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

# INSTITUTE OF AERONAUTICAL ENGINEERING

(Autonomous)

Dundigal, Hyderabad - 500 043

MODEL QUESTION PAPER-I

B.Tech VII Semester End Examinations, December–2025

Regulations: IARE - UG20

## AEROSPACE STRUCTURAL DYNAMICS

## AERONAUTICAL ENGINEERING

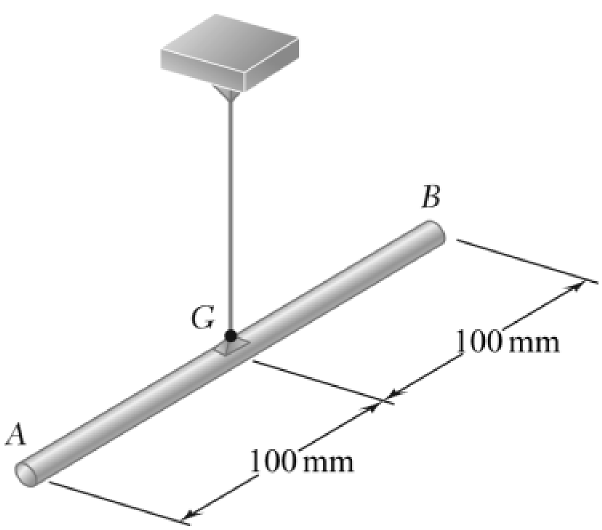
Time: 3 hour Maximum Marks: 70

**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) Discuss the response of under damped , critically damped and over damped systems using respective response equations and curves. [BL: Understand— CO: 1—Marks: 7]

   (b) A mass of 20kg is supported on two isolators as shown in fig below. Determine the undamped and damped natural frequencies of the system, neglecting the mass of the Isolators. [BL: Apply— CO: 1—Marks: 7]



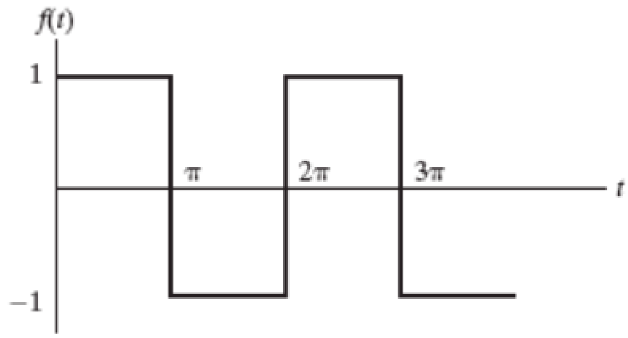

### MODULE-II

2. (a) A diesel engine, weighing 3000 N is supported on a pedestal mount. It has been observed that the engine induces vibration into the surrounding area through its pedestal mount at an operating speed of 6000rpm. Determine the parameters of the vibration absorber that

will reduce the vibration when mounted on the pedestal. The magnitude of the exciting force is 250 N and the amplitude of the auxiliary mass is to be limited to 2mm.

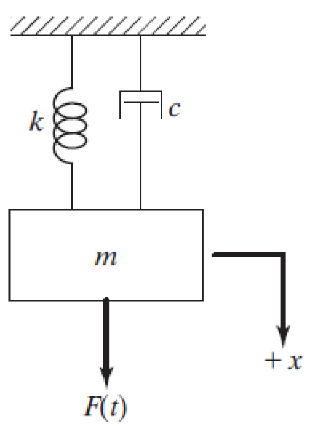
[BL: Understand— CO: 2—Marks: 7]

(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 $m_1 = m_2 = m$ and $l_1 = l, l_2 = 2l, l_3 = 3l$. [BL: Apply— CO: 2—Marks: 7]




## MODULE-III

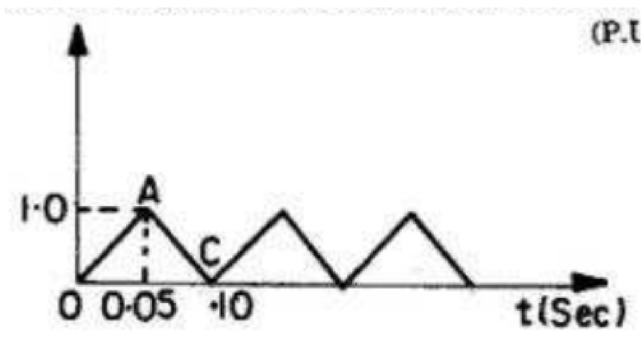
3. (a) Find the lowest natural frequency of the cantilever rotor system shown in Figure by matrix method. Take m1=100 kg, m2=50 kg. [BL: Understand— CO: 3—Marks: 7]




(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 $x = 0.08sin20t$. [BL: Apply— CO: 3—Marks: 7]

4. (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. [BL: Apply— CO: 4—Marks: 7]

(b) Determine the natural frequencies and mode shapes associated with the system shown in Figure for $m_1 = 10kg, m_2 = 20kg, k_1 = 100N/m, k_2 = 100N/m, andk_3 = 50N/m.$




[BL: Apply— CO: 4—Marks: 7]

**MODULE-IV**

5. (a) Time-domain wave farms can be used to detect dushate damages of the machinery. Explain. [BL: Understand— CO: 5—Marks: 7]

(b) Derive expessions for critical speed of shaft when damping is present in the form of air resistance. [BL: Understand— CO: 5—Marks: 7]

6. (a) Explain the following : i) Vibration isolation transmissibility ii) Torsional vibration of circular shafts [BL: Understand— CO: 4—Marks: 7]

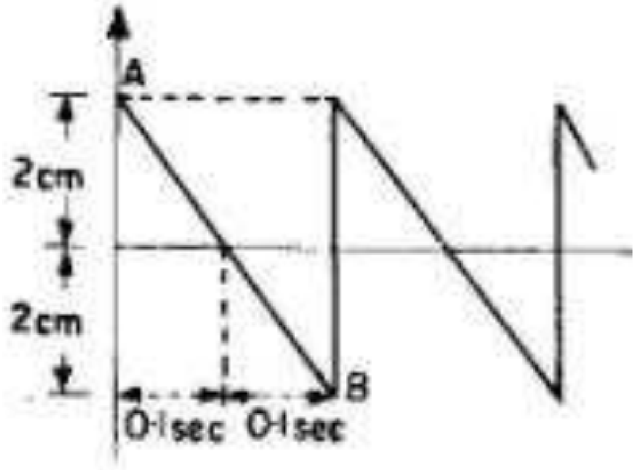
(b) Root cause analysis is very essential for introducing to implement using fishbone chart. Explain. [BL: Understand— CO: 4—Marks: 7]

**MODULE-V**

7. (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.

[BL: Understand— CO: 5—Marks: 7]

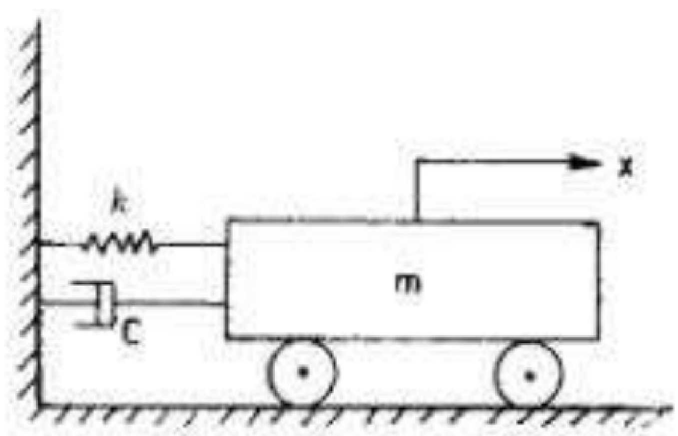
(b) An aerofoil using in its first bending and torsional modes can be represented schematically as shown in figure connected through a translational spring of stiffness k and a torsional spring of stiffness kT. Write the equations of motion for the system and obtain the two natural frequencies. Assume 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 [BL: Understand— CO: 5—Marks: 7]




8. (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.

[BL: Understand— CO: 5—Marks: 7]

(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. [BL: Understand— CO: 5—Marks: 7]

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****END OF EXAMINATION****

## COURSE OBJECTIVES:

**The students will try to:**

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| 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:**

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| 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. | Analyze |
| 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 | Discuss the response of under damped , critically damped and over damped systems using respective response equations and curves. | Understand | CO 1 | PO 1,2 |
| | b | A mass of 20kg is supported on two isolators as shown in fig below. Determine the undamped and damped natural frequencies of the system, neglecting the mass of the Isolators. | Understand | CO 1 | PO 1,2 |
| 2 | a | Derive an expression for the transmissibility and transmitted force for a spring - massdamper system subjected to external excitation. Draw the vector diagram for the forces. | Understand | CO 1 | PO 1,2 |

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| | b | A 25 kg mass is resting on a spring of 4900 N/m and dashpot of 147 N-se/m in Parallel. If a velocity of 0.10 m/sec is applied to the mass at the rest position, what will be its displacement from the equilibrium position at the end of first second? | Understand | CO 1 | PO 1,2 |
| 3 | a | A diesel engine, weighing 3000 N is supported on a pedestal mount. It has been observed that the engine induces vibration into the surrounding area through its pedestal mount at an operating speed of 6000rpm. Determine the parameters of the vibration absorber that will reduce the vibration when mounted on the pedestal. The magnitude of the exciting force is 250 N and the amplitude of the auxiliary mass is to be limited to 2mm. | Apply | 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 $m_1 = m_2 = 9.8kg K_1 = K_3 = 8820N/m, K_2 = 3430N/m$. 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 |

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|---|---|---|---|---|---|
| | 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 , $I = 0.12kgm^2, k = 5X10^3N/m, k_T = 0.4X10^3$ 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 |

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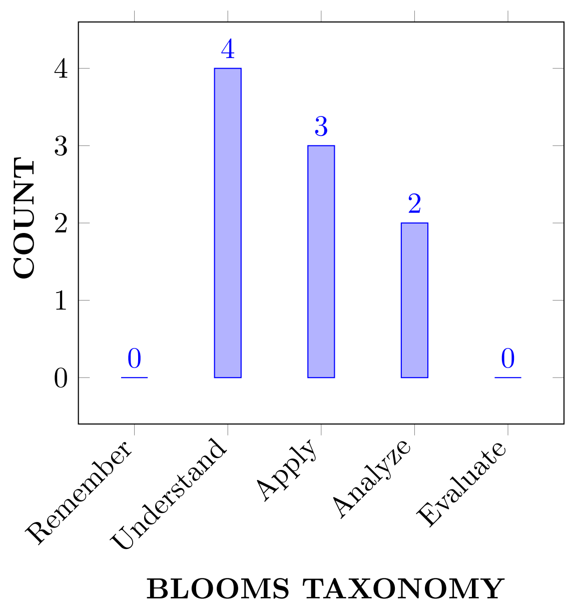
| 10 | a | Find the time it takes for a transverse wave to travel along a transmission line from one tower to another one 300 m away. Assume the horizontal component of the cable tension as 30,000N and the mass of the cable as 2Kg/m of length. | Understand | CO 5 | PO 1,2 |
| | b | A uniform bar of cross-sectional 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**
**Mr. K Arun Kumar, Assistant Professor**