No. of Pages: 3 **C**

APJ ABDUL KALAM TECHNOLOGICAL UNIVERSITY

FIRST SEMESTER M.TECH. DEGREE EXAMINATION, DECEMBER 2017

Branch: CIVIL ENGINEERING

Stream(s): STRUCTURAL ENGINEERING

01CE6105 – Structural Dynamics

Answer ***any two full*** questions from ***each*** part

Limit answers to the required points.

Max. Marks: 60 Duration: 3 hours

PART A

1. a. Derive the basic equation of motion of a damped system excited by a force $P_o Sin\bar{\omega}t$. (3)

   b. A light beam of stiffness 10^3 N/mm supports a mass of 4000 kg at its tip. The beam is undamped and set into free vibration. If the initial displacement is 5 mm and the displacement after 2 seconds is 4 mm, obtain the displacement after 3 seconds and the amplitude of vibration. (3)

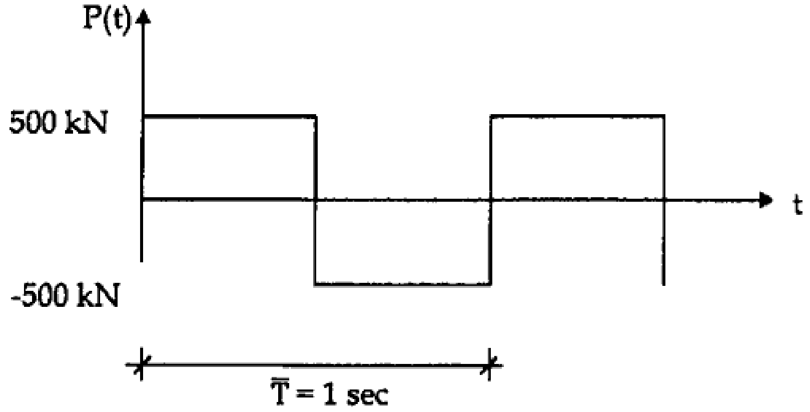
   c. An undamped single degree of freedom system of mass 60 kg and stiffness 0.15 N/mm initially at rest is subjected to a rectangular impulse input as P(t) = 600 N for $0 \le t \le 0.3$ sec and P(t) = 0 for $t \ge 0.3$ sec. Obtain the time displacement history upto 0.5 sec at an interval of 0.1 sec. (3)

2. a. Enumerate the methods for numerical evaluation of response of dynamic systems and explain the concept involved in any one method. (4)

   b. Determine the natural frequency of a cantilever beam of span 5 m propped at its end and carrying a concentrated load of 5 kN at midspan, neglecting the mass of the beam. E = 2×10^5 N/mm^2, I = 4.5×10^8 mm^4. (5)

3. a. Define logarithmic decrement. (2)

b. Calculate the response of a damped single degree of freedom system subjected to a periodic loading as shown with $\overline{T} = 1$ sec and $P_o = 500$ kN. The system has the following properties. k = 10000kN/m, m = 10000 kg and $\xi = 0.05$. Truncate the series with n = 5 and consider only the steady state response. (7)



PART B

4. a. Explain the concept of shear building model for the analysis of a multi-storeyed building frame. (5)

b. Determine the mass orthonormalised modeshape vectors for a system whose mass properties and mode shapes are as given. Take m = 10000 kg.

$$m_1 = 2m,\ m_2 = 1.5\ m,\ m_3 = m \text{ and } [\varphi] = \begin{bmatrix} 0.300 & -0.676 & 2.470 \\ 0.644 & -0.601 & -2.570 \\ 1.000 & 1.000 & 1.000 \end{bmatrix}$$ (4)

5. A three storeyed building frame of storey height 3.2 m and beam span 8 m is loaded on the top beam with a UDL of 25 kN/m and the other beams carry a UDL of 35 kN/m. If the columns have a uniform moment of inertia of $5\text{x}10^7$ mm^4 and if $E = 2\text{x}10^5$ N/mm^2, compute the frequencies and mode shapes of the frame using Stodola's method. (9)

6. Evaluate the steady state response at middle level at t = 0.15 sec when a three storeyed frame is subjected to a harmonic load of 400 Sin ($1.3\omega_2 t$) kN at top level, considering the contribution from all the modes. Given damping ratio = 0.05 for the system and $m_1 = m_2 = m_3 = 20000$ kg and $k_1 = 1.5k$, $k_2 = k_3 = k$, where k = 160 kN/mm.

$$\{\omega\} = \begin{Bmatrix} 43.872 \\ 120.155 \\ 167 \end{Bmatrix} \text{rad/sec and } [\varphi] = \begin{bmatrix} 0.3361 & -1.1572 & 2.512 \\ 0.7594 & 0.8047 & -2.427 \\ 1.000 & 1.000 & 1.000 \end{bmatrix}$$ (9)

PART C

7. a. Derive the differential equation of motion for the flexural vibration of beams including shear deformation and rotary inertia. (6)

b. Plot the first three possible modeshapes of a beam with distributed mass under the following support conditions: (i). Both ends hinged (ii). Both ends fixed (iii). One end fixed and the other end free. (6)

8. a. Derive the equations of motion for a two degree of freedom system using Lagrange's equation. (4)

b. Derive the solution for the differential equation of undamped free flexural vibration of an one dimensional distributed mass system. (6)

c. Explain the role of tuned mass dampers in vibration control. (2)

9. a. Determine the amplitude of the response at quarter point from the left support of a simply supported beam due to the first three modes, neglecting damping, for the beam particulars given below. m = 200Nsec^2/cm per cm of span, EI = 500Nmm^2, L = 320 cm, P(t) = 1000 Sin 500 t N applied at midspan. (8)

b. Differentiate between discrete parameter systems and continuous parameter systems. (4)

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