Hall Ticket No | | | | | | | | | | | Question Paper Code: AAE015

INSTITUTE OF AERONAUTICAL ENGINEERING

(Autonomous)

Dundigal, Hyderabad - 500 043

MODEL QUESTION PAPER-I

B.Tech VII Semester End Examinations, November/December – 2019

Regulations: IARE - R16

AEROSPACE STRUCTURAL DYNAMICS

(Aeronautical Engineering)

Time: 3 hours **Max. Marks: 70**

Answer ONE Question from each Unit
All Questions Carry Equal Marks
All parts of the question must be answered in one place only

UNIT – I

1. a) Discuss the response of under damped , critically damped and over damped systems using respective response equations and curves. **[7M]**

   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. **[7M]**

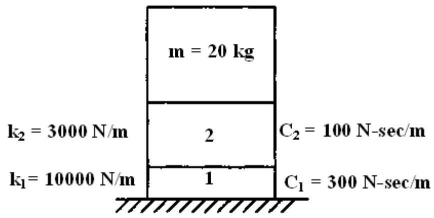


Fig Q (2)

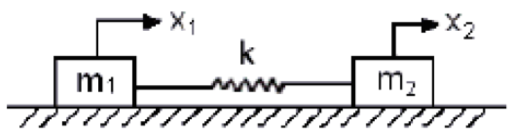
2. a) Derive an expression for the transmissibility and transmitted force for a spring - mass-damper system subjected to external excitation. Draw the vector diagram for the forces. **[7M]**

   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? **[7M]**

UNIT – II

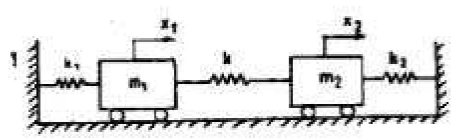
3. a) A diesel engine, weighing 3000 N is supported on a pedestal mount. It has been observed that the engine induces vibration into the surrounding area through its pedestal mount at an operating speed of 6000rpm. Determine the parameters of the vibration absorber that will reduce the vibration when 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. **[7M]**

b) Solve the problem shown in figure. m1=10kg, m2=15kg and k = 320 N/m. **[7M]**



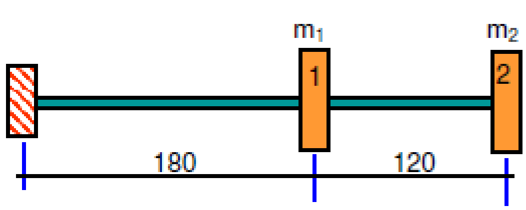
4. a) For the system shown in fig find the two natural frequencies when m_1=m_2=9.8 kg K_1=K_3=8820N/m, K_2=3430N\m. Find out the resultant motions of m_1 and m_2 for the following cases. The displacements mentioned below are from the equilibrium positions of the respective masses. Both masses are displaced 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. **[7M]**

b) Determine the natural frequencies, the ratio of amplitudes and locate the nodes for each mode of vibrations when m_1 = m_2= m. **[7M]**



UNIT – III

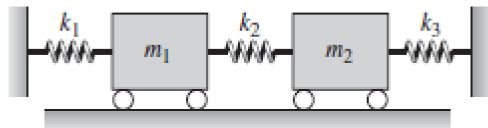
5. a) Find the lowest natural frequency of the cantilever rotor system shown in Figure by matrix method. Take m1=100 kg, m2=50 kg. **[7M]**



b) A commercial type vibration pick up has a natural frequency of 6cps and a damping factor ζ=0.6.calculate the relative displacement amplitude if the instrument is subject to motion x=0.08sin 20t. **[7M]**

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. **[7M]**

b) Determine the natural frequencies and mode shapes associated with the system shown in Figure for $m1$ = 10 kg, $m2$ = 20 kg, $k1$ = 100 N/m, $k2$ = 100 N/m, and $k3$ = 50 N/m. **[7M]**



UNIT – IV

7. a) Time-domain wave farms can be used to detect dushate damages of the machinery. Explain. **[7M]**

b) What conclusion can be drawn during condition monitoring of mechanical systems using failure mode analysis? **[7M]**

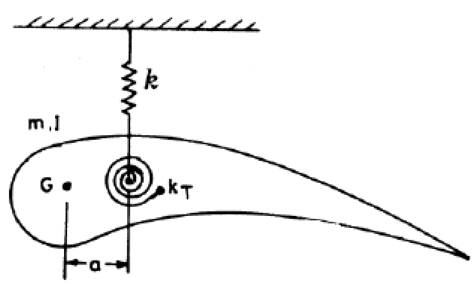
8. a) Compare theoretical and Real-time harmonic profiles of the vibrating systems with explanation. **[7M]**

b) Root cause analysis is very essential for introducing to implement using fishbone chart. Explain. **[7M]**

UNIT – V

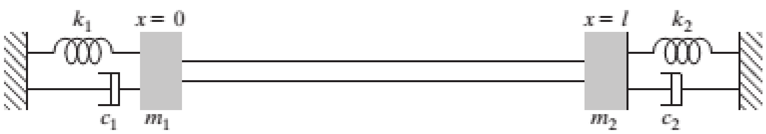
9. a) Find the time it takes for a transverse wave to travel along a transmission line from one tower to another one 300 m away. Assume the horizontal component of the cable tension as 30,000N and the mass of the cable as 2Kg/m of length. **[7M]**

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 k_T. Write the equations of motion for the system and obtain the two natural frequencies. Assume the following data. M = 5kg , I = 0.12 kg m^2, k = 5 X 10^3 N/m, k_T = 0.4 X 10^3 Nm/rad, a = 0.1 m **[7M]**



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. **[7M]**

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. **[7M]**



COURSE OBJECTIVES:

The course should enable the students to:

S. No	Description
I	Demonstrate the knowledge of mathematics, science, and engineering by developing the equations of motion for vibratory systems and solving for the free and forced response.
II	Understand to identify, formulate and solve engineering problems. This will be accomplished by having students model, analyze and modify a vibratory structure order to achieve specified requirements.
III	Introduce to structural vibrations which may affect safety and reliability of engineering systems.
IV	Describe structural dynamic and steady and unsteady aerodynamics aspects of airframe and its components of space structures.

COURSE OUTCOMES (COs):

CO 1	Understand the concept of vibrations, equation of motion, response to harmonic excitation, impulsive excitation, step excitation, periodic excitation (Fourier series), Fourier transform), Laplace transform (Transfer Function).
CO 2	Remember and describe the concept of Eigen value problem, damping effect; Modeling of continuous systems as multi-degree-of-freedom systems, equations of motion of undamped systems in matrix form, unrestrained systems, free and forced vibration vibration of undamped systems; using modal analysis, forced vibration of viscously damped systems.
CO 3	Determine and apply the concept of nonlinear vibrations physical properties of nonlinear systems single-degree-of-freedom and multi-degree-of-freedom nonlinear systems. Random vibrations;, single-degree-of-freedom response, response to a white noise
CO 4	Describe about transverse vibration of a string or cable, longitudinal vibration of a bar or rod, torsional vibration of shaft or rod, lateral vibration of beams, the Rayleigh-Ritz method.
CO 5	Understand the concept of Collar's aero elastic triangle, static aero elasticity aero elastic problems at transonic speeds, active flutter suppression. Effect of aero elasticity in flight vehicle design

COURSE LEARNING OUTCOMES (CLOs):

Students, who complete the course, will have demonstrated the ability to do the following:

AAE015.01	Apply principles of engineering, basic science, and mathematics (including multivariate calculus and differential equations) to model, analyze, design, and realize physical systems, components or processes, and work professionally in mechanical systems areas.
AAE015.02	Become proficient in the modeling and analysis of one degree of freedom systems - free vibrations, transient and steady-state forced vibrations, viscous and hysteric damping.
AAE015.03	Understanding the response to periodic excitation (Fourier series ,Fourier transform)
AAE015.04	Using Laplace transforms and the Convolutional integral formulations to understand shock spectrum and system response for impact loads.
AAE015.05	Become proficient in the modeling and analysis of multi-dof systems - Lagrange's equations, reduction to one-dof systems for proportionally damped systems, modal analysis, vibration absorbers, vibration transmission, Fourier transforms.
AAE015.06	Convert the physical domain to mathematical formulation and development of governing equation based on number of masses in the system.

AAE015.07	Understanding the phenomenon of generalized coordinates and generalized forces, Lagrange‘s equations to derive equations of motion
AAE015.08	Apply the Eigen value problem and describe expansion theorem, unrestrained systems, free vibration of undamped systems; forced vibration of undamped systems
AAE015.09	Understand the concepts of nonlinear vibrations, simple examples of nonlinear systems, physical properties of nonlinear systems
AAE015.10	Formulate simple problem solutions of the equation of motion of a single-degree-of-freedom nonlinear system, multi-degree-of-freedom nonlinear systems.
AAE015.11	Understand the concept of random processes, probability distribution and density functions, description of the mean values in terms of the probability density function
AAE015.12	Understand the concept of autocorrelation function, power spectral density function, properties of the power spectral density function, white noise and narrow and large bandwidth
AAE015.13	Understand the concepts of transverse vibration of a string or cable
AAE015.14	Derive the equations longitudinal vibration of a bar or rod, torsional vibration of shaft or rod,
AAE015.15	Solve the problems for lateral vibration of beams, and the Rayleigh-Ritz method.
AAE015.16	Understand the concepts of Collar's aeroelastic triangle, static aeroelasticity phenomena
AAE015.17	Understand the concept of dynamic aeroelasticity phenomena
AAE015.18	Calculate the aeroelastic problems at transonic speeds, aeroelastic tailoring, active flutter suppression. Effect of aeroelasticity in flight vehicle design.

MAPPING OF SEMESTER END EXAMINATION TO COURSE OUTCOMES

SEE Question No		Course Learning Outcomes		Course Outcomes	Blooms Taxonomy Level
1	a	AAE015.01	Apply principles of engineering, basic science, and mathematics (including multivariate calculus and differential equations) to model, analyze, design, and realize physical systems, components or processes, and work professionally in mechanical systems areas.	CO 1	Understand
	b	AAE015.02	Become proficient in the modeling and analysis of one degree of freedom systems - free vibrations, transient and steady-state forced vibrations, viscous and hysteric are damping.	CO 1	Understand
2	a	AAE015.02	Understanding the response to periodic excitation (Fourier series ,Fourier transform)	CO 1	Remember
	b	AAE015.03	Using Laplace transforms and the Convolutional integral formulations to understand shock spectrum and system response for impact loads.	CO 1	Understand
3	a	AAE015.04	Apply principles of engineering, basic science, and mathematics (including multivariate calculus and differential equations) to model, analyze, design, and realize physical systems, components or processes, and work professionally in mechanical systems areas.	CO 2	Remember
	b	AAE015.05	Become proficient in the modeling and analysis of multi-dof systems - Lagrange’s equations, reduction to one-dof systems for proportionally damped systems, modal analysis, vibration absorbers, vibration transmission, Fourier transforms.	CO 2	Remember
4	a	AAE015.06	Convert the physical domain to mathematical formulation and development of governing equation based on number of masses in the system.	CO 2	Understand

	b	AAE015.07	Understanding the phenomenon of generalized coordinates and generalized forces, Lagrange‘s equations to derive equations of motion	CO 2	Understand
5	a	AAE015.08	Apply the Eigen value problem and describe expansion theorem, unrestrained systems, free vibration of undamped systems; forced vibration of undamped systems	CO 3	Remember
	b	AAE015.08	Understand the concepts of nonlinear vibrations, simple examples of nonlinear systems, physical properties of nonlinear systems	CO 3	Understand
6	a	AAE015.09	Formulate simple problem solutions of the equation of motion of a single-degree-of-freedom nonlinear system, multi-degree-of-freedom nonlinear systems.	CO 3	Understand
	b	AAE015.10	Understand the concept of random processes, probability distribution and density functions, description of the mean values in terms of the probability density function	CO 3	Remember
7	a	AAE015.11	Understand the concept of autocorrelation function, power spectral density function, properties of the power spectral density function, white noise and narrow and large bandwidth	CO 4	Understand
	b	AAE015.12	Understand the concepts of transverse vibration of a string or cable	CO 4	Understand
8	a	AAE015.11	Derive the equations longitudinal vibration of a bar or rod, torsional vibration of shaft or rod,	CO 4	Remember
	b	AAE015.13	Solve the problems for lateral vibration of beams, and the Rayleigh-Ritz method.	CO 4	Understand
9	a	AAE015.14	Understand the concepts of transverse vibration of a string or cable	CO 5	Remember
	b	AAE015.15	Understand the concepts of Collar's aeroelastic triangle, static aeroelasticity phenomena	CO 5	Understand
10	a	AAE015.14	Understand the concept of dynamic aeroelasticity phenomena	CO 5	Remember
	b	AAE015.14	Calculate the aeroelastic problems at transonic speeds, aeroelastic tailoring, active flutter suppression. Effect of aeroelasticity in flight vehicle design.	CO 5	Understand

Signature of Course Coordinator **HOD, AE**