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

INSTITUTE OF AERONAUTICAL ENGINEERING

(Autonomous)

Dundigal, Hyderabad - 500 043

MODEL QUESTION PAPER-II

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

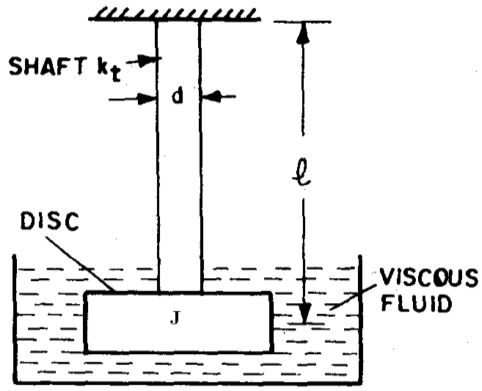
UNIT – I

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

   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. **[7M]**

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. **[7M]**

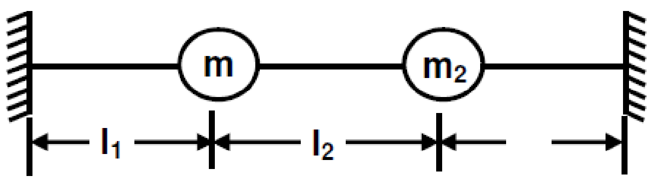
   b) A disc of a torsional pendulum has a moment of inertia of 6E-2 kg-m2 and is immersed in a viscous fluid. The shaft attached to it is 0.4m long and 0.1m in diameter. When the pendulum is oscillating, the observed amplitudes on the same side of the mean position for successive cycles are 90, 60 and 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. **[7M]**



UNIT – II

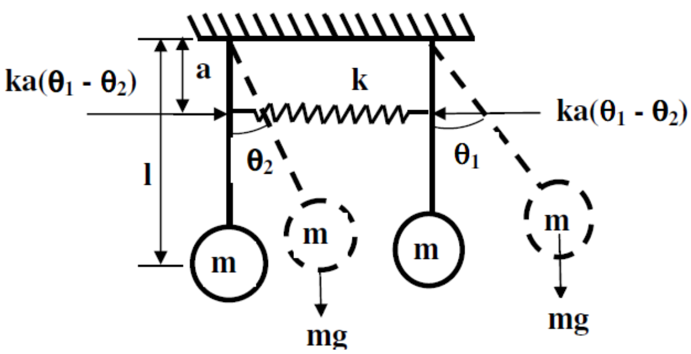
3. a) What is meant by static and dynamic coupling? How can coupling of the equations of motion be eliminated? Derive the governing equations through Lagrange energy approach. **[7M]**

   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 $l_1 = l$, $l_2 = 2l$, $l_3 = 3l$. **[7M]**



4. a) Determine the natural frequencies of undamped dynamic vibration absorber. Derive appropriate expression. **[7M]**

   b) Determine the natural frequencies of the coupled pendulum shown in the figure. Assume that the light spring of stiffness 'k' is un-stretched and the pendulums are vertical in the equilibrium position. **[7M]**



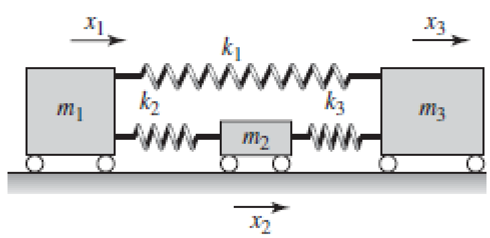
UNIT – III

5. 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. **[7M]**

   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. **[7M]**

6. a) A vibrometre having a natural frequency of 4 rad/s and ζ =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. **[7M]**

   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. **[7M]**



UNIT – IV

7. a) Explain different types of data acquisition systems with compression to merits and demerits of each other. **[7M]**

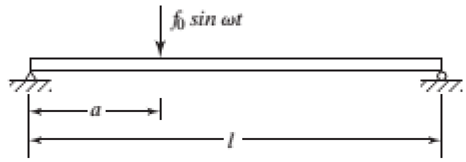
   b) Machine condition monitoring is very important. Explain thro trending analysis and its interpretation. **[7M]**

8. a) Machine condition monitoring is very important. Explain thro trending analysis and its interpretation. **[7M]**

   b) Name two frequency measuring instruments. Explain any one instrument's working principle. **[7M]**

UNIT – V

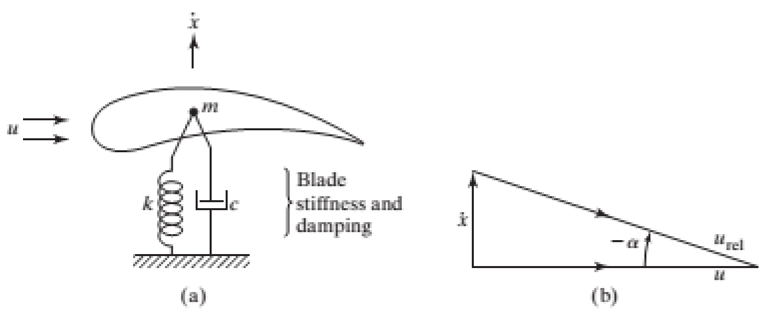
9. a) Find the steady state response of a pinned-pinned beam subject to a harmonic force $f(x,t)=f_0 \sin \omega t$ applied at x=a as shown in the figure. **[7M]**



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. **[7M]**

10. a) Determine the natural frequencies of vibration of a uniform beam fixed at x=0 and simply supported at x=l. **[7M]**

b) Find the value of free-stream velocity u at which the airfoil section (SDOF) shown in Fig becomes unstable **[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	CO 2	Understand

			formulation and development of governing equation based on number of masses in the system.		
	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**