. The mass of the machine is 4000 kg and is added to that of the time of the frame. The mass of the frame at the floor level is 5000 kg and lateral stiffness of the frame is 4 x 10 6 N/m. Calculate the Maximum static deflection of the system?
6. A Portal frame supports a machine that exerts a sinusoidal force of 8.5 kN at a frequency of 1.75 Hz. The mass of the machine is 4000 kg and is added to that of the time of the frame. The mass of the frame at the floor level is 5000 kg and lateral stiffness of the frame is 4 x 10 6 N/m. At Resonance, Calculate the steady state amplitude of vibration?
7. A Delicate instrument weighing 0.45 kN is to be mounted on a rubber pad to the floor of a test laboratory where the Vertical acceleration 0.1 g at a frequency of 10 Hz. It has been determined experimentally that the ratio of the stiffness K to the damping coefficient C = 100(1/sec) for the type of rubber pad material used in the isolation. If the acceleration transmitted to the instrument is 0.01 g for 10% of damping. Calculate the Frequency Ratio?
8. A Delicate instrument weighing 0.45 kN is to be mounted on a rubber pad to the floor of a test laboratory where the Vertical acceleration 0.1 g at a frequency of 10 Hz. It has been determined experimentally that the ratio of the stiffness K to the damping coefficient C = 100(1/sec) for the type of rubber pad material used in the isolation. If the acceleration transmitted to the instrument is 0.01 g for 10% of damping. Calculate the natural frequency and stiffness of the system?
9. A heavy table is supported by flat steel legs (Fig. 9.1). Its natural period in lateral vibration is 0.5 sec. When a 50-lb plate is clamped to its surface, the natural period in lateral vibration is lengthened to 0.75 sec. What are the weight and the lateral stiffness of the table?

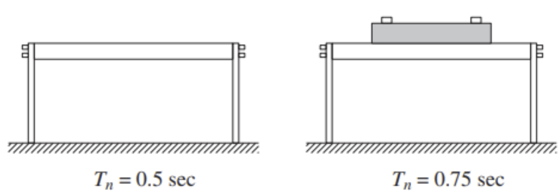


Fig. 9.1

10. The weight of the wooden block shown in Fig. 10.1 is 10 lb and the spring stiffness is 100 lb/in. A bullet weighing 0.5 lb is fired at a speed of 60 ft/sec into the block and becomes embedded in the block. Determine the resulting motion u(t) of the block.

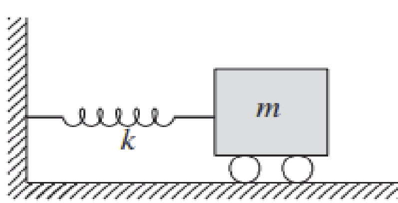


Fig. 10.1

Module 3

1. Explain in detail time stepping method for numerical evaluation of dynamic response?
2. Explain central difference method for numerical evaluation of dynamic response?
3. Explain Newmark's method for numerical evaluation of dynamic response?
4. What is mean by Response Spectra? Explain in detail?
5. Explain Deformation Response Spectrum?
6. Explain Pseudo-velocity Response Spectrum?
7. Write procedure to construct Response Spectrum?
8. Derive equations for and plot deformation, pseudo-velocity, and pseudo-acceleration response spectra for ground acceleration $\ddot{u}_g(t) = \dot{u}_{go}\delta(t)$, where $\delta(t)$ is the Dirac delta function and $\dot{u}_{go}$ is the increment in velocity, or the magnitude of the acceleration impulse. Only consider systems without damping.
9. A 12-ft-long vertical cantilever, a 4-in.-nominal-diameter standard steel pipe, supports a 5200-lb weight attached at the tip as shown in Fig. 9.1
   The properties of the pipe are:
   a. outside diameter, do = 4.500 in,
   b. inside diameter di = 4.026 in.,
   c. thickness t = 0.237 in., and
   d. second moment of cross-sectional area, I = 7.23 in^4,
   e. elastic modulus E = 29,000 ksi, and weight = 10.79 lb/foot length.

   Determine the peak deformation and bending stress in the cantilever due to the El Centro ground motion. Assume that $\zeta = 2\%$.

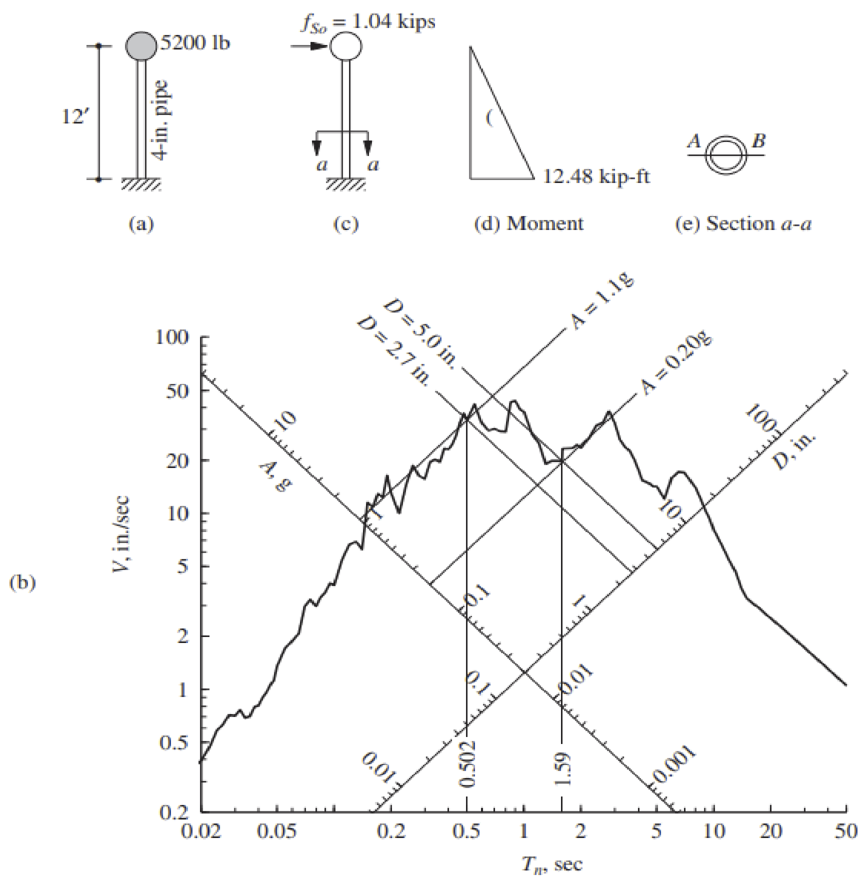
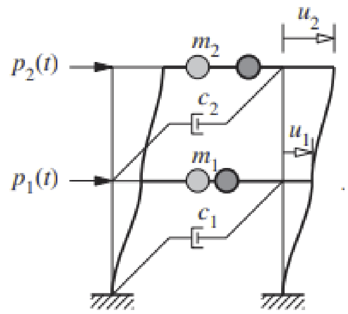


Fig. 9.1

10. The stress computed in Example 9 (as above) exceeded the allowable stress and the designer decided to increase the size of the pipe to an 8-in.-nominal standard steel pipe. Its properties are do = 8.625 in., di = 7.981 in., t = 0.322 in., and I = 72.5 in4. Comment on the advantages and disadvantages of using the larger pipe.

Module 4

1. Derive general equation of motion for MDoF system as two-story shear building as shown in fig 1.1



2. Write the equations of motion for an MDF system subjected to external dynamic forces $p_j(t)$, j = 1 to N.
3. A uniform rigid bar of total mass m is supported on two springs k_1 and k_2 at the two ends and subjected to dynamic forces shown in Fig. 3.1. The bar is constrained so that it can move only vertically in the plane of the paper; with this constraint the system has two DOFs.

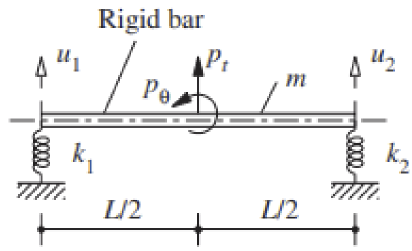


Fig 3.1

4. Formulate the equations of motion of the system of Fig. 3.1 with the two DOFs defined at the center of mass O of the rigid bar: translation u_t and rotation u_θ (Fig. 4.1)

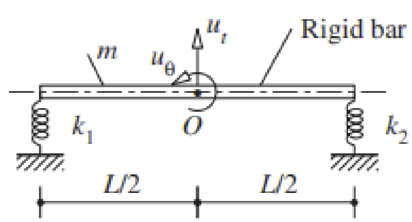


Fig 4.1

5. A massless cantilever beam of length L supports two lumped masses m L/2 and m L/4 at the midpoint and free end as shown in Fig. 5.1a. The flexural rigidity of the uniform beam is EI. With the four DOFs chosen as shown in Fig.5.1 b and the applied forces p1(t) and p2(t), formulate the equations of motion of the system. Axial and shear deformations in the beam are neglected.

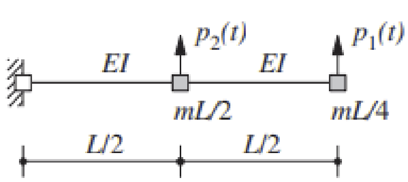


Fig 5.1 a

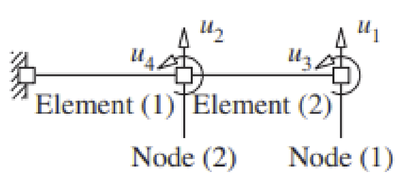


Fig 5.1 b

Module 5

1. Determine the natural vibration frequencies and modes of the system of Fig. 1.1 using the first set of DOFs shown.

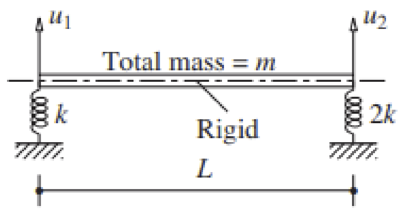


Fig1.1

2. Determine the natural frequencies &modes of vibration of the system shown in Fig. 2.1

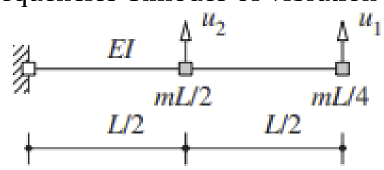


Fig 2.1

3. Determine the natural frequencies and modes of the system shown in Fig. 3.1

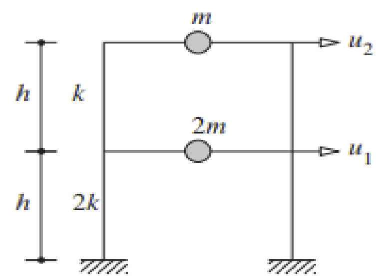


Fig 3.1

4. Determine the natural frequencies and modes of the system shown in Fig. 4.1

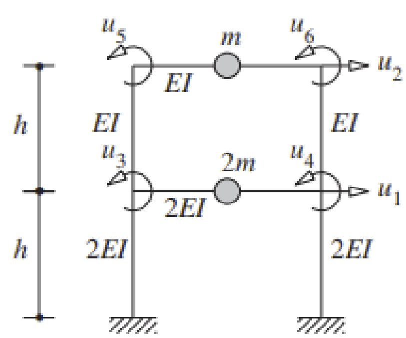


Fig 4.1

5. Write a short note on vibration of continuous systems.
6. Explain in short dynamics of rigid blocks.
7. What is mean by Floor Response Spectrum.
8. Explain the concept of vibration control.