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**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.

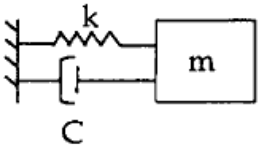
Max. Marks: 60 Duration: 3 hours

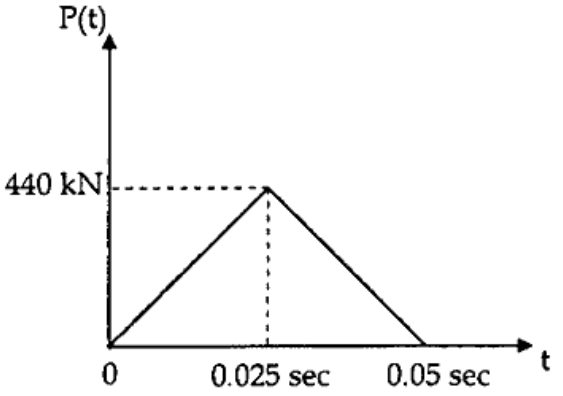
**PART A**

1. a. A beam of length 6 m is simply supported at the ends and carries a central load of 20 kN. The moment of inertia of the beam is 8250 x $10^4$ $mm^4$. If the beam weighs 500 N/m, determine the natural frequency of vibration taking into account the effect of self weight of the beam also. E = 2x$10^5$ $N/mm^2$. (4)

   b. Derive the dynamic load factor in the forced and free vibration phases for a structural system subjected to a rectangular impulse. For what values of $t_o/T$ ($t_o$ - duration of impulse and T - natural period of vibration), maximum dynamic load factor occurs in the two phases? (5)

2. a. Evaluate the response for the SDOF system shown in figure by average acceleration method for t = 0 to 0.06 sec., if m = 44000kg, k = 41 x$10^3$ kN/m, $\xi$ = 0.05 and $\Delta t$ = 0.01 sec. (5)




   b. What are the different types of dynamic loading? (4)

3. a. Derive the expression for the response of an undamped system subjected to a blast load varying in the form of a ramp using Duhamel integral. Hence, evaluate the deflection of the tower at 0.06 sec., if the mass and stiffness of the tower are 600 kN and 50 kN/mm respectively. The maximum value of the load is 350 kN and the corresponding time is 0.1 sec. (5)

b. Show that for an underdamped system in free vibration logarithmic decrement is expressed as $\delta = \frac{1}{k} \ln \frac{A_i}{A_{i+k}}$, where 'k' is the number of cycles separating two measured peak amplitudes $A_i$ and $A_{i+k}$. (4)

## PART B

4. a. Differentiate between lumped and consistent mass systems. (4 )

b. Evaluate the fundamental frequency of a three storeyed building frame using Rayleigh's method. Given the properties from the bottom level as $m_1 = 2m$, $m_2 = 1.5m$, $m_3 = m$ and $k_1 = 3k$, $k_2 = 2k$, $k_3 = k$ where $m = 10000kg$ and $k = 10^6$ N/m. (5)

5. a. Develop the general equations of motion for a two degree of freedom system. (3)

b. The higher modes of vibration do not have significant influence in the final response of a dynamic system. Justify. (3)



c. Determine the mass-orthonormalised modeshape vectors for the following data.

$$[M] = \begin{bmatrix} 12000 & 0 & 0 \\ 0 & 18000 & 0 \\ 0 & 0 & 18000 \end{bmatrix} \text{kg and}$$

$$[\emptyset] = \begin{bmatrix} 1.0000 & 1.0000 & 1.000 \\ 0.759 & -0.805 & -2.455 \\ 0.336 & -1.158 & 2.571 \end{bmatrix}$$ (3)

6. a. Describe the mode superposition method for the forced vibration analysis of a multi- degree of freedom system. (5)

b. Develop the orthogonality relations of natural modes of vibration as applied to lumped mass systems. (4)

## PART C

7. a. Derive the equation of motion and the solution for the axial vibration of a prismatic member. (5)

b. A simly supported beam of span 'L' is subjected to a concentrated constant force suddenly applied at the midspan. Determine the response using modal anlysis and also findout the maximum response. (7)

8. a. Determine the first three natural frequencies and mode shapes of a smply supported beam of span 'L' with uniform flexural rigidity 'EI' and mass 'm' per unit length. (7)

b. A rotating machine having a total mass of 200 kg is supported by four isolators on a rigid floor. The total stiffness of the isolators is $1000 \times 10^3$ N/m. While operating, the machine generates a vertical harmonic force with an amplitude of 450N at a rotation frequency of 50 Hz. Assuming damping ratio as 0.2, check whether the amplitude of motion and the force transmitted to the floor are within the allowable values of 0.03 mm and 50 N respectively. (5)

9. a. Define transmissibility and derive the expression for the same with regard to support motion. (4)

b. Develop the frequency equation for a cantilever beam of span 'L' with uniform flexural rigidity 'EI' and mass 'm' per unit length. (5)

c. Write down short note on vibration measuring instruments. (3)