INSTITUTE OF AERONAUTICAL ENGINEERING

(Autonomous)

Dundigal, Hyderabad -500 043

AERONAUTICAL ENGINEERING

TUTORIAL QUESTION BANK

Course Title	**AEROSPACE STRUCTURAL DYNAMICS**				
Course Code	AAE015				
Programme	B.Tech				
Semester	VII	AE			
Course Type	Core				
Regulation	**IARE - R16**				
Course Structure	**Theory**			**Practical**	
	Lectures	**Tutorials**	**Credits**	**Laboratory**	**Credits**
	3	1	4	3	2
Chief Coordinator	Dr. Sudhir Sastry .Y.B, Professor, AE				
Course Faculty	Dr. Sudhir Sastry .Y.B, Professor, AE Mr. T Mahesh Kumar, Assistant Professor, AE				

COURSE OBJECTIVES:

The course should enable the students to:	
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.

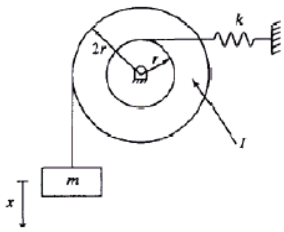
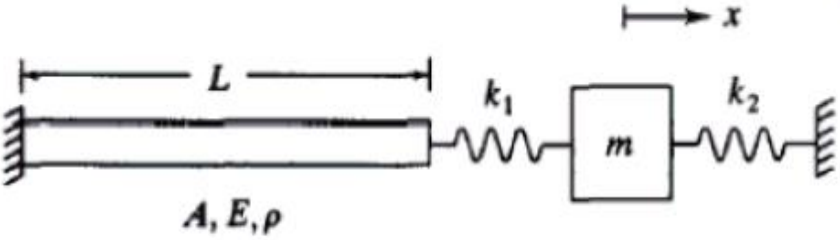
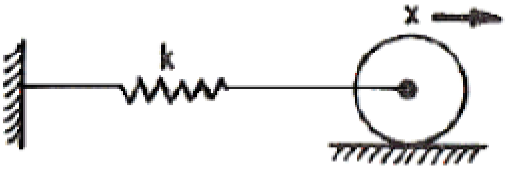
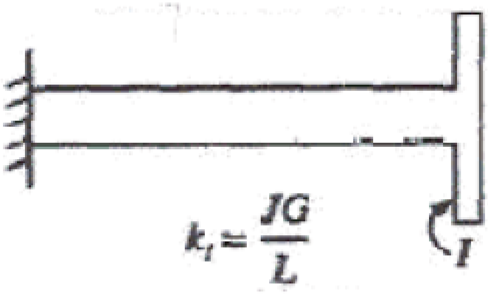
COURSE LEARNING OUTCOMES (CLOs):

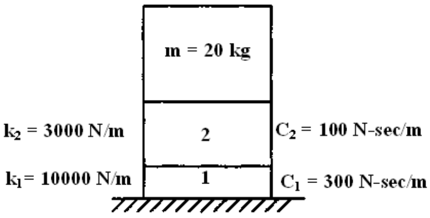
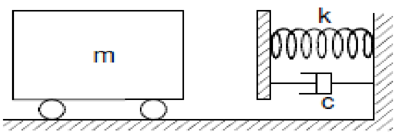
AAE015.01	Apply principles of engineering, basic science, and mathematics (including multivariate calculus and differential equations) to model, analyze, design, and realize physical systems, components or processes, and work professionally in mechanical systems areas.
AAE015.02	Become proficient in the modeling and analysis of one degree of freedom systems - free vibrations, transient and steady-state forced vibrations, viscous and hysteric are 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.

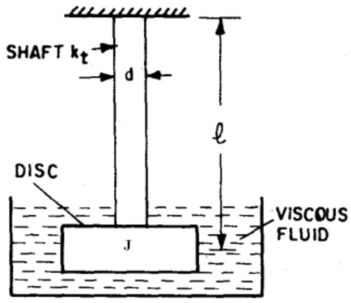
TUTORIAL QUESTION BANK

UNIT – I SINGLE-DEGREE-OF-FREEDOM LINEAR SYSTEMS				
Part - A (Short Answer Questions)				
S No	**QUESTION**	**Blooms Taxonomy Level**	**Course Outcomes**	**Course Outcomes**
1	What is Vibration? Define natural frequency. Why is it important to determine the natural frequency of a vibrating system?	Remember	CO 1	AAE015.1
2	What are the three elementary parts of a vibrating system?	Understand	CO 1	AAE015.1
3	Define the following terms: Free, undamped, damped and forced vibrations.	Understand	CO 1	AAE015.1
4	Define the following terms: Resonance, phase difference, periodic motion, time period, amplitude and degree of freedom.	Understand	CO 1	AAE015.1

5	Distinguish between free and forced vibrations.	Understand	CO 1	AAE015.1
6	Distinguish between damped and undamped vibrations.	Remember	CO 1	AAE015.1
7	Distinguish between Rectilinear and torsional system.	Remember	CO 1	AAE015.1
8	What are the various elements of a vibratory system?	Remember	CO 1	AAE015.1
9	Define longitudinal, transverse and torsional vibrations.	Remember	CO 1	AAE015.1
10	What is Forced Vibration? Give one example.	Remember	CO 1	AAE015.2
11	Write equation of motion for simple vibration system.	Understand	CO 1	AAE015.2
12	Define damping. What is damping ratio?	Remember	CO 1	AAE015.2
13	Give three practical applications of the concept of center of percussion.	Remember	CO 1	AAE015.3
14	What is the difference between a vibration isolator and a vibration absorber?	Remember	CO 1	AAE015.2
15	What is the function of a vibration isolator?	Remember	CO 1	AAE015.3
16	What is a vibration absorber?	Remember	CO 1	AAE015.2
17	Define the transmissibility. Write the expression for motion transmissibility.	Remember	CO 1	AAE015.2
18	What happens to the response of an undamped system at resonance?	Understand	CO 1	AAE015.3
19	Why does the amplitude of free vibration gradually diminish in practical systems?	Remember	CO 1	AAE015.2
20	Define the term magnification factor.	Remember	CO 1	AAE015.2
21	Indicate some methods for finding the response of a system under non periodic forces.	Remember	CO 1	AAE015.2
22	What is a response spectrum? And what are engineering applications?	Remember	CO 1	AAE015.2
23	How is the Laplace transformation of a function x(t) defined and advantages of this transformation method.	Understand	CO 1	AAE015.2
24	Define unit impulse, unit step and unit ramp functions?	Remember	CO 1	AAE015.3
Part - B (Long Answer Questions)				
1	Discuss the response of under damped , critically damped and over damped systems using respective response equations and curves.	Remember	CO 1	AAE015.1
2	A machine part of mass 2.5Kg vibrates in a viscous medium. A harmonic exiting force of 30N acts on the part and causes resonant amplitude of 14mm with a period of 0.22 sec. Find the damping coefficient if the frequency of the exciting force is changed to 4Hz. Determine the increase in the amplitude of forced vibration upon removal of the damper.	Understand	CO 1	AAE015.1
3	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.	Remember	CO 1	AAE015.2
4	In a particular case of a large canon, the gun barrel and recoil mechanism have a mass of 500kg with recoil spring stiffness 10,000N/m. The gun recoils 0.4m upon firing. Find i) Critical damping co efficient of the damper. (ii) Initial recoil velocity of the gun.	Understand	CO 1	AAE015.2
5	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.	Understand	CO 1	AAE015.2
6	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	AAE015.1

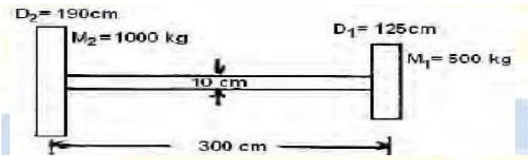
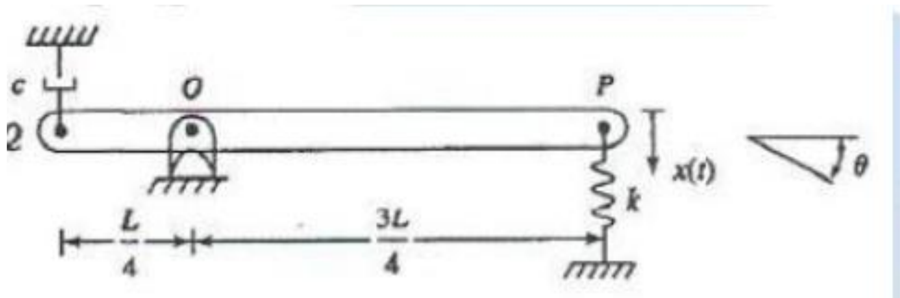
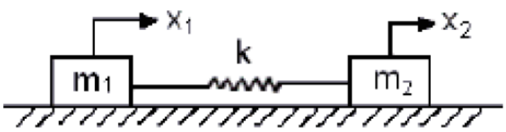
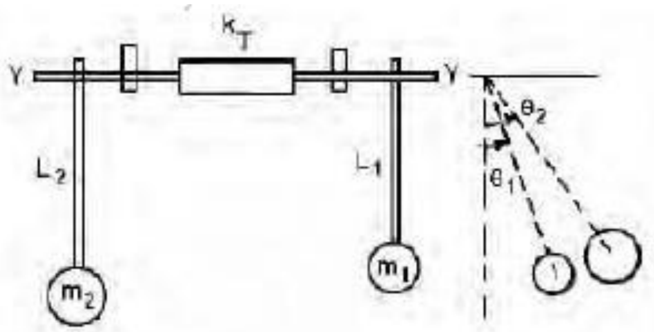
7	Determine the frequency of oscillations for the system shown in fig. Also determine the time period if m = 4 kg and r = 80 mm. 	Understand	CO 1	AAE015.3
8	Find the equivalent stiffness, frequency and time period for the system shown in figure below. If K_1=200 N/m, K_2= 100N/m, m= 20Kg, L= 2000mm, A= 100m^2, density is 7200kg/mm^3 	Remember	CO 1	AAE015.2
9	A circular cylinder of mass m and radius r is connected by a spring of stiffness k as shown in fig. If it is free to roll on the rough surface which is horizontal without slipping, determine the natural frequency. 	Remember	CO 1	AAE015.1
10	A wheel is mounted on a steel shaft (G = 8 3 * 1 0 ^{9} N/m2) of length 1.5m and 0.80 cm. The wheel is rotated 5o and released. The period of oscillation is observed as 2.3s. Determine the mass moment of inertia of the wheel. 	Remember	CO 1	AAE015.2
11	Derive the convolution integral for a single degree of freedom subjected to an impulse.	Understand	CO 1	AAE015.3
12	In the vibration testing of a structure, an impact hammer with a load cell to measure the impact force is used to cause excitation. Assuming m=5kg, k=2000n/m, c=10Ns/m and F=20 N. Find the response of the system.	Remember	CO 1	AAE015.3
13	Explain the terms generalized impedance and admittance of a system.	Remember	CO 1	AAE015.2
14	Find the undamped response spectrum for the sinusoidal pulse force using initial conditions x(0)=0,dx/dt (0)=0.	Understand	CO 1	AAE015.2

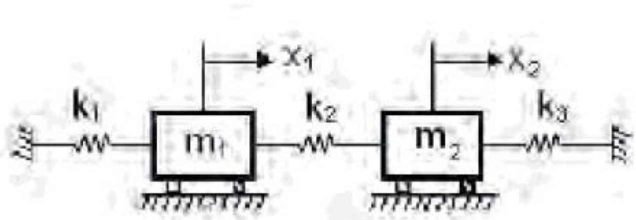
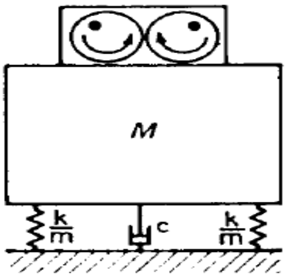
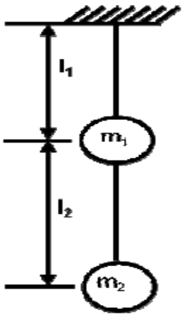
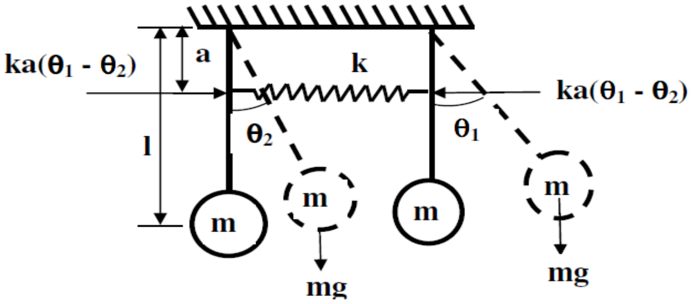
15	A compacting machine modelled as a single d.o.f system. the force on the mass m due to a sudden application of pressure can be idealized as a step force. Determine the response of the system.	Understand	CO 1	AAE015.2
16	Use the convolution integral to determine the response of an undamped 1- degree-of-freedom system of natural frequency ω_n and m when subject to a constant force of magnitude F_0. The system is at rest in equilibrium at t=0.	Remember	CO 1	AAE015.2
17	Use the convolution integral to determine the response of an undamped 1- degree-of-freedom system of natural frequency ω_n, damping ratio and mass m when subject to a constant force of magnitude F_0. The system is at rest in equilibrium at t=0.	Remember	CO 1	AAE015.2
18	Use the convolution integral to determine the response of an undamped 1- degree-of-freedom system of natural frequency ω_n and mass m when subject to a time-dependent excitation of the form $F(t)=F_0e^{-\alpha t}$. The system is at rest in equilibrium at *t=0.*	Understand	CO 1	AAE015.2
19	Use the convolution integral to determine the response of an undamped 1- degree-of-freedom system of natural frequency ω_n and mass m when subject to a harmonic excitation of the form $F(t)=F_0 \sin \omega t$ with.	Remember	CO 1	AAE015.2
20	Use the Laplace transform method to determine the response of an under damped 1 DOF system of damping ratio , natural frequency ω_n, mass m, initially at rest in equilibrium and subject to a series of applied impulses each of magnitude I, beginning at t=0 and each a time t_0 apart.	Remember	CO 1	AAE015.2
Part - C (Problem Solving and Critical Thinking Questions)				
1	The mass of a spring-mass-dashpot system is given an initial velocity 5_n, where is the undamped natural frequency of the system. Find the equation of motion for the system.	Remember	CO 1	AAE015.2
2	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.  Fig Q (2)	Understand	CO 1	AAE015.2
3	A gun barrel of mass 500kg has a recoil spring of stiffness 3, 00,000 N/m. If the barrel recoils 1.2 meters on firing, determine, (a) initial velocity of the barrel (b) critical damping coefficient of the dashpot which is engaged at the end of the recoil stroke (c) Time required for the barrel to return to a position 50mm from the initial Position.	Understand	CO 1	AAE015.2
4	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	AAE015.2
5	A rail road bumper is designed as a spring in parallel with a viscous damper. What is the bumper's damping coefficient such that the system has a damping ratio of 1.25, when the bumper is engaged by a rail car of 20000 kg mass. The stiffness of the spring is 2E5 N/m. If the rail car engages the bumper, while traveling at a speed of 20m/s, what is the maximum deflection of the bumper? 	Remember	CO 1	AAE015.2

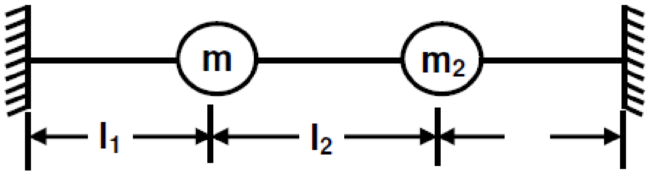
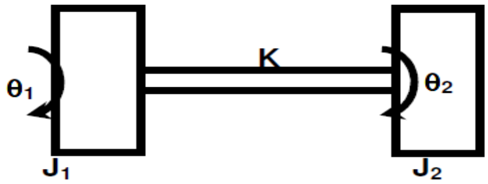
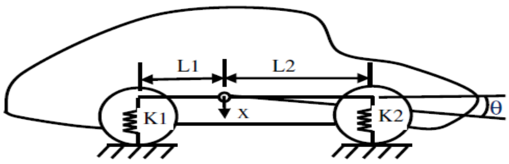
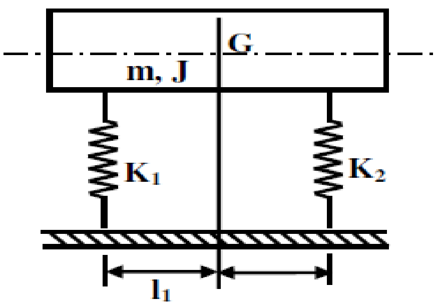
6	A disc of a torsional pendulum has a moment of inertia of 6E-2 kg-m2 and is immersed in a viscous fluid. The shaft attached to it is 0.4m long and 0.1m in diameter. When the pendulum is oscillating, the observed amplitudes on the same side of the mean position for successive cycles are 90, 60 and 40. 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. 	Understand	CO 1	AAE015.2
7	A mass of 1 kg is to be supported on a spring having a stiffness of 9800 N/m. The Damping coefficient is 5.9 N-sec/m. Determine the natural frequency of the system. Find also the logarithmic decrement and the amplitude after three cycles if the Initial displacement is 0.003m.	Remember	CO 1	AAE015.2
8	The damped vibration record of a spring-mass-dashpot system shows the Following data. Amplitude on second cycle = 0.012m; Amplitude on third cycle = 0.0105m; Spring constant k = 7840 N/m; Mass m = 2kg. Determine the damping constant, Assuming it to be viscous.	Remember	CO 1	AAE015.2
9	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**.**	Remember	CO 1	AAE015.2
10	A system of beam supports a mass of 1200 kg. The motor has an unbalanced mass of 1 kg located at 6 cm radius. It is known that the resonance occurs at 2210 rpm. What amplitude of vibration can be expected at the motors operating speed of 1440 rpm if the damping factor is assumed to be less than 0.1?	Understand	CO 1	AAE015.2
11	An eccentric mass exciter is used to determine the vibratory characteristics of a structure of mass 200 kg. At a speed of 1000 rpm a stroboscope showed the eccentric mass to be at the bottom position at the instant the structure was moving downward through its static equilibrium position and the corresponding amplitude was 20 mm. If the unbalance of the eccentric is 0.05 kg-m, determine, (a) un damped natural frequency of the system (b) the damping factor of the structure (c) the angular position of the eccentric at 1300 rpm at the instant when the structure is moving downward through its equilibrium position.	Remember	CO 1	AAE015.2
12	A 40 kg machine is supported by four springs each of stiffness 250 N/m. The rotor is unbalanced such that the unbalance effect is equivalent to a mass of 5 kg located at 50mm from the axis of rotation. Find the amplitude of vibration when the rotor rotates at 1000 rpm and 60 rpm. Assume damping coefficient to be 0.15.	Remember	CO 1	AAE015.3
13	A vertical single stage air compressor having a mass of 500 kg is mounted on springs having a stiffness of 1.96×105 N/m and a damping coefficient of 0.2. The rotating parts are completely balanced and the equivalent reciprocating parts have a mass of 20 kg. The stroke is 0.2 m. Determine the dynamic amplitude of vertical motion and the phase difference between the motion and excitation force if the compressor is operated at 200 rpm.	Remember	CO 1	AAE015.3
14	The support of a spring mass system is vibrating with amplitude of 5 mm and a frequency of 1150 cpm. If the mass is 0.9 kg and the stiffness of springs is 1960 N/m, Determine the amplitude of vibration of mass. What amplitude will result if a damping factor of 0.2 is included in the system?	Remember	CO 1	AAE015.3
15	The springs of an automobile trailer are compressed 0.1 m under its own weight. Find the critical speed when the trailer is travelling over a road with a profile approximated by a sine wave of amplitude 0.08 m and a wavelength of 14 m. What will be the amplitude of vibration at 60 km/hr.	Remember	CO 1	AAE015.3

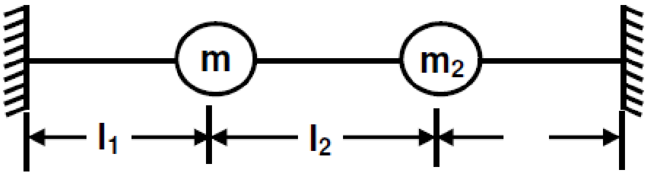
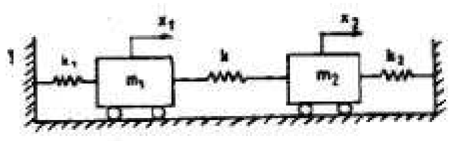
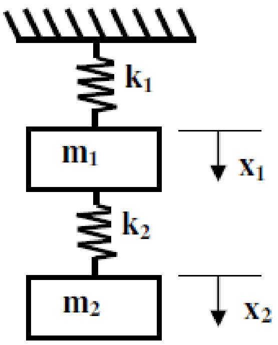
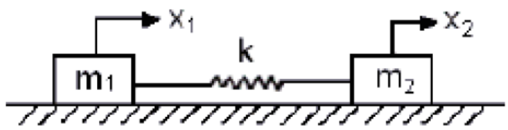
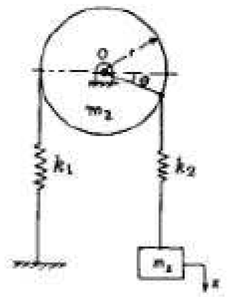
16	A heavy machine of 3000 N, is supported on a resilient foundation. The static deflection of the foundation due to the weight of the machine is found to be 7.5 cm. It is observed that the machine vibrates with an amplitude of 1 cm when the base of the machine is subjected to harmonic oscillations at the undamped natural frequency of the system with an amplitude of 0.25 cm. Find (a) the damping constant of the foundation (b) the dynamic force amplitude on the base (c) the amplitude of the displacement of the machine relative to the base.	Remember	CO 1	AAE015.3
17	The time of free vibration of a mass hung from the end of a helical spring is 0.8 s. When the mass is stationary, the upper end is made to move upwards with displacement *y* mm given by $y = 18 \sin 2\pi t$, where t is time in seconds measured from the beginning of the motion. Neglecting the mass of spring and damping effect, determine the vertical distance through which the mass is moved in the first 0.3 seconds.	Understand	CO 1	AAE015.2

UNIT - II MULTI-DEGREE-OF-FREEDOM LINEAR SYSTEMS				
Part – A (Short Answer Questions)				
1	Write the frequency equation for the two DOF spring mass systems.	Remember	CO 2	AAE015.4
2	Write the frequency equation for the two DOF torsional systems.	Remember	CO 2	AAE015.4
3	What is the main disadvantage of a dynamic vibration absorber?	Understand	CO 2	AAE015.5
4	What is coordinate coupling?	Remember	CO 2	AAE015.5
5	What are static and dynamic couplings?	Remember	CO 2	AAE015.6
6	Define mass coupling.	Remember	CO 2	AAE015.4
7	Define velocity coupling.	Understand	CO 2	AAE015.4
8	Define elasticity coupling.	Remember	CO 2	AAE015.4
9	What is semi definite system?	Understand	CO 2	AAE015.4
10	Write a short note on principal mode of vibration.	Remember	CO 2	AAE015.6
11	What are generalized coordinates?	Understand	CO 2	AAE015.6
12	What are principle coordinates?	Remember	CO 2	AAE015.4
13	Write a short note on Orthogonality principle as applied to two degree freedom system.	Remember	CO 2	AAE015.4
14	What is the basic working principle of a dynamic vibration absorber?	Remember	CO 2	AAE015.5
15	How can we make system vibrate in one of its natural modes?	Remember	CO 2	AAE015.6
16	In a two D.O.F spring mass system, explain how Dynamic coupling exists.	Understand	CO 2	AAE015.4
17	What are principal co-ordinates when the system h subjected to linear as well as angular displacement?	Remember	CO 2	AAE015.6
18	Under what conditions a tuned absorber exists?	Understand	CO 2	AAE015.6
19	Explain conditions that are to be satisfied for a Ring tensional vibration absorber.	Remember	CO 2	AAE015.4
20	What in the principle of working in a Houdille unturned damper?	Remember	CO 2	AAE015.4
Part - B (Long Answer Questions)				
1	Obtain the frequency equation for the two DOF spring mass systems. Also determine the natural frequencies and mode shapes. Assume m_1 , m_2 ,k_1 and k_2 for governing equations.	Understand	CO 2	AAE015.5
2	Obtain the frequency equation for the two DOF torsional systems. Also determine the natural frequencies and mode shapes. Assume J_1 , J_2 ,kt_1 and kt_2 for governing equations.	Understand	CO 2	AAE015.4
3	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.	Remember	CO 2	AAE015.4

4	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	AAE015.4
5	Determine the natural frequency of torsional vibrations of a shaft with two circularises of uniform thickness at the ends. The masses of the discs are M1= 500 kg andM2 = 1000 kg and their outer diameters are D1 = 125 cm and D2 = 190 cm. The length of the shaft is l = 300 cm and its diameter d = 10 cm as shown in fig. G = 0.83 x 10^{11}N/m^2 	Understand	CO 2	AAE015.6
6	A slender rod of length L and mass m is pinned at O as shown in figure below. A spring of stiffness K is connected to the rod at point P while a dashpot of damping coefficient c is connected to the rod at point Q. Assuming small displacements; Derive a linear differential equation governing the free vibration of this system. Use the displacement of the point P, measured from the systems equilibrium position as the generalized coordinate. 	Understand	CO 2	AAE015.4
7	Solve the problem shown in figure. m1=10kg, m2=15kg and k = 320 N/m. 	Remember	CO 2	AAE015.4
8	Two pendulums of different lengths are free to rotate y-y axis and coupled together by a rubber hose of torsional stiffness 7.35 X 103 Nm / rad as shown in figure. Determine the natural frequencies of the system if masses m1 = 3kg, m2 = 4kg, L1 = 0.30 m, L2 = 0.35 m. 	Understand	CO 2	AAE015.4

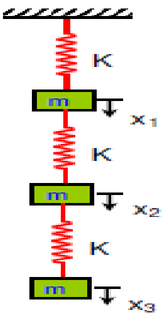
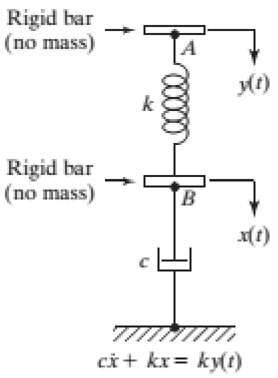
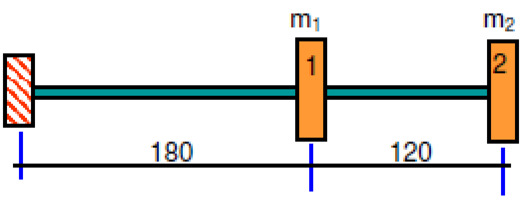
9	Determine the modes of vibrations for the system shown in figure. 	Remember	CO 2	AAE015.6
10	A counter rotating eccentric weight exciter is used to produce the forced oscillation of a spring-supported mass as shown in Fig. By varying the speed of rotation, resonant amplitude of 0.60 cm was recorded. When the speed of rotation was increase considerably beyond the resonant frequency, the amplitude appeared to approach a fixed value of 0.08 cm. Determine the damping factor of the system. 	Understand	CO 2	AAE015.6
11	Derive the frequency equation for a double pendulum shown in figure. Determine the natural frequency and mode shapes of the double pendulum when $m_1=m_2=m$, $l_1=l_2=l$. 	Understand	CO 2	AAE015.5
12	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. 	Remember	CO 2	AAE015.4

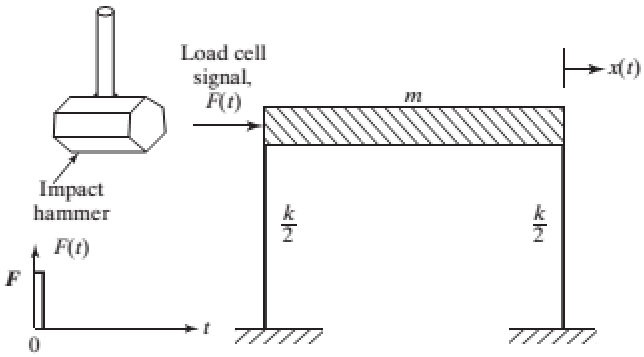
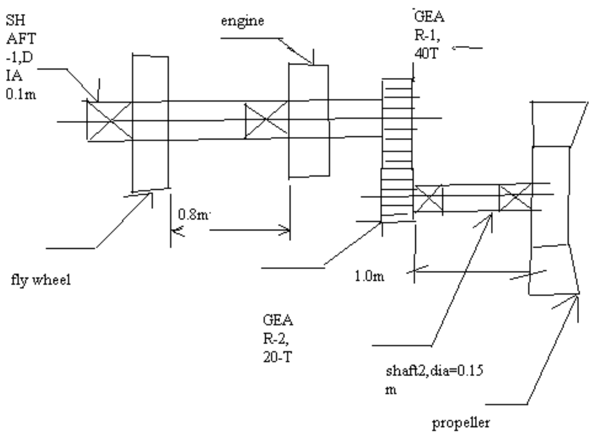
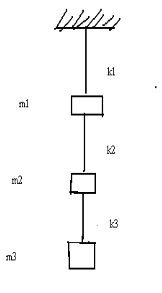
13	Derive the equation of motion of the system shown in figure. Assume that the initial tension 'T' in the string is too large and remains constants for small amplitudes. Determine the natural frequencies, the ratio of amplitudes and locate the nodes for each mode of vibrations when $m_1 = m_2 = m$ and $l_1 = l_2 = l_3 = l$. 	Remember	CO 2	AAE015.4
14	Derive the equation of motion of a torsional system shown in figure  Figure Two Rotor System	Remember	CO 2	AAE015.4
15	For the system shown in fig find the two natural frequencies when $m_1=m_2=9.8$ kg $K_1=K_3=8820$N/m, $K_2=3430$N\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.	Remember	CO 2	AAE015.4
16	Explain the working principle of Bifilar Suspension absorber with a neat diagram.	Remember	CO 2	AAE015.4
17	A diesel Engine weighing 3000N, supported on a pedestal mount. It has been observed that the engine induces vibration into the surrounding area through L'ts pedestal mount at an operating speed of 6000rpm. Determine the parameters of the exciting force in 250N and amplitude of the motion of the auxiliary mass in limited to 2mm.	Remember	CO 2	AAE015.4
18	With a neat sketch, derive the governing equation of the Ring Tensional absorber.	Remember	CO 2	AAE015.4
19	Explain the absorber principle in the case of centrifugal pendulum absorber from the first principles.	Remember	CO 2	AAE015.4
20	Draw and explain the amplitude and phase plots in a dynamic Vibration absorber.	Remember	CO 2	AAE015.4
	Part – C (Problem Solving and Critical Thinking)			
1	Determine the normal mode of vibration of an automobile shown in figure. Simulated by a simplified two degree of freedom system with the following numerical values m = 1460 kg, L1 = 1.35m, L2 = 2.65 m, K1 = 4.2x105N/m, K2 = 4.55x105 N/m and J=mr2 where r= 1.22 m. 	Understand	CO 2	AAE015.4
2	Determine the natural frequencies and mode shape of un-damped coordinate coupling system with two degrees of freedom. 	Understand	CO 2	AAE015.4

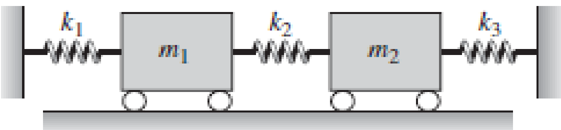
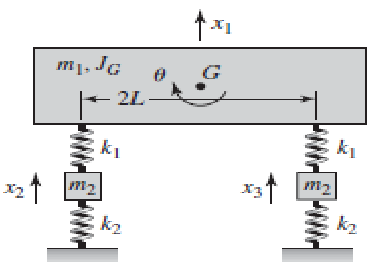
3	Determine the natural frequencies of undamped dynamic vibration absorber.	Remember	CO 2	AAE015.4
4	Determine the frequencies and the location of oscillation centres of an automobile with the following data: m= 1000kg, r_g=0.9m, distance between the front axle and centre of gravity=1m, distance between the rear axle and centre of gravity =1.5m. Front spring stiffness, k_1=8 K/m, rear sprig stiffness k_2= 22KN/m.	Remember	CO 2	AAE015.4
5	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. 	Understand	CO 2	AAE015.4
6	Determine the natural frequencies, the ratio of amplitudes and locate the nodes for each mode of vibrations when m_1 = m_2= m. 	Remember	CO 2	AAE015.5
7	Figure shows a vibrating system having two DOF. Determine the two natural frequencies of vibrations and the ratio of amplitudes of the motion of m1 and m2for the two modes of vibrations. 	Understand	CO 2	AAE015.6
8	Solve the problem shown in figure. m_1= 20kg, m_2= 35kg and k= 360 N/m. 	Remember	CO 2	AAE015.6
9	Find the natural frequencies of the system shown in figure. Assume that there is no slip between the cord and cylinder. K_1= 40 N/m, k_2= 60N/m, m_1= 2kg, m_2= 10kg. 	Understand	CO 2	AAE015.6

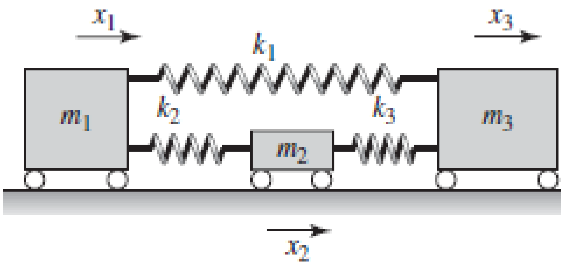
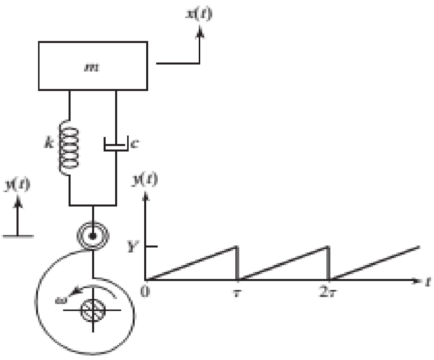
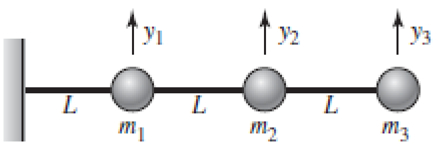
10	For the system shown in fig find the two natural frequencies when $m_1=m_2=9.8$ kg $K_1=K_3=8820N/m$, $K_2=3430N\m$. Find out the resultant motions of m_1 and m_2 for the following cases. The displacements mentioned below are from the equilibrium positions of the respective masses. Mass m1 displaced 5mm downward and mass m2 is displaced 7.5mm downwards both masses are released simultaneously. Mass m_1 displaced 5mm upward while m2 is held fixed. Both masses are then released simultaneously.	Understand	CO 2	AAE015.6

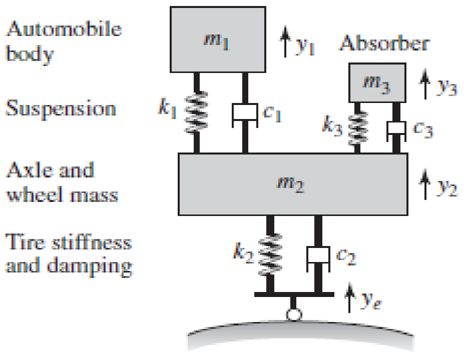
UNIT-III NONLINEAR AND RANDOM VIBRATION				
Part - A (Short Answer Questions)				
1	How can we make a system to vibrate in one of its natural made?	Remember	CO 3	AAE015.7
2	Name a few methods for finding the fundamental natural frequency of a multi degree of freedom system.	Understand	CO 3	AAE015.7
3	What is the matrix iteration method?	Understand	CO 3	AAE015.8
4	Can we use any trial vector in the matrix iteration method to find the largest natural frequency?	Understand	CO 3	AAE015.7
5	What is the difference between the matrix iteration method and Jacobi's method?	Understand	CO 3	AAE015.8
6	Using the matrix iteration method, how do you find the intermediate natural frequencies?	Understand	CO 3	AAE015.8
7	What are the different methods by which a vibrating system having several degrees of freedom can be analysed?	Remember	CO 3	AAE015.9
8	State Maxwell reciprocal theorem.	Remember	CO 3	AAE015.8
9	Distinguish between flexibility influence coefficient and stiffness coefficient.	Understand	CO 3	AAE015.9
10	Define stiffness influence coefficient as applicable to multi degree freedom vibrations.	Remember		AAE015.9
MID-II				
11	Write short notes on matrix iteration method as applied to multi degree freedom.	Understand	CO 3	AAE015.9
12	Write short notes on orthogonality principle.	Understand	CO 3	AAE015.9
13	What is mode shape?	Remember	CO 3	AAE015.7
14	State orthogonality principle in case of multi degree freedom system.	Understand	CO 3	AAE015.7
15	Write short notes on modal analysis.	Remember	CO 3	AAE015.8
16	What is the difference between vibiometer and Velometer?	Understand	CO 3	AAE015.4
17	What is the need for vibration measuring instruments?	Understand	CO 3	AAE015.4
18	Draw the sketch of a seismic instrument and label the parts.	Understand	CO 3	AAE015.4
19	Write the governing equation for the instrument we the low natural frequency and Name the instrument.	Understand	CO 3	AAE015.4
20	An instrument having high fundamental frequency. What is the governing equation and name of the instrument?	Understand	CO 3	AAE015.4
Part - B (Long Answer Questions)				
1	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.	Understand	CO 3	AAE015.7
2	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.	Remember	CO 3	AAE015.7

3	A simple model of a motor vehicle can vibrate in the vertical direction while travelling over a rough road. The vehicle has a mass of 1200kg.The suspension system has a spring constant of 400KN/m and a damping ratio of ζ=0.5.If the vehicle speed is 20km/hr, determine the displacement amplitude of the vehicle mounted with vibrometre. The road surface varies sinusoidal with amplitude Y=0.05 and wave length of 6m.	Remember	CO 3	AAE015.7
4	Obtain the approximate fundamental natural frequency of the linear spring system shown in Fig. using matrix method. 	Understand	CO 3	AAE015.8
5	Find the response of the spring damper system shown in figure. Subjected to a periodic force with equation of motion. 	Understand	CO 3	AAE015.8
6	Determine the response of a spring mass damper system subjected to a periodic force with the equation of motion given by $m\ddot{x} + c\dot{x} + kx = F(t) = \frac{a_0}{2} + \sum_{j=1}^{\infty} a_j \cos j\omega t + \sum_{j=1}^{\infty} b_j \sin j\omega t$. Assume the initial conditions as zero.	Understand	CO 3	AAE015.9
7	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	AAE015.9

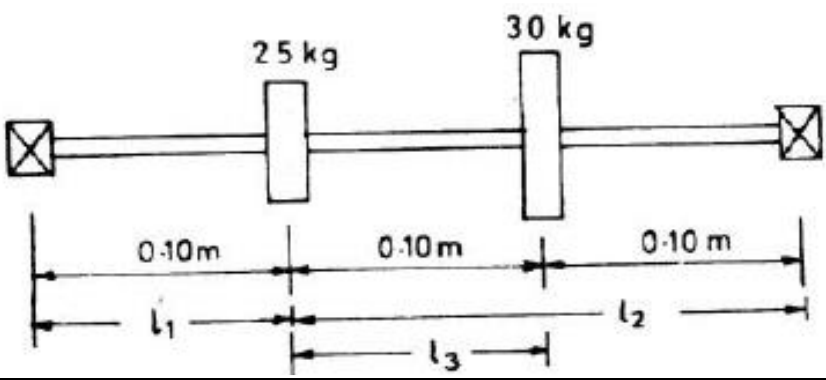
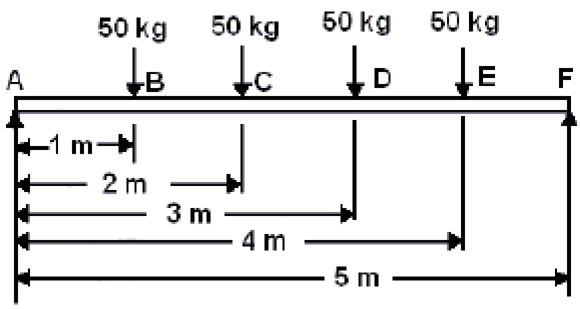
8	In the vibration testing of a structure an impact hammer with a load cell to measure the impact force is used to cause excitation as shown in fig. Assuming m=5Kg, k=2000N/m, c=10N-s/m, and F=20N-s. Find the response of the system.  	Understand	CO 3	AAE015.9
9	Find the total response of a viscously damped single degree of freedom system subjected to a harmonic base excitation for the following data m=10Kg c=20N-s/m, k=4000N/m, y(t)=0.05sin 5t m, x_0=0.02 m, $\dot{x}_0$=10 m/s	Remember	CO 3	AAE015.9
10	The schematic diagram of a marine engine connected to a propeller thro gears as shown in fig. The moment of inertia of the flywheel =9000kg-m^2,engine=1000kg-m^2,gear1=250 kg-m^2,gear2=150 kgm^2,propeller=2000kg-m^2.find the natural frequencies and mode shapes of the system in torsional vibration. Considering inertia of the gears Considering inertia of the gears.  	Remember	CO 3	AAE015.9
	MID-II			
11	Explain principle of orthogonality of modal vectors.  	Understand	CO 3	AAE015.9
12	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.	Understand	CO 3	AAE015.8
13	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	AAE015.8

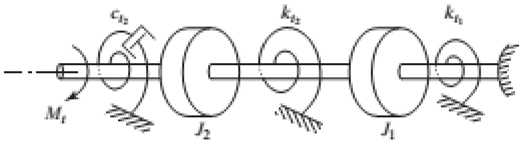
14	Seismic instrument has natural frequency of 6 Hz. What is the lowest frequency beyond which the amplitude can be measured within 2% error? Neglect damping.	Understand	CO 3	AAE015.8
15	Seismic instrument has natural frequency of 6 Hz. What is the lowest frequency beyond which the amplitude can be measured within 2% error?	Understand	CO 3	AAE015.7
16	A vibrometer with a natural frequency of 2 Hz and with negligible damping is attached to a vibrating system which performs a harmonic motion. Assuming the difference between the maximum and minimum recorded value as 0.6mm, determine the amplitude of motion of the vibrating system when its frequency is (i) 20Hz (ii) 4Hz.	Remember	CO 3	AAE015.7
17	An accelerometer having natural frequency of 1000cpm and a damping factor of 0.7 is attached to a vibrating system. Determine the maximum acceleration of the system when the recorded amplitude is $\omega^2 Z$=0.5m/s^2 when the system performs a harmonic motion at (i) 400 cpm (ii) 800cpm.	Understand	CO 3	AAE015.7
18	An undamped vibration pickup having a natural frequency of 1Hz is used to measure a harmonic vibration of 4Hz. If the amplitude recorded is 0.52mm, what is the correct amplitude?	Remember	CO 3	AAE015.7
19	A seismic instrument is mounted on a machine running at 1200 rpm. The natural frequency of the seismic instrument is 30 rad/sec. The instrument records relative amplitude of 0.7 mm. Compute the displacement, velocity and acceleration of the machine. Damping in seismic instrument is neglected.	Remember	CO 3	AAE015.8
20	A commercial type vibration pick up has a natural frequency of 6cps and a damping factor ζ=0.8.calculate the relative displacement amplitude if the instrument is subject to motion x=0.1sin 30t.	Understand	CO 3	AAE015.9
	Part – C (Problem Solving and Critical Thinking)			
1	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.	Understand	CO 3	AAE015.7
2	Determine the natural frequencies and mode shapes associated with the system shown in Figure for *m*1 = 10 kg, *m*2 = 20 kg, *k*1 = 100 N/m, *k*2 = 100 N/m, and *k*3 = 50 N/m. 	Remember	CO 3	AAE015.7
3	An elastically supported machine tool with a total mass of 4000 kg has a resonance frequency of 80 Hz. An 800 kg absorber system with a natural frequency of 80 Hz is attached to the machine tool. Determine the natural frequencies and mode shapes of this system.	Remember	CO 3	AAE015.7
4	One model that has been used to study the vibratory motion of motor vehicles is shown in Figure. The body of the vehicle has a mass *m*1 and a rotary inertia J_G about an axis through the center. The elasticity of the tires is represented by springs k_2, and the elasticity of the suspension by springs *k*1. The mass of the tire assemblies is m_2. a) Determine the matrix form for the governing equations of the system. b) Obtain the natural frequencies and mode shapes for the case where *m*1 = 800 kg, m_2 = 25 kg, k_1= 60 kN/m, k_2 =20 kN/m, *L* = 1.4 m, and J_G= 180 kg m2. 	Understand	CO 3	AAE015.8

5	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. 	Understand	CO 3	AAE015.7
MID-II				
6	Determine the modal mass, modal stiffness, and modal damping factors associated with the system whose mass matrix, stiffness matrix, and damping matrix are given by the following: $$[M] = \begin{bmatrix} 1 & 0 \\ 0 & 2 \end{bmatrix}, \quad [K] = \begin{bmatrix} 1 & -1 \\ -1 & 2 \end{bmatrix},$$ $$[C] = \begin{bmatrix} 3 & -2 \\ -2 & 6 \end{bmatrix}$$	Remember	CO 3	AAE015.8
7	The base of a spring mass damper system is subjected to the periodic displacement shown in fig. Determine the response of the mass using the principle of superposition. 	Remember	CO 3	AAE015.9
8	An instrument for measuring accelerations records 30 oscillation/sec. The natural frequency of the instrument is 800 cycles/sec. What is the acceleration of the machine part to which the instrument is attached if the amplitude recorded is 0.02mm? What is the amplitude of vibration of the machine part?	Understand	CO 3	AAE015.9
9	Consider the system shown in Figure E8.10 in which the three masses $m1$, $m2$, and $m3$ are located on a uniform cantilever beam with flexural rigidity EI. The inverse of the stiffness matrix for this system, which is called the flexibility matrix, is given by $$[K]^{-1} = \frac{L^3}{3EI}\begin{bmatrix} 27 & 14 & 4 \\ 14 & 8 & 2.5 \\ 4 & 2.5 & 1 \end{bmatrix}$$ If the masses of the system are all identical; that is, $m_1 = m_2 = m_3 = m$, then determine the response of this system when it is forced sinusoidally at the location of mass m_2 with a forcing amplitude F_2 and an excitation frequency v. 	Understand	CO 3	AAE015.9

10	Derive the equations of motion of the vehicle model shown in Figure 	Understand	CO 3	AAE015.9

UNIT-IV DYNAMICS OF CONTINUOUS ELASTIC BODIES				
Part – A (Short Answer Questions)				
1	Why vibration analysis is important to monitor the condition of machine?	Understand	CO 4	AAE015.10
2	Write a short note on fast Fourier transform Theory?	Remember	CO 4	AAE015.10
3	What is complex fast Fourier transform theory?	Remember	CO 4	AAE015.10
4	Name some signal measurement and display units?	Remember	CO 4	AAE015.11
5	Name few vibration and acoustic measurement sensors.	Remember	CO 4	AAE015.11
6	Name sources of vibrations in mechanical systems.	Remember	CO 4	AAE015.12
7	Explain the vibration phenomenon due to mechanical motion and force.	Understand	CO 4	AAE015.11
8	Reciprocating linear motion machinery causes vibration why?	Understand	CO 4	AAE015.11
9	Write a short note on root cause analysis.	Remember	CO 4	AAE015.10
10	Explain flow induced vibrations in mechanical systems.	Remember	CO 4	AAE015.11
11	Write a short note on machine train monitoring parameters.	Understand	CO 4	AAE015.12
12	Monitoring the overall mechanical condition of machinery for more than 20 years. In this case what type system to be used for analysis?	Understand	CO 4	AAE015.12
13	What types of instrumentation systems are used for condition monitoring of machines?	Remember	CO 4	AAE015.11
14	Change in vibration amplitude in an indication of a compounding change in operating system. Name the type of analysis technique to be used and explain.	Remember	CO 4	AAE015.12
15	Name different types of data types acquired and displaced in a vibrating system.	Understand	CO 4	AAE015.10
16	Write a short note on computer based instrumentation system.	Understand	CO 4	AAE015.10
17	What is the major limitation of the velocity transducer indicate the range.	Remember	CO 4	AAE015.11
18	Write short notes on time domain analysis.	Remember	CO 4	AAE015.11
19	What are the factors to be considered for acquiring data in a vibration system?	Remember	CO 4	AAE015.11
20	State three methods of representing frequency response data.	Understand	CO 4	AAE015.12
Part – B (Long Answer Questions)				
1	Explain trending analysis.	Remember	CO 4	AAE015.10
2	Explain failure node analysis.	Understand	CO 4	AAE015.12
3	Explain root cause analysis.	Remember	CO 4	AAE015.12
4	Explain signature analysis.	Understand	CO 4	AAE015.11
5	Explain machine monitoring parameters.	Remember	CO 4	AAE015.10
6	Explain vibration data acquisition.	Remember	CO 4	AAE015.10
7	Explain briefly frequency domain analysis.	Remember	CO 4	AAE015.10
8	Explain bode plots for amplitude and phase to represent the seismic and accelerometer range.	Understand	CO 4	AAE015.11
9	Explain what is a seismic Instrument and frequency range?	Remember	CO 4	AAE015.14

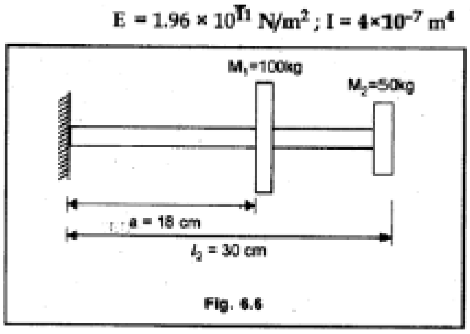
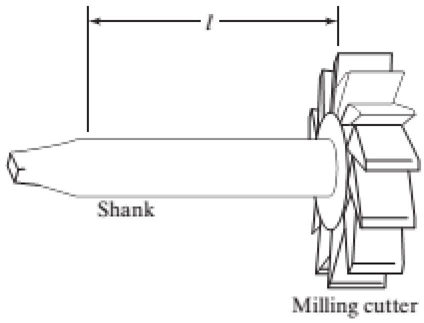
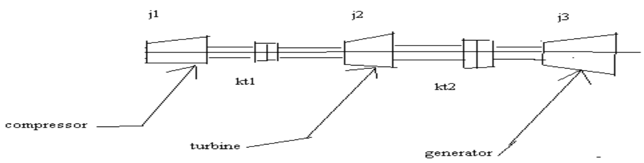
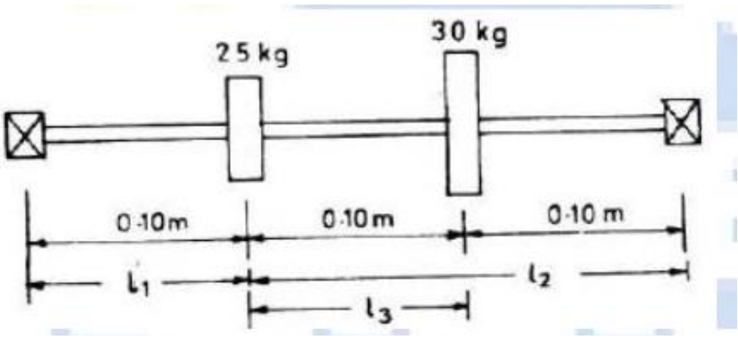
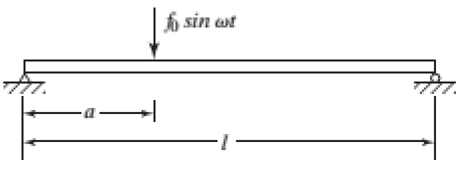
10	Explain what is the advantage of experimental modes Analysis?	Remember	CO 4	AAE015.14
11	Explain how are a bit used in machine diagnostics.	Remember	CO 4	AAE015.13
12	Explain the principle of mode Superposition. What is its use in model Analysis?	Understand	CO 4	AAE015.13
13	Name two frequency measuring instruments. Explain any one instrument's working principle.	Remember	CO 4	AAE015.14
14	State the three types of maintenance schemes used for machinery.	Understand	CO 4	AAE015.15
15	Time-domain wave farms can be used to detect dushate damages of the machinery. Explain.	Remember	CO 4	AAE015.14
16	A spectrum Analyser is a device that analyses a signal in the frequency domain. Explain in detail the working.	Remember	CO 4	AAE015.14
17	Compare theoretical and Real-time harmonic profiles of the vibrating systems with explanation.	Remember	CO 4	AAE015.13
18	Draw and explain working of accelerometer for vibration pickup in a mechanical system.	Understand	CO 4	AAE015.14
19	Name the factors that must be considered for acquiring the data in a root dynamic system.	Remember	CO 4	AAE015.14
20	How the vibration data measurement is carried a out for machine characterization?	Understand	CO 4	AAE015.13
Part – C (Problem Solving and Critical Thinking)				
1	Determine the frequency of vibrations for the system shown in figure using stodola method. 	Remember	CO 4	AAE015.12
2	Explain the consequences of misalignment and pre loaded shafts on the performance of the machine assembly with plots.	Understand	CO 4	AAE015.12
3	Explain faults in rolling element of the bearing.	Remember	CO 4	AAE015.11
4	Explain the procedure to find out natural frequency of vibrations by Dunker leys method for simple supported beam subjected to three point loads at equidistance along the span	Understand	CO 4	AAE015.11
5	A shaft of negligible weight 6 cm diameter and 5 meters long is simply supported at the ends and carries four weights 50 kg each at equal distance over the length of the shaft as shown in Figure. Find the frequency of vibration by Dunkerley's method. Take E = 2 x 106 kg / cm2 if the ends of the fixed. 	Remember	CO 4	AAE015.12
6	Explain different types of data acquisition systems with compression to merits and demerits of each other.	Remember	CO 4	AAE015.12

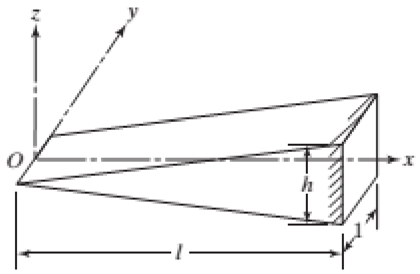
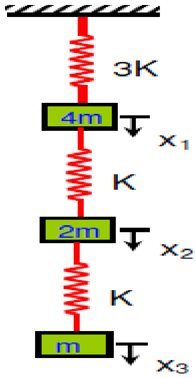
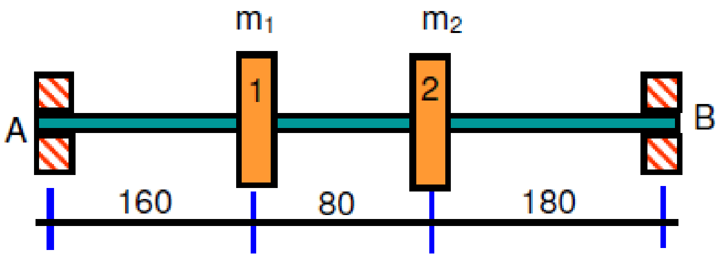
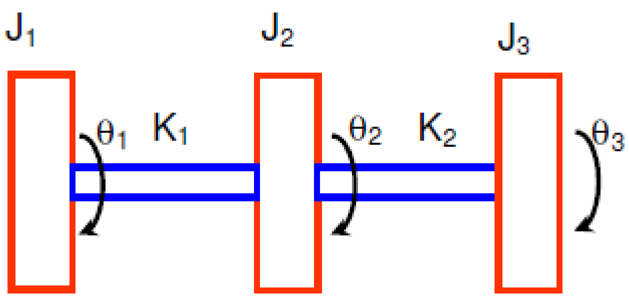
7	Derive the equations of motion for system shown in fig below 	Understand	CO 4	AAE015.12
8	What conclusion can be drawn during condition monitoring of mechanical systems using failure mode analysis?	Remember	CO 4	AAE015.11
9	Explain signature analysis of a mechanical system subjected to forced vibration.	Understand	CO 4	AAE015.11
10	Root cause analysis is very essential for introducing to implement using fishbone chart. Explain.	Remember	CO 4	AAE015.12

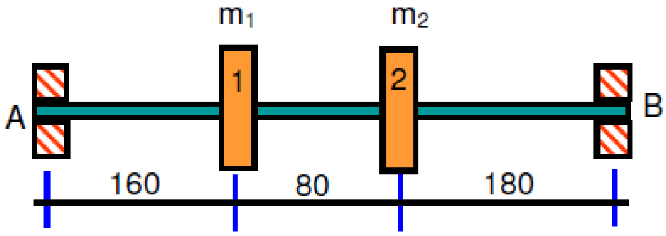
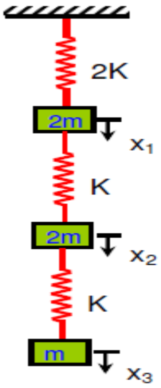
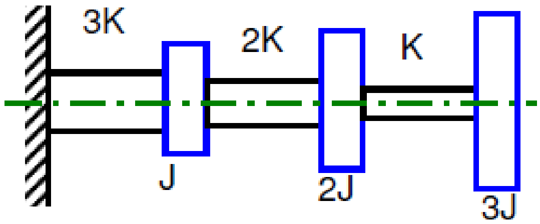
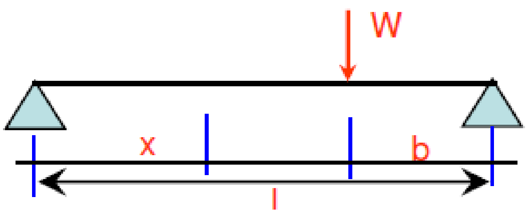
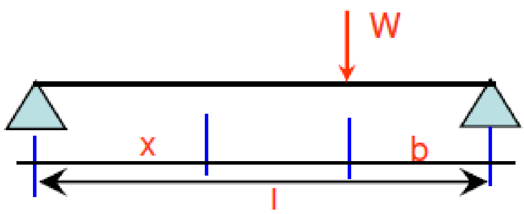
UNIT-V

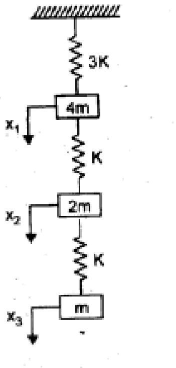
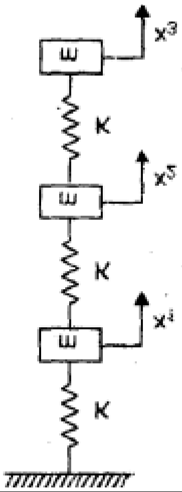
INTRODUCTION TO AEROELASTICITY

Part - A (Short Answer Questions)				
1	Write short notes on Stodola’s method.	Understand	CO 5	AAE015.13
2	Write short notes on Rayleigh-ritz method.	Remember	CO 5	AAE015.13
3	Write short notes on Holzer’s method.	Remember	CO 5	AAE015.13
4	Write short notes on matrix iteration method.	Remember	CO 5	AAE015.14
5	Which numerical method is particularly used for torsional vibrations of shafts?	Remember	CO 5	AAE015.14
6	Which numerical method is usually applicable for solving for beam problems?	Understand	CO 5	AAE015.14
7	Which method is used to determine fundamental natural frequency of free undamped vibrating systems?	Remember	CO 5	AAE015.13
8	What are the disadvantages of stodola’s method?	Remember	CO 5	AAE015.13
9	Write a short note on sweeping technique.	Understand	CO 5	AAE015.14
10	Write equation of motion of a vibrating system of n DOF in matrix form.	Remember	CO 5	AAE015.15
11	Write down the fundamental natural frequency equation for Rayleigh Energy method applied for “n” masses.	Remember	CO 5	AAE015.14
12	Dum Kerly’s method used for determining natural frequency of 3 Rotor systems E X plain the procedure.	Understand	CO 5	AAE015.14
13	Distinguish between 3 to dole and Holzer methods.	Remember	CO 5	AAE015.13
14	Write any three numerical methods for obtaining fundamental frequency.	Remember	CO 5	AAE015.13
15	What are node points and mode shapes in case of matrix iteration method?	Remember	CO 5	AAE015.14
16	Which numerical method is used to finding torsional vibrations of shaft?	Understand	CO 5	AAE015.15
17	Write down the form in which frequencies are obtained using Rayleigh’s Energy method.	Remember	CO 5	AAE015.14
18	Which method is most commonly used for determining fundamental frequency when the system me end in free and other end in fixed.	Understand	CO 5	AAE015.14
19	For solving beam problems, which numerical method is applied?	Remember	CO 5	AAE015.13
20	Explain node points and mode shapes. What is its physical significance?	Remember	CO 5	AAE015.13
Part - B (Long Answer Questions)				
1	Find the natural frequencies and the free vibration solution of a bar fixed at one end and free at the other.	Understand	CO 5	AAE015.15
2	Determine the natural frequencies of vibration of a uniform beam fixed at x=0 and simply supported at x=l.	Understand	CO 5	AAE015.15
3	Explain the Rayleigh Ritz method for vibration analysis?	Remember	CO 5	AAE015.14

4	Find the lowest natural frequency of vibration for the system shown in Fig. by Rayleigh's method 	Remember	CO 5	AAE015.15
5	Find the natural frequency of the milling cutter shown in the figure when the free end of the shank is fixed. Assume the torsional rigidity of the shank as GJ and the mass moment of inertia of the cutter as I_0 	Remember	CO 5	AAE015.14
6	Deduce the governing equation for semi definite torsional vibratory multi DOF System. Using Holzars method. Assume j1=j2=j3 =1, kt1=kt2 =1 (as shown below) 	Remember	CO 5	AAE015.13
7	Determine the frequency of vibrations for the system shown in figure using stodola method. 	Understand	CO 5	AAE015.15
8	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. 	Remember	CO 5	AAE015.16

9	Find the natural frequencies of the tapered cantilever beam by using Rayleigh-Ritz method. 	Remember	CO 5	AAE015.15
10	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.	Remember	CO 5	AAE015.16
11	For the system shown in Fig. find the lowest natural frequency by holzer's method(carryout two iterations) 	Understand	CO 5	AAE015.17
12	Find the lowest natural frequency of transverse vibrations of the system shown in Fig. by holzer's method. E=196 GPa, I=10-6 m4, m1=40 kg, m2=20 kg 	Remember	CO 5	AAE015.14
13	With suitable assumptions derive the Rayleigh's equation for determining the fundamental natural frequency of a multi mass system.	Remember	CO 5	AAE015.13
14	Explain Holzer's method of analysing multi degree freedom system.	Remember	CO 5	AAE015.16
15	Explain stodola's method to estimate the natural frequency and mode shapes of multi degree freedom system.	Understand	CO 5	AAE015.16
16	For the system shown in the Fig, obtain natural frequencies using Holzar's method**.** 	Remember	CO 5	AAE015.15
17	Derive the equation of Collar's method for "n" number of masses in systems.	Remember	CO 5	AAE015.13
18	Derive the equation of Rayleigh's Energy method for determining the natural frequency of "n" masses of a system.	Remember	CO 5	AAE015.15

19	Derive the governing equation of the Collar's method when both ends of the system are free.	Understand	CO 5	AAE015.16
20	When both ends of the rotor system are fixed, use Holzer method for determining the natural frequency.	Remember	CO 5	AAE015.15
Part – C (Problem Solving and Critical Thinking)				
1	Find the lowest natural frequency of transverse vibrations of the system shown in Fig. by matrix iteration method. E=196 GPa, I=10-6 m4, m1=40 kg, m2=20 kg 	Remember	CO 5	AAE015.13
2	Estimate the approximate fundamental natural frequency of the system shown in Fig. Using stodola's method. Take: m=2kg and K=1000 N/m. 	Understand	CO 5	AAE015.13
3	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.	Remember	CO 5	AAE015.14
4	For the system shown in the figure estimate natural frequencies using Collar's Method. 	Remember	CO 5	AAE015.17
5	Find first natural frequency and modal vector of the system shown in the Fig. using Matrix iteration method. Use flexibility influence coefficient. 	Remember	CO 5	AAE015.14
6	Find the fundamental natural frequency and modal vector of a vibratory system shown in Fig. using Stodola's method. 	Understand	CO 5	AAE015.17

7	Determine the fundamental frequency and first mode of the system shown in Fig. using matrix Iteration method 	Remember	CO 5	AAE015.18
8	Determine the natural frequencies of the system shown in Fig using Collar's method. 	Understand	CO 5	AAE015.18
9	When one end is fixed and other end in free derive from the first principles for obtaining natural frequency using Collar's method.	Remember	CO 5	AAE015.18
10	A cord of length l is made to vibrate in a viscous medium. Derive the equation of motion considering the viscous damping force.	Remember	CO 5	AAE015.18

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