Hall Ticket No | | | | | | | | | | Question Paper Code: AAEC35

INSTITUTE OF AERONAUTICAL ENGINEERING

(Autonomous)

Dundigal, Hyderabad - 500 043

MODEL QUESTION PAPER-II

B.Tech VII Semester End Examinations, December–2025

Regulations: IARE - UG20

AEROSPACE STRUCTURAL DYNAMICS

AERONAUTICAL ENGINEERING

Time: 3 hour Maximum Marks: 70

Answer ALL questions in Module I and II

Answer ONE out of two questions in Modules III, IV and V

All Questions Carry Equal Marks

All parts of the question must be answered in one place only

MODULE-I

1. (a) A damped system has following elements: Mass = 4 kg; k = 1 kN/m; C = 40 N-sec/m. Determine: (a) Damping factor and natural frequency of damped oscillation. (b) Logarithmic decrement and number of cycles after which the original amplitude is reduced to 20. [BL: Understand— CO: 1—Marks: 7]

   (b) A mass of 2kg is supported on an isolator having a spring scale of 2940 N/m and viscous damping. If the amplitude of free vibration of the mass falls to one half its original values in 1.5 seconds, determine the damping coefficient of the isolator.

   [BL: Understand— CO: 1—Marks: 7]

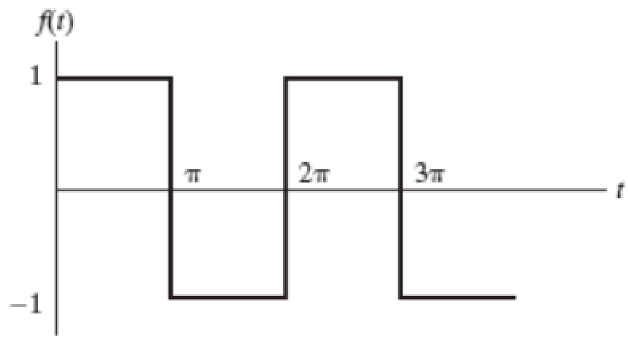
MODULE-II

2. (a) What is meant by static and dynamic coupling? How can coupling of the equations of motion be eliminated? Derive the governing equations through Lagrange energy approach.

   [BL: Understand— CO: 2—Marks: 7]

   (b) Derive the equation of motion of the system shown in figure. Assume that the initial tension 'T' in the string is too large and remains constants for small amplitudes. Determine the natural frequencies, the ratio of amplitudes and locate the nodes for each mode of vibrations when m1 = m2= m and l1=l, l2 = 2l, l3 =3l.

   [BL: Understand— CO: 2—Marks: 7]



MODULE-III

3. (a) A seismic instrument is fitted to measure the vibration characteristics of a machine running at 120rpm. If the natural frequency of the instrument is 5Hz and if it shows 0.004cm. Determine the displacement, velocity and acceleration assuming no damping.

[BL: Understand— CO: 3—Marks: 7]

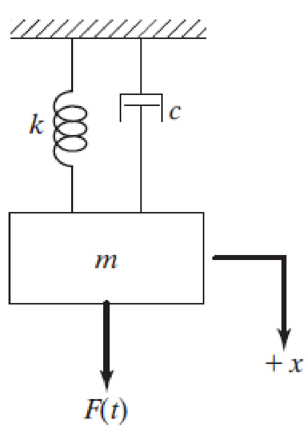
(b) It is desired to measure maximum acceleration of a machine part, which vibrates violently with a frequency of 700cycles/min. An accelerometer with negligible damping, 0.5 kg mass and 18 KN/m spring constant is attached to it. The total travel of the indicator is found to be 8.2 mm, find the maximum amplitude and maximum acceleration of the part.

[BL: Understand— CO: 3—Marks: 7]

4. (a) A vibrometer having a natural frequency of 4 rad/s and $/zeta = 0.2$ is attached to a structure performs a harmonic motion. If the difference between the maximum and minimum recorded values is 8mm, find the amplitude of motion of the vibrating structure when its frequency is 40 rad/s. [BL: Apply— CO: 3—Marks: 7]

(b) Determine the characteristic equation for the system shown in Figure .and solve this equation for the special case when k1= k2= k3 = k and m1 = m2 = m3 = m. Determine if the system has any rigid-body modes.

[BL: Apply— CO: 3—Marks: 7]



MODULE-IV

5. (a) Explain different types of data acquisition systems with compression to merits and demerits of each other. [BL: Understand— CO: 4—Marks: 7]

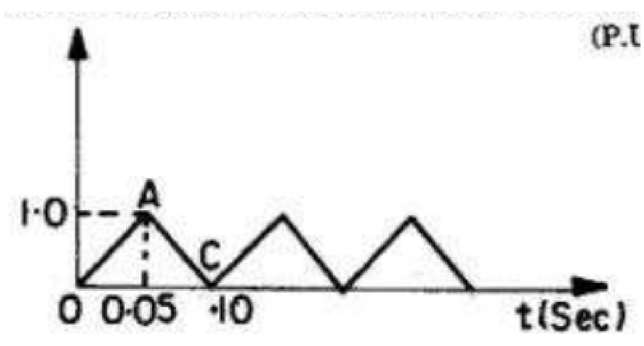
   (b) Machine condition monitoring is very important. Explain thro trending analysis and its interpretation. [BL: Understand— CO: 4—Marks: 7]

6. (a) Machine condition monitoring is very important. Explain thro trending analysis and its interpretation. [BL: Understand— CO: 4—Marks: 7]

   (b) Name two frequency measuring instruments. Explain any one instrument's working principle. [BL: Understand— CO: 5—Marks: 7]

MODULE-V

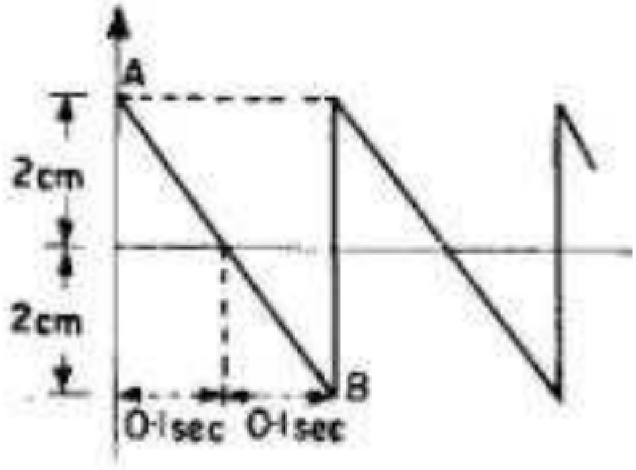
7. (a) Find the steady state response of a pinned-pinned beam subjected to a harmonic force $f(x,t) = f0\ \sin(\omega t)$ applied at x=a as shown in the figure. [BL: Understand— CO: 5—Marks: 7]



   (b) A steel wire of 2 mm diameter is fixed between two points located 2 m apart. The tensile force in the wire is 250N. Determine the fundamental natural frequency and the velocity of wave propagation in the wire. [BL: Understand— CO: 5—Marks: 7]

8. (a) Determine the natural frequencies of vibration of a uniform beam fixed at x=0 and simply supported at x=l. [BL: Understand— CO: 5—Marks: 7]

   (b) Find the value of free-stream velocity u at which the airfoil section (SDOF) shown in Fig becomes unstable [BL: Understand— CO: 5—Marks: 7]



****END OF EXAMINATION****

COURSE OBJECTIVES:

The students will try to:

I	Formulate mathematical models of problems in vibrations using Newton's second law or energy principles.
II	Determine a complete solution to the modelled mechanical vibration problems.
III	design a mechanical system that has desirable vibrational behavior.
IV	Assess the underlying assumptions in the aeroelastic analysis of fixed wing and rotary wing aerospace vehicles/systems.

COURSE OUTCOMES:

After successful completion of the course, students should be able to:

CO 1	**Apply** principles of mechanical vibrations such as Newton's second law, and the principle of conservation of energy to the mathematical models for obtaining their governing equations of motion.	Apply
CO 2	**Analyze** the mathematical modeling of the two degrees of freedom systems for determining the frequency of the spring-mass system.	Apply
CO 3	**Solve** the natural frequencies and mode shapes of a multi degree of freedom system for the numerical solution of distributed parameter systems	Apply
CO 4	**Apply** theoretical and numerical procedures for predicting the dynamic response of continuous structural systems under the most diverse loading conditions.	Apply
CO 5	**Formulate** the static aeroelasticity problems such as typical section and wing divergence problems; for their selection in real world applications.	Apply

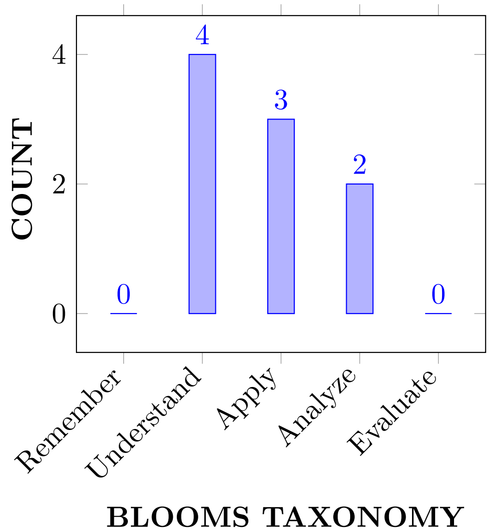
QUESTION PAPER 1: MAPPING OF SEMESTER END EXAMINATION QUESTIONS TO COURSE OUTCOMES

Q.No		All Questions carry equal marks	Taxonomy	CO's	PO's
1	a	A damped system has following elements: Mass = 4 kg; k = 1 kN/m; C = 40 N-sec/m. Determine: (a) Damping factor and natural frequency of damped oscillation. (b) Logarithmic decrement and number of cycles after which the original amplitude is reduced to 20.	Apply	CO 1	PO 1,2
	b	A mass of 2kg is supported on an isolator having a spring scale of 2940 N/m and viscous damping. If the amplitude of free vibration of the mass falls to one half its original values in 1.5 seconds, determine the damping coefficient of the isolator.	Apply	CO 1	PO 1,2
2	a	A metal block, placed on a rough surface, is attached to a spring and is given an initial displacement of 10cmfrom its equilibrium position. After five cycles of oscillation in 2s, the final position of the metal block found to be 1cm from its equilibrium positions. Find the coefficient of friction between the surface and the metal block.	Understand	CO 1	PO 1,2
	b	A disc of a torsional pendulum has a moment of inertia of 6E-2 kg-m2 and is immersed in a viscous fluid. The shaft attached to it is 0.4m long and 0.1m in diameter. When the pendulum is oscillating, the observed amplitudes on the same side of the mean position for successive cycles are 90, 60 and 40. Determine i) logarithmic decrement ii) damping torque per unit velocity and (iii) the periodic time of vibration. Assume G = 4.4E10 N/m2, for the shaft material.	Apply	CO 1	PO 1,2
3	a	What is meant by static and dynamic coupling? How can coupling of the equations of motion be eliminated? Derive the governing equations through Lagrange energy approach.	Understand	CO 2	PO 1,2

	b	Derive the equation of motion of the system shown in figure. Assume that the initial tension 'T' in the string is too large and remains constants for small amplitudes. Determine the natural frequencies, the ratio of amplitudes and locate the nodes for each mode of vibrations when $m_1 = m_2 = m$ and $l_1 = l, l_2 = 2l, l_3 = 3l$.	Apply	CO 2	PO 1,2
4	a	For the system shown in fig find the two natural frequencies when $m_1 = m_2 = 9.8kgK_1 = K_3 = 8820N/m, K_2 = 3430N/m$. Find out the resultant motions of m_1 and m_2 for the following cases. The displacements mentioned below are from the equilibrium positions of the respective masses. Both masses are displaced 5mm in the downward direction and released simultaneously both masses are displaced 5mm, in the downward direction and m_2 in the upward direction and released simultaneously.	Apply	CO 3	PO 1,2
	b	Determine the natural frequencies, the ratio of amplitudes and locate the nodes for each mode of vibrations when m_1= m_2= m.	Apply	CO 3	PO 1,2
5	a	Find the lowest natural frequency of the cantilever rotor system shown in Figure by matrix method. Take m1=100 kg, m2=50 kg.	Understand	CO 3	PO 1,2
	b	A commercial type vibration pick up has a natural frequency of 6cps and a damping factor $/Tau = 0.6$. calculate the relative displacement amplitude if the instrument is subject to motion $x = 0.08sin20t$.	Apply	CO 3	PO 1,2
6	a	A seismic instrument is mounted on a machine running at 1000 rpm. The natural frequency of the seismic instrument is 20 rad/sec. The instrument records relative amplitude of 0.5 mm. Compute the displacement, velocity and acceleration of the machine. Damping in seismic instrument is neglected.	Understand	CO 3	PO 1,2
	b	Determine the natural frequencies and mode shapes associated with the system shown in Figure for $m_1 = 10kg, m_2 = 20kg, k_1 = 100N/m, k_2 = 100N/m, andk_3 = 50N/m$.	Apply	CO 3	PO 1,2

7	a	Explain the following : i) Vibration isolation transmissibility ii) Torsional vibration of circular shafts	Analyze	CO 4	PO 1,2
	b	Analyze the concepts of transverse vibration of a string or cable	Explain	CO 4	PO 1,2
8	a	Analyze the equations longitudinal vibration of a bar or rod, torsional vibration of shaft or rod,	Analyze	CO 4	PO 1,2
	b	Analyze the problems for lateral vibration of beams, and the Rayleigh-Ritz method.	Analyze	CO 4	PO 1,2
9	a	An aerofoil using in its first bending and torsional modes can be represented schematically as shown in figure connected through a translational spring of stiffness k and a torsional spring of stiffness kT. Write the equations of motion for the system and obtain the two natural frequencies. Assume the following data. M = 5kg , $I = 0.12kgm^2, k = 5X10^3 N/m, k_T = 0.4X10^3$ Nm/rad, a = 0.1 m	Understand	CO 5	PO 1,2
	b	Find the time it takes for a transverse wave to travel along a transmission line from one tower to another one 300 m away. Assume the horizontal component of the cable tension as 30,000N and the mass of the cable as 2Kg/m of length.	Analyze	CO 5	PO 1,2
10	a	Find the time it takes for a transverse wave to travel along a transmission line from one tower to another one 300 m away. Assume the horizontal component of the cable tension as 30,000N and the mass of the cable as 2Kg/m of length.	Understand	CO 5	PO 1,2
	b	A uniform bar of cross-sectional area A, length l and Young's modulus E is connected at both ends by springs, dampers and masses as shown in the figure. State the boundary conditions.	Analyze	CO 5	PO 1,2

KNOWLEDGE COMPETENCY LEVELS OF MODEL QUESTION PAPER



Signature of Course Coordinator **HOD, AE**
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