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KUMARAGURU college of technology character is life

B.E/B.TECH DEGREE EXAMINATIONS: APRIL /MAY 2024

(Regulation 2018)

Sixth Semester

AERONAUTICAL ENGINEERING

U18AET6003**:** Vibrations and Aeroelasticity

COURSE OUTCOMES

CO1: Explain the concept and types of vibration.

CO2: Determine the natural frequencies and mode shapes of the vibrating system.

CO3: Solve the equations of motion for multi degree-of-freedom systems.

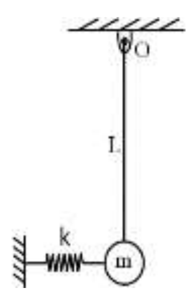
CO4: Determine the natural frequency of continuous systems of free-vibration.

CO5: Identify the effects of vibrations on aircraft structures and the static and dynamic aeroelastic effects.

Time: Three Hours **Maximum Marks: 100**

Answer all the Questions:-
PART A (10 x 2 = 20 Marks)
(Answer not more than 40 words)

1. If a simple pendulum completes 50 oscillations in 10 seconds, determine the period in seconds. CO1 [K_2]
2. Write the relationship between CO1 [K_1]
    a) Angular frequency 'ω' and linear frequency 'f'
    b) Linear frequency 'f' and Time period 'T'.
3. Write the equation of motion for the simple pendulum with a spring attached as shown in Figure. CO2 [K_2]

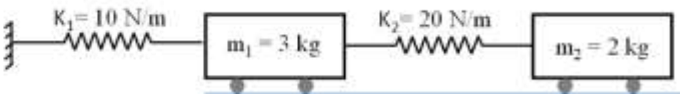


4. Indicate the phase difference between CO2 [K_2]
    a) Displacement and velocity
    b) Displacement and Acceleration.

5. Verify whether the given masses and Eigenvectors satisfy the orthogonality condition. CO3 [K_1]
$m_1 = 3$ kg, $m_2 = 2$ kg, $A_1 = A_2 = 1$ unit, $B_1 = 1.69$ unit and $B_2 = -0.89$ unit.
Where A_1 and B_1 are the amplitude of vibration of mass m_1 and m_2 respectively for the fundamental natural frequency. A_2 and B_2 are the amplitude of vibration of mass m_1 and m_2 respectively for the second natural frequency.

6. Define a degenerative/ Semi-infinite system. CO3 [K_1]

7. Write the mass matrix [m] and flexibility matrix [δ] for the spring-mass system shown in the Figure. CO4 [K_L]

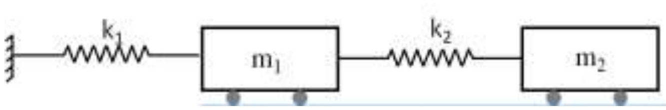


8. Write the geometric boundary conditions used in the vibration of a simply supported string. CO4 [K_L]

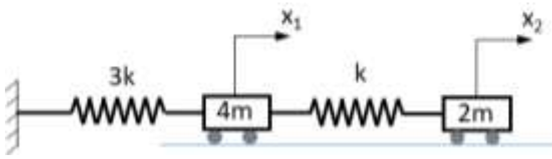
9. Define buffeting in aeroelasticity. CO5 [K_L]

10. State the function of a seismometer. CO5 [K_L]

Answer any FIVE Questions:-
PART B (5 x 16 = 80 Marks)
(Answer not more than 400 words)

11.	Prove that in an under damping oscillation of a spring mass system, the logarithmic decrement is given by $$\delta = \frac{1}{n}\ln\left(\frac{x_0}{x_n}\right)$$ where n is the number of cycles, x0 and xn are the amplitudes of mass at 0^{th} and n^{th} cycles respectively.	16	CO1	[K_3]
12.	Explain the working principle of a vibrometer by deriving the required equation and with the help of a neat sketch.	16	CO2	[K_3]
13.	Determine the natural frequencies and the corresponding mode shapes for the two degrees of freedom system shown in Figure. Derive the equation of motion from the condition of force equilibrium. Consider $k_1 = 150$ N/m, $k_2 = 100$ N/m and $m_1 = m_2 = 3$ kg. 	16	CO3	[K_3]
14.	Derive the natural frequencies for a fixed-free bar under longitudinal vibration.	16	CO4	[K_3]

15. Determine the fundamental natural frequency and the corresponding mode shapes for the system shown in Figure by matrix iteration method. Also, obtain higher mode shape and natural frequency by applying the orthogonality condition. Consider m = 2 kg and k = 100 N/m. 16 CO4 [K3]



$$\delta_{11} = \frac{1}{3k}; \qquad \delta_{21} = \frac{1}{3k}$$

$$\delta_{12} = \delta_{21} = \frac{1}{3k}; \qquad \delta_{22} = \frac{1}{3k} + \frac{1}{k} = \frac{4}{3k}$$

16. Explain each aeroelastic phenomenon that occurs due to the combined effect of aerodynamic, elastic and inertia forces using the Collar's triangle. 16 CO5 [K3]

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