INSTITUTE OF AERONAUTICAL ENGINEERING

(Autonomous)

Dundigal, Hyderabad -500 043.

AERONAUTICAL ENGINEERING

TUTORIAL QUESTION BANK

Course Name	:	MECHANICAL VIBRATIONS AND STRUCTURAL DYNAMICS
Course Code	:	R15-A72122
Class	:	IV B. Tech I Semester
Branch	:	Aeronautical Engineering
Year	:	2018 – 2019
Course Coordinator	:	Mr. GSD Madhav, Assistant Professor, Dept of AE
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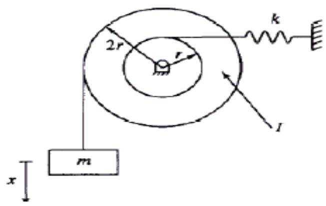
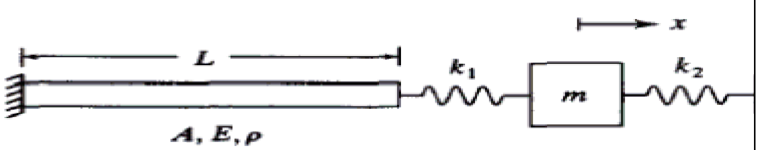
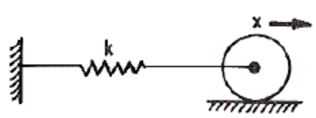
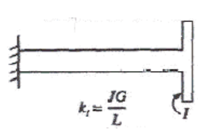
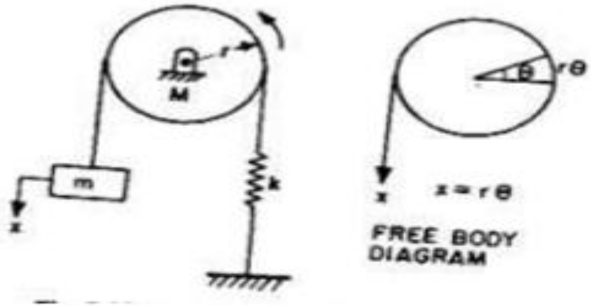
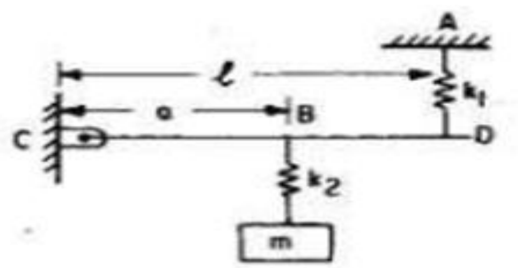
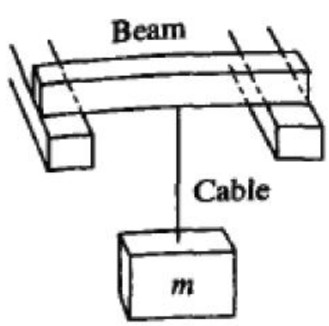
OBJECTIVES:

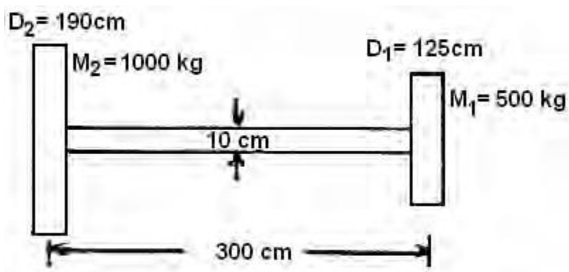
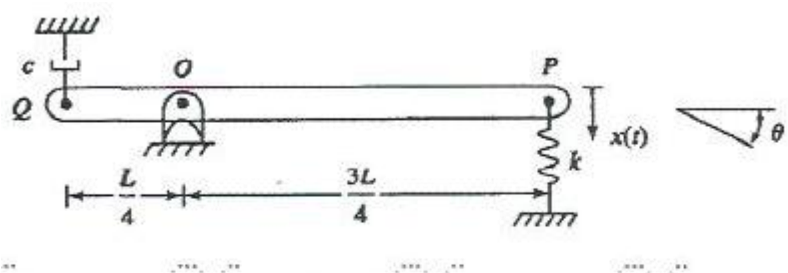
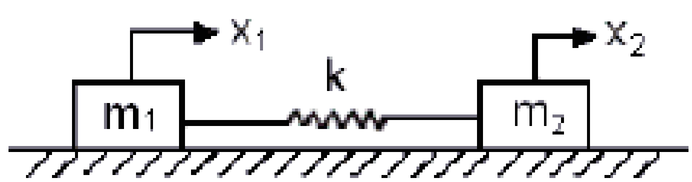
To meet the challenge of ensuring excellence in engineering education, the issue of quality needs to be addressed, debated and taken forward in a systematic manner. Accreditation is the principal means of quality assurance in higher education. The major emphasis of accreditation process is to measure the outcomes of the program that is being accredited.

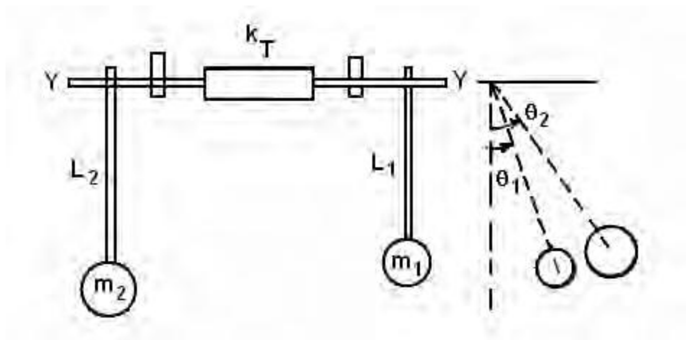
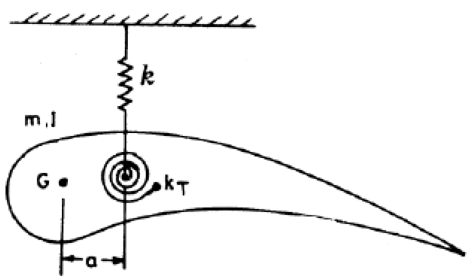
In line with this, Faculty of Institute of Aeronautical Engineering, Hyderabad has taken a lead in incorporating philosophy of outcome based education in the process of problem solving and career development. So, all students of the institute should understand the depth and approach of course to be taught through this question bank, which will enhance learner's learning process.

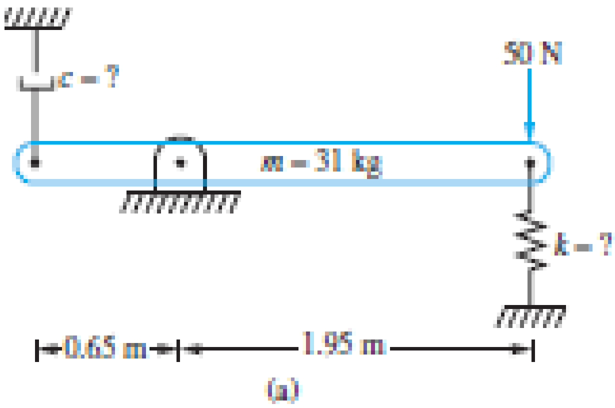
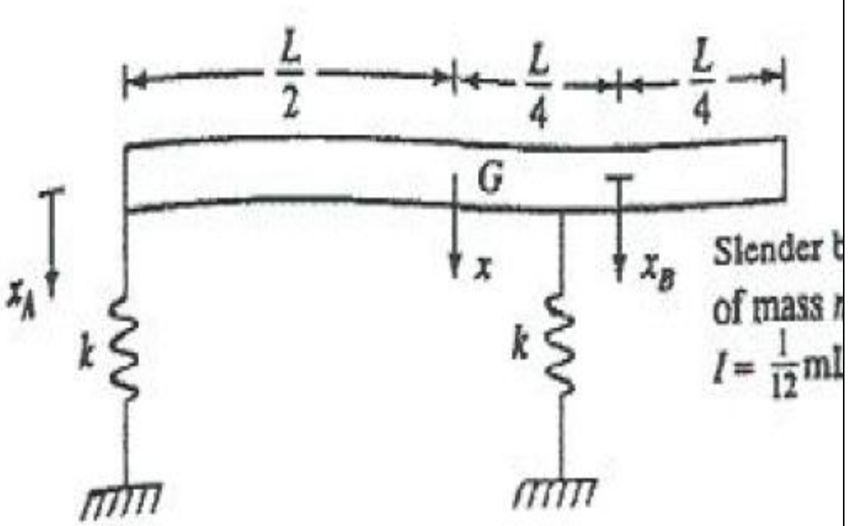
S. No	Question	Blooms Taxonomy	Course Outcomes
	UNIT-1		
	Part - A (Short Answer Questions)		
1.	Explain the term Vibration and deals with which kind of bodies.	Remember	1
2.	Give some typical examples of vibration system.	Remember	1
3.	What are the three elementary parts of Vibration system?	Remember	2
4.	Discuss about Simple Harmonic Motion?	Remember	3
5.	Define Degrees of freedom with an example of vibratory system	Remember	3
6.	What is Free Vibration? Give one example.	Remember	3
7.	What is Forced Vibration? Give one example.	Remember	1
8.	Write equation of motion for simple vibration system.	Remember	1
9.	What is natural frequency? What are its units?	Remember	1

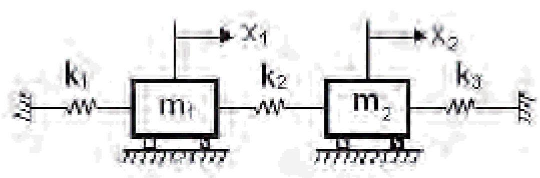
10.	Define damping. How many types of damping elements exists explain briefly	Remember	1
12	What is the difference between a vibration isolator and a vibration absorber?	Remember	1
13	Does spring mounting always reduce the vibration of the foundation of a machine?	Remember	2
Part - B (Long Answer Questions)			
1.	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	4
2.	Determine the equivalent stiffness, frequency and time period for the system shown in figure below, If k1= 200 N/m k2 = 100 N/m, m = 20 Kg L = 2000 mm, A = 100 mm2 density is 7200 kg/mm3 	Understand	4
3.	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. 	Understand	4
4.	A wheel is mounted on a steel shaft (G=83×10^9 $\frac{N}{m^2}$) of length 1.5m and 0.80 cm. The wheel is rotated 5^0 And released. The period of oscillation is observed as 2.3s. **Determine** the mass moment of inertia of the wheel. 	Understand	4
5.	Determine the natural frequency of spring mass system as shown in the figure.	Understand	4

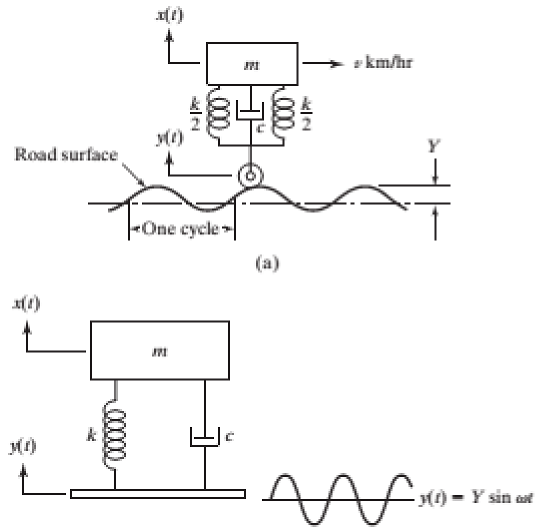
			
6.	Find the natural frequency of system in the figure 2.20 assuming the bar CD to be weightless and rigid.  Fig. 2.20.	Understand	5
Part - C (Problem Solving and Critical Thinking Questions)			
1.	Explain the equivalent stiffness concept. Determine the equivalent stiffness of the beam cable system, if the mass is 800 kg. Also determine the frequency of oscillations as shown in below figure  Beam: $E = 200 \times 10^9\ N/m^2$ $I = 3.5 \times 10^{-4}\ m^4$ Cable: $E = 200 \times 10^7\ N/m^2$ $r = 10$ cm	Understand	6
2.	Determine the natural frequency of torsional vibrations of a shaft with two circulariscs 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	Understand	6

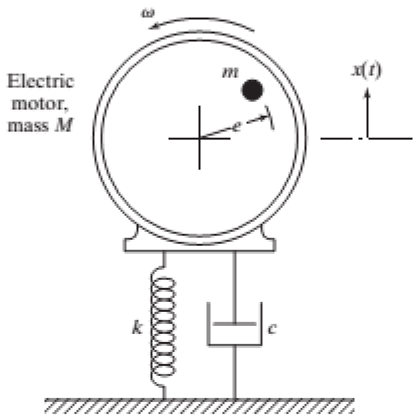
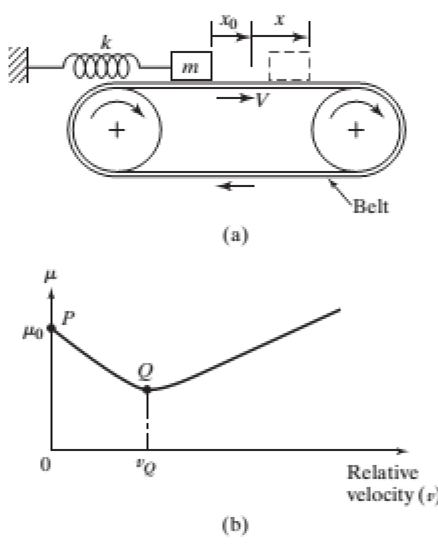
	shown in fig $G = 0.83 \times 10^{11} N/m^2$. 		
3.	A slender rod of length L and mass m is pinned at O as shown in figure below. A spring of stiffness K is connected to the rod at point P while a dashpot of damping coefficient c is connected to the rod at point Q. Assuming small displacements; Derive a linear differential equation governing the free vibration of this system. Use x_t the displacement of the point P, measured from the systems equilibrium position as the generalized coordinate. 	Understand	4
4.	Solve the problem shown in figure. m1=10kg, m2=15kg and k = 320 N/m. 	Understand	5
UNIT-2			
Part - A (Short Answer Questions)			
1.	Why is it important to find the natural frequency of a vibrating system?	Understand	6
2.	What happens to the response of an undamped system at resonance?	Understand	6
3.	Define the flexibility and stiffness influence coefficients	Understand	7
4.	What is the difference between a vibration absorber and a vibration isolator?	Remember	7
5.	Give two examples each of the bad and good effects of vibration.	Remember	7
6.	What is meant by logarithmic decrement?	Remember	7
7.	Define the term magnification factor	Remember	5
8.	How does a continuous system differ from a discrete system in the nature of its equation of motion?	Remember	6

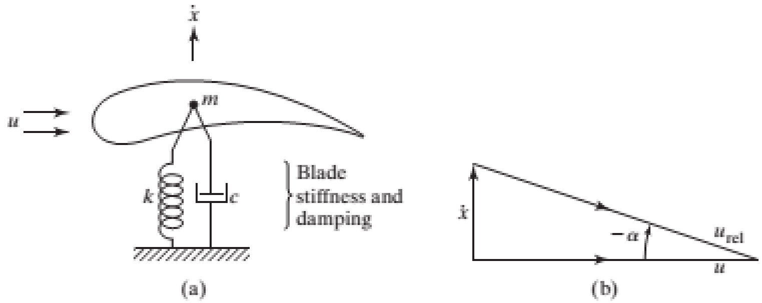
9.	How many natural frequencies does a continuous system have?	Remember	6
10	Write the equation of motion of an undamped system under harmonic force.	Remember	5
	Part – B (Long Answer Questions)		
1.	Two pendulums of different lengths are free to rotate y-y axis and coupled together by a rubber hose 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. 	Remember	4
2.	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 	Understand	5
3.	The slender bar of Figure 3.9(a) has a mass of 31 kg and a length of 2.6 m. A 50 N forceis statically applied to the bar at P then removed. The ensuing oscillations of P are monitored,and the acceleration data is shown in Figure 3.9(b) where the time scale is calibratedbut the acceleration scale is not. Use the data to **find** the spring stiffness k and the damping coefficient c.	Understand	5

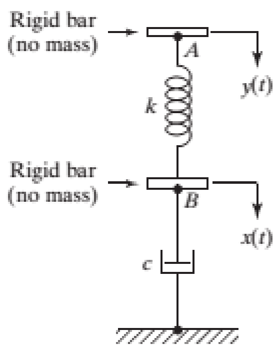
			
4.	Derive the differential equations governing the free vibration of the system shown in the figure below comprising a slight slender bar supported by two springs and discuss the coupling using *x* and θ as generalized coordinates. 	Understand	8
5.	Derive the governing equation for continues vibration of a slender axial bar of length L, cross- sectional area A and density ρ.	Understand	8
6.	Derive the solution for wave equation of torsional vibration and give the displacement boundary conditions for various end conditions	Understand	8
7.	Show that the equation of transverse vibrations of a beam at a distance x with deflection `y' is given by $d^4y/d^4x + \rho A/EI\ d^2y/dt^2 = 0$.	Understand	9
8.	Determine the response of undamped system under harmonic force for all the three cases	Understand	9
9.	Explain the beating phenomenon for a undamped system under harmonic force	Understand	9

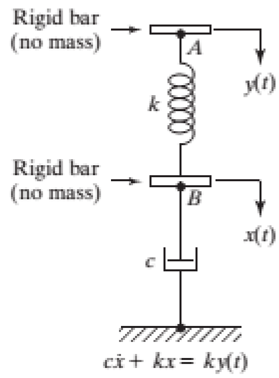
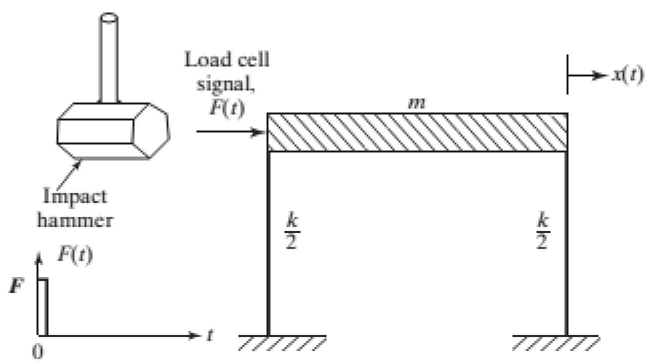
10.	Determine the response of damped system under harmonic force for all the three cases	Understand	9
Part - C (Problem Solving and Critical Thinking Questions)			
1.	A bar of uniform cross-section having length l is fixed at both ends as shown in figure 7.8. The bar is subjected to longitudinal vibrations having a constant velocity V_0 at all points. Derive suitable mathematical expression of longitudinal vibration in the bar.	Remember	10
2.	A bar of length L fixed at left end and is pulled at the other end with a force P. The force is suddenly released. Investigate the vibration of the bar.	Remember	7
3.	Determine the modes of vibrations for the system shown in figure 	Remember	7
4	Find the total response of a single degree of freedom system with m=10kg, c=20 N-s/m, k=4000n/m, x_0=0.01m and $\dot{x}$=0 under following conditions a) An external force F(t)=F0cosωt acts on the system with F_0=100N and ω=10 rad/s b) Free vibration with F(t) = 0	Understand	9
5	The following figure shows a simple model of motor vehicle that 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 400 KN/m and a damping ratio of 0.5. if the vehicle speed is 20 Km/hr, determine the displacement amplitude of the vehicle. The road surface varies sinusoidally with an amplitude of Y=m and wavelength of 6m	Understand	9

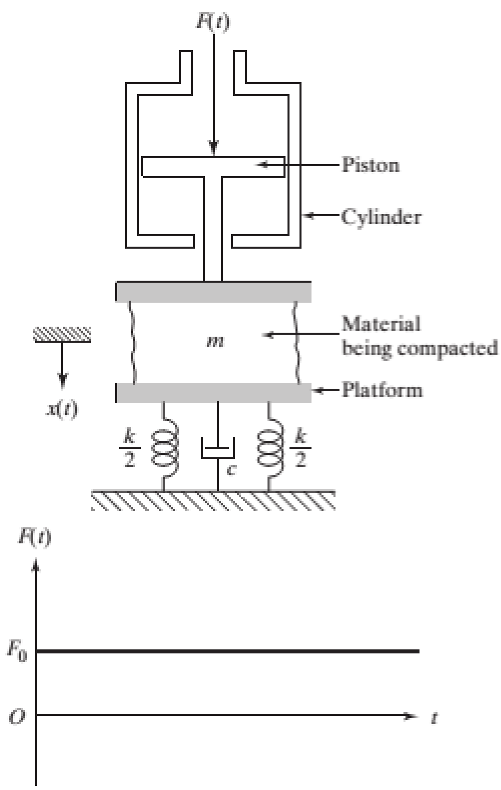
			
6	A heavy machine, weighing 3000 N, is supported on a resilient foundation. The static deflection of the foundation due to the weight of the machine is found to be 7.5 cm. It is observed that the machine vibrates with an amplitude of 1 cm when the base of the foundation is subjected to harmonic oscillation 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, and c. the amplitude of the displacement of the machine relative to the base	Understand	9
7	An electric motor of mass M, mounted on an elastic foundation, is found to vibrate with a deflection of 0.15 m at resonance. It is known that the unbalanced mass of the motor is 8% of the mass of the rotor due to manufacturing tolerances used, and the damping ratio of the foundation is 0.025. Determine the following: a) the eccentricity or radial location of the unbalanced mass b) the peak deflection of the motor when the frequency ratio varies from resonance, and c) the additional mass to be added uniformly to the motor if the deflection of the motor at resonance is to be reduced to 0.1 m	Understand	9

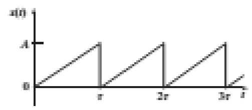
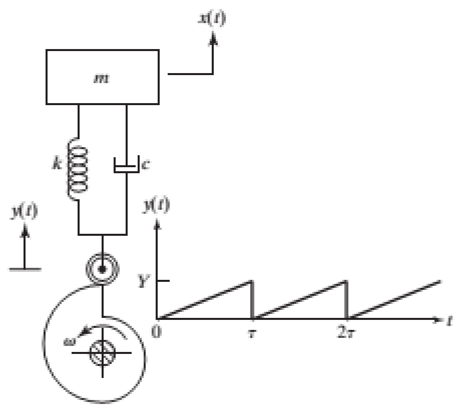
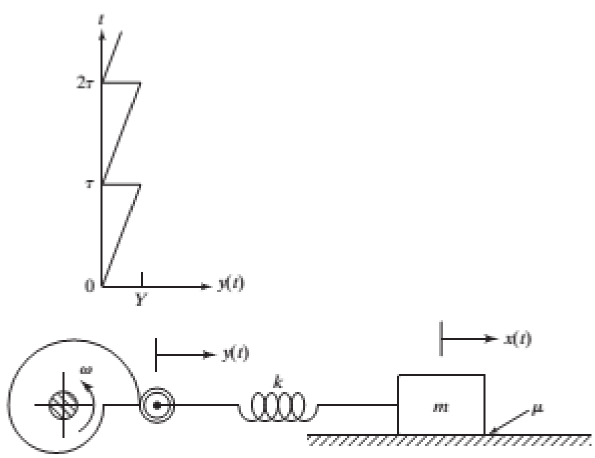
			
8	A spring-mass system, having a mass of 10 kg and a spring of stiffness of 4000 N/m, vibrates on a horizontal surface. The coefficient of friction is 0.12. When subjected to a harmonic force of frequency 2 Hz, the mass is found to vibrate with an amplitude of 40 mm. Find the amplitude of the harmonic force applied to the mass.	Understand	8
9	Consider a spring-supported mass on a moving belt, as shown in fig. The kinetic coefficient of friction between the mass and the belt varies with the relative (rubbing) velocity, as shown in Fig. As rubbing velocity increases, the coefficient of friction first decreases from its static value, is less than the transition v linearly and then starts to increase. Assuming that the rubbing velocity, value, the coefficient of friction can be expressed as $\mu = \mu_0 - \frac{a}{W} v$ 	Understand	8
10	Find the value of free-stream velocity u at which the airfoil section	Understand	8

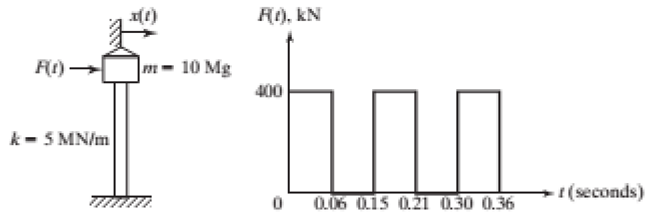
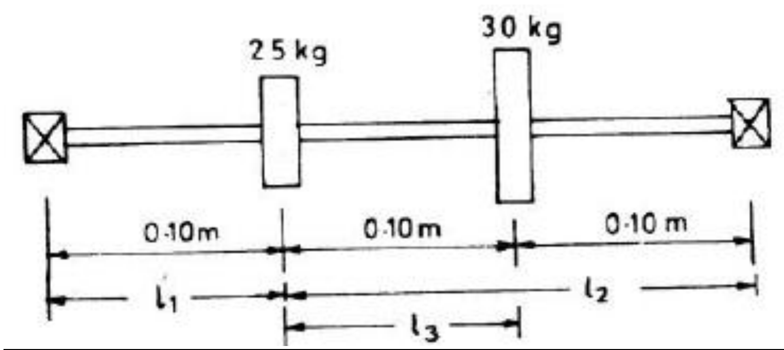
	(SDOF) shown in Fig becomes unstable 		
UNIT-3			
Part - A (Short Answer Questions)			
1.	State the possible boundary conditions at the ends of a string.	Remember	8
2.	What is the main difference in the nature of the frequency equations of a discrete system and a continuous system?	Remember	8
3.	How can we make a system to vibrate in one of its natural made?	Understand	8
4.	Name a few methods for finding the fundamental natural frequency of a multi degree of freedom system	Understand	8
5.	What are the various methods available for vibration control?	Understand	9
6.	What is single-plane balancing?	Understand	9
7	What is the basis for expressing the response of a system under periodic excitation as a summation of several harmonic responses	Understand	9
8	Indicate some methods for finding the response of a system under non periodic forces.	Understand	9
9	What is the Duhamel integral? What is its use	Understand	9
10	How are the initial conditions determined for a single-degree-of-freedom system subjected to an impulse at t=0?	Understand	9
11	Derive the equation of motion of a system subjected to base excitation	Understand	9
12	What are the advantages of the Laplace transform method?	Understand	9
13	How is the Laplace transform of a function x(t) defined?	Understand	9
14	What is the use of a pseudo spectrum?	Understand	9
15	Define the terms generalized impedance and admittance of a system	Understand	9
16	State the interpolation models that can be used for approximating an arbitrary function.	Understand	9
17	How do you compute the frequency of the first harmonic of a periodic force?	Understand	9
18	What is the relation between the frequencies of higher harmonics and frequency of the first harmonic for a periodic excitation?	Understand	9

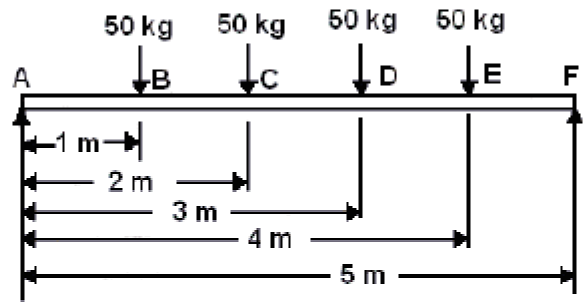
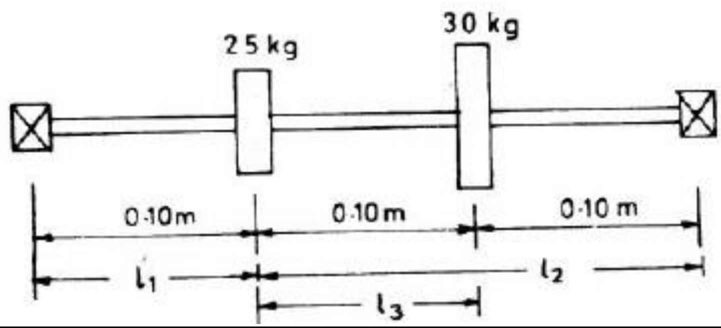
19	What is the difference between transient and steady-state responses?	Understand	9
20	How many resonant conditions are there when the external force is not harmonic?	Understand	9
Part - B (Long Answer Questions)			
1.	The equations of motion of a two degree of freedom system is given by $\begin{bmatrix} m & 0 \\ 0 & m\frac{l^2}{2} \end{bmatrix} \begin{bmatrix} \ddot{x} \\ \ddot{\theta} \end{bmatrix} + \begin{bmatrix} 2k & -k\frac{l}{4} \\ -k\frac{l}{4} & 5k\frac{l^2}{16} \end{bmatrix} \begin{bmatrix} x \\ \theta \end{bmatrix} = \begin{bmatrix} 0 \\ 0 \end{bmatrix}$ The eigen vectors for the above system are given by $X_1 = \begin{bmatrix} 1 \\ \frac{1.43}{l} \end{bmatrix}$ $X_2 = \begin{bmatrix} 1 \\ \frac{-8.42}{l} \end{bmatrix}$ Calculate the principal coordinates of the system..	Understand	9
2.	Derive the governing equation for continues vibration of a slender axial bar of length L, cross- sectional area A and density ρ.	Understand	10
3.	Find the whirling speed of a 50 mm diameter steel shaft simply supported at the ends in bearings 1.6 m apart, carrying masses of 75 kg at 0.4 m from one end, 100 kg at the center and 125 kg at 0.4 m from the other end. Ignore the mass of the shaft. Assume the required data.	Remember	10
4.	A shaft 1600 mm long and diameter 40 mm has a rotor of mass 5kg at its midspan. It is observed that the deflection of the shaft at mid span is 0.4 mm under the weight of the rotor. Find the critical speed of the shaft.	Remember	10
5	Find the response of the spring damper system shown in figure. Subjected to a periodic force with equation of motion.  $c\dot{x} + kx = ky(t)$	Remember	10
6	Determine the response of spring damper system similar to the one shown in figure with the equation of motion $\dot{x} + 1.5x = 7.5 + 4.5\cos t + 3\sin 5t$	Remember	10

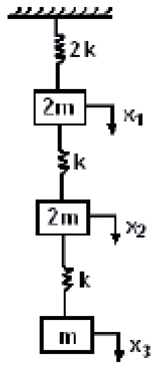
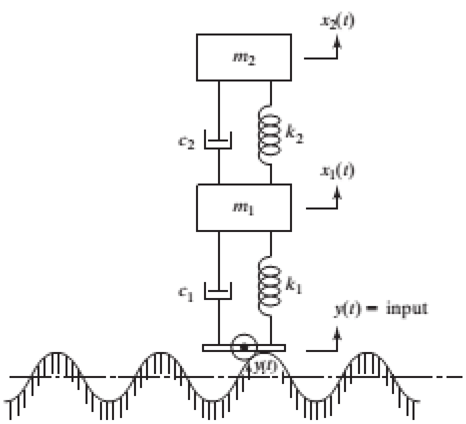
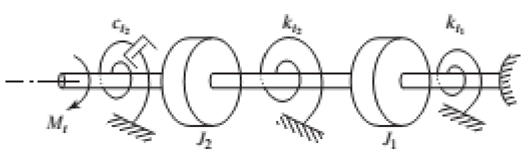
			
7	Determine the response of a spring mass damper system subjected to a periodic force with the equation of motion given by $m\ddot{x} + c\dot{x} + kx = F(t) = \frac{a_0}{2} + \sum_{i=1}^{\infty} a_j \cos j\omega t + \sum_{j=1}^{\infty} b_j \sin j\omega t$. Assume the initial conditions as zero.	Remember	10
8	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	10
9	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. 	Remember	10
10	A compacting machine modelled as SDOF system is shown in fig. The force acting on the mass m (m includes the masses of the piston, the platform and the material being compacted) due to sudden application of the pressure can be idealized as a step force as shown. Determine the response of the system.	Remember	10

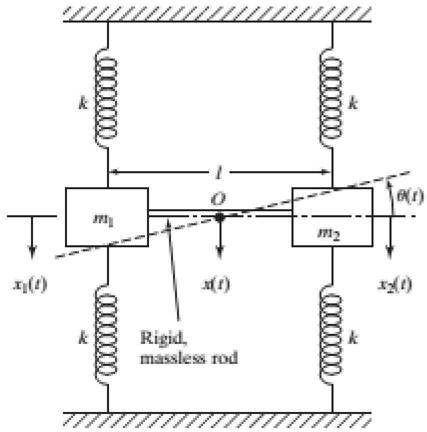
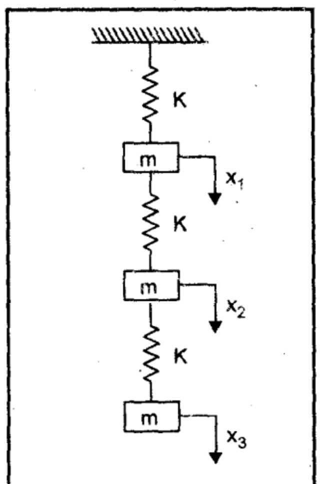
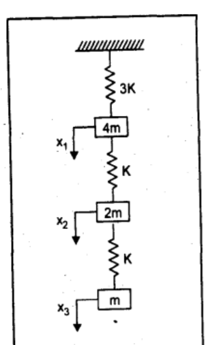
			
Part - C (Problem Solving and Critical Thinking Questions)			
1.	A disc of mass 5 kg is mounted midway between bearings which may be assumed to be simple supports. The bearing span is 48 cm. the steel shaft, which is horizontal, is 9 mm in diameter. The C.G of the disc is placed 3 mm from the geometric center. The equivalent viscous damping at the center of the disc – shaft may be taken as 48 N-s/m. if the shaft rotates at 675 rpm, find the maximum stress in the shaft and compare it with dead load stress in the shaft. Also find the power required to drive the shaft at this speed.	Remember	10
2.	A shaft 40 mm diameter and 2.5 m long has a mass of 15 kg per meter length. It is simply supported at the ends and carries three masses 90 kg, 140 kg and 60 kg at 0.8 m, 1.5 m and 2m respectively from the left support. E = 200 GN/m^2 .Find the whipping speed of the shaft.	Understand	11
3.	A shaft 1600 mm long and diameter 40 mm has a rotor of mass 5kg at its midspan. It is observed that the deection of the shaft at mid span is 0.4 mm under the weight of the rotor. Find the critical speed of the shaft.	Understand	11
4.	Find the whirling speed of a 50 mm diameter steel shaft simply supported at the ends in bearings 1.6 m apart, carrying masses of 75 kg at 0.4 m from one end, 100 kg at the center and 125 kg at 0.4 m from the other end. Ignore the mass of the shaft. Assume the required data.	Understand	12
5.	A shaft 1600 mm long and diameter 40 mm has a rotor of mass 5kg at its midspan. It is observed that the deection of the shaft at mid span is 0.4 mm under the weight of the rotor. Find the critical speed of the shaft.	Understand	13

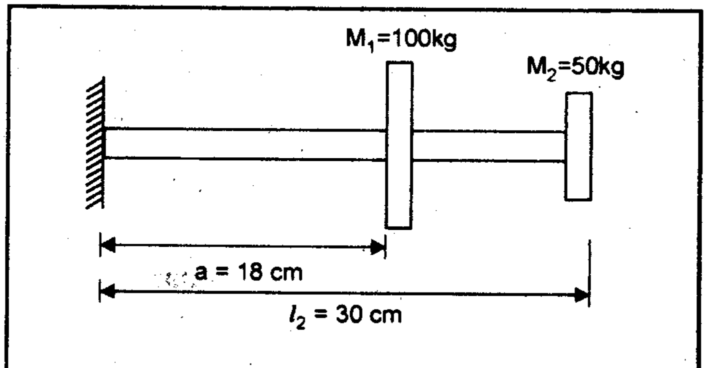
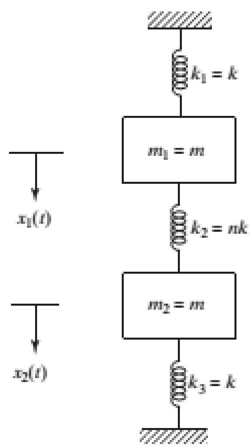
6	Find the steady state response of a viscously damped system to the forcing functioning obtained by replacing x(t) and A with F(t) and F_0 respectively in fig. 	Understand	13
7	The base of a spring mass damper system is subjected to the periodic displacement shown in fig. Determine the response of the mass using the principle of superposition. 	Understand	13
8	A roller cam is used to impart a periodic motion to the base of the spring mass system shown in the fig. If the coefficient of friction between the mass and the surface is μ, find the response of the system using the principle of superposition. Discuss the validity of the result. 	Understand	13
9	Find the total response of a viscously damped SDOF system subjected to a harmonic excitation for the following data m=10Kg, c=20N-s/m, k=4000N/m, y(t)=0.05cos5t m, x_0=0.1m, $\dot{x}$=1m/s	Understand	13
10	Find the displacement of the water tank shown in the fig a, under the periodic force shown in fug b by treating it as an undamped SDOF system. Use the numerical procedure.	Understand	13

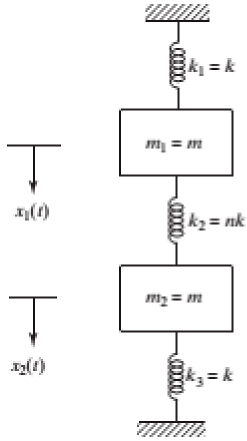
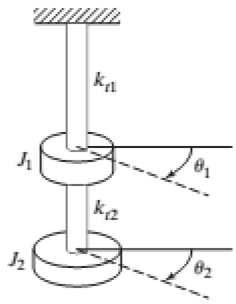
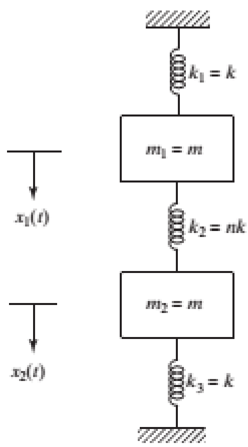
	 (a) (b)		
UNIT -4			
Part - A (Short Answer Questions)			
1.	Describe the two-plane balancing procedure.	Understand	14
2.	Why are mass, damping and stiffness matrices symmetrical?	Understand	14
3.	What is the difference between stationary damping and rotary damping?	Remember	14
4.	How is the critical speed of a shaft determined?	Remember	15
5.	What causes instability in a rotor system?	Remember	15
6.	How do you determine the number of degrees of freedom of a lumped-mass system?	Remember	10
7	Define the terms mass coupling, velocity coupling, elastic coupling.	Remember	10
8	What are principal coordinates? What is their use?	Remember	10
9	What is meant by static and dynamic coupling? How can you eliminate coupling of the equations of motion?	Remember	10
10	How many natural frequencies can be zero for an unrestrained two DOF system?	Understand	10
11	How many degenerate codes does a vibrating system have?	Understand	11
12	How can we make a system vibrate in one of its natural modes?	Understand	11
Part - B (Long Answer Questions)			
1.	Determine the frequency of vibrations for the system shown in figure using stodola method. 	Understand	10
2.	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	11

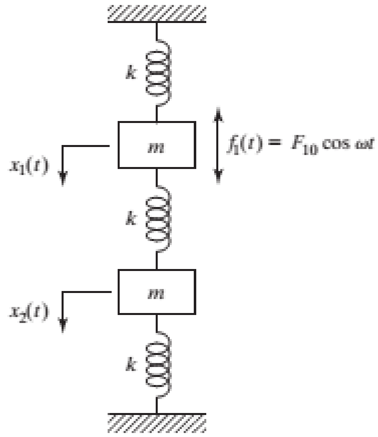
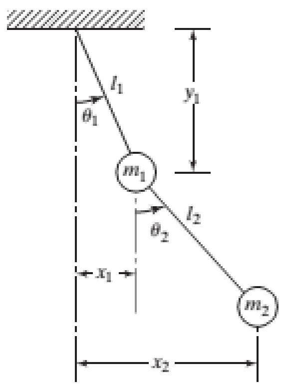
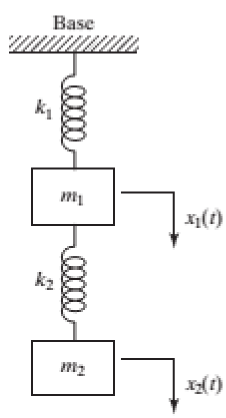
3.	A solid steel shaft of uniform diameter, which carries two discs of weights 600N and 1000 N is represented by a SSB 10 cm and 20 cm from the left support of 30cm length shaft made of steel with density 7800 kg/m3. Determine the frequency of oscillation using Dunkerleys method by considering the weight of the shaft. E =19.6 x10^6 N/cm^2 and I = 40 cm^4	Understand	11
4.	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	11
5.	Determine the frequency of vibrations for the system shown in figure using Stodola method. 	Remember	12
6.	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	Remember	11

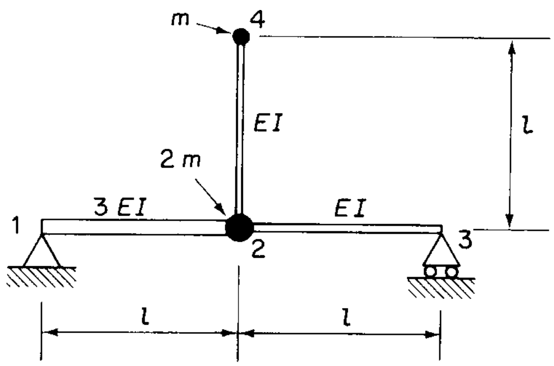
7.	Using matrix method determine the natural frequencies of the system shown in Fig 	Remember	12
8	Derive the equations of motion for system shown in fig below 	Understand	12
9	Derive the equations of motion for system shown in fig below 	Understand	12
10	Two masses m_1 and m_2 each connected by two springs of stiffness k, are connected by a rigid mass less horizontal rod of length l as shown in fig. Derive the equations of motion of the system in terms of the vertical displacement of the C.G of the system, x(t) and the rotation about the C.G of the system, Θ(t). Also find the natural frequencies of vibration of the system for m_1=50kg m_2=200kg and k=1000N/m.	Understand	12

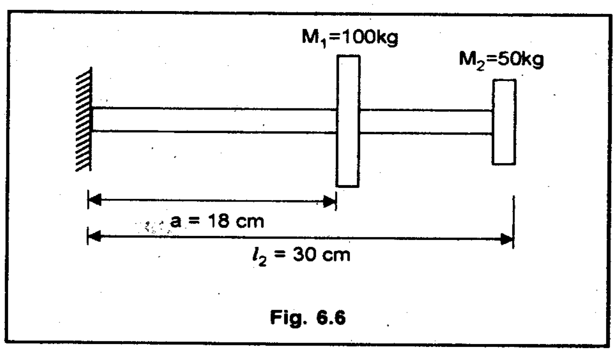
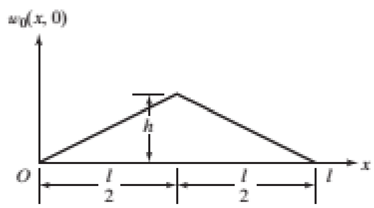
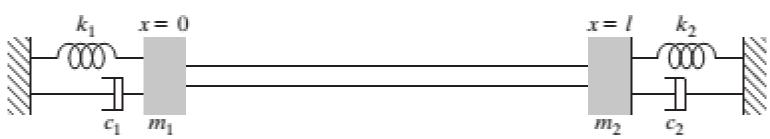
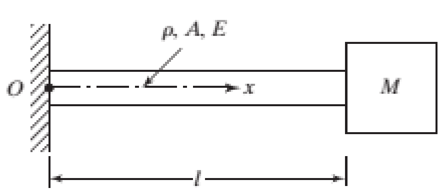
			
Part - C (Problem Solving and Critical Thinking Questions)			
1.	Determine the natural frequencies of the system shown in Fig. 6.2. using matrix method.  **Fig. 6.2**	Understand	12
2.	Determine the fundamental frequency and first mode of the system shown in Fig. 6.3 using matrix Iteration method.  **Fig. 6.3**	Understand	13

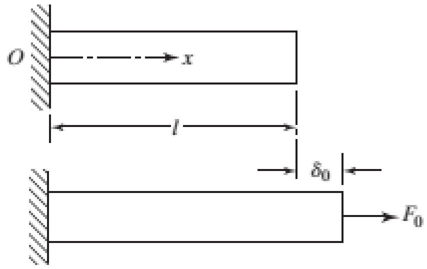
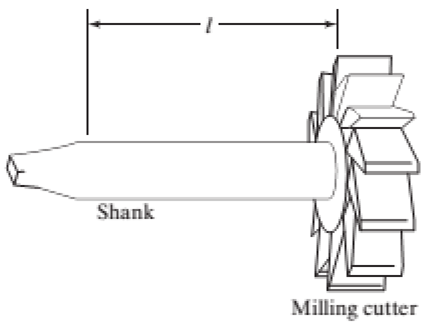
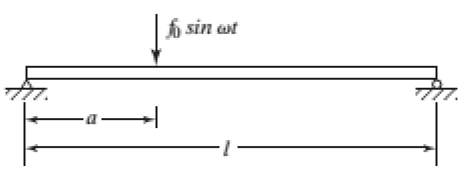
3.	Find the lowest natural frequency of vibration for the system shown in Fig. 6.6 by Rayleigh's method $E = 1.96 \times 10^{11}\ N/m^2$; $I = 4\times10^{-7}\ m^4$  Fig. 6.6	Understand	13
4	Find the natural frequencies and mode shapes of a spring mass system shown in figure which is constrained to move in the vertical direction only. Take n=1. 	Understand	13
5	Find the initial conditions that need to be applied to the system shown in the figure so as to make it vibrate in a (a) first mode and (b) second mode	Understand	13

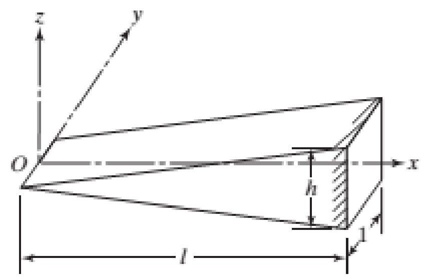
			
6	Find the natural frequencies and mode shapes for the torsional system shown in the figure for $J_1=J_0$, $J_2=2J_0$ and $k_{t1}=k_{t2}=k_t$. 	Understand	13
7	Determine the principle coordinates for the spring mass system shown in the figure. 	Understand	13
8	Find the steady state response of the system shown in figure when the mass m_1 is excited by the force $F_1(t)$= F10 cos ωt. Also plot the frequency response curve.	Understand	13

			
9	Derive the equations of motion of the double pendulum shown in the figure using the coordinates Θ_1 and Θ_2. Also find the natural frequencies and mode shapes of the system for $m_1=m_2=m$ and $l_1=l_2=l$. 	Understand	13
10	Find the natural frequencies and mode shapes of the system shown in the figure for $m_1=m_2=m$ and $k_1=k_2=k$. 	Understand	13

UNIT-5			
Part - A (Short Answer Questions)			
1.	How does a continuous system differ from a discrete system in the nature of its equation of motion?	Understand	14
2.	How many natural frequencies does a continuous system have?	Understand	14
3.	What is wave equation? What is a travelling wave solution?	Understand	14
4.	Give two practical examples of the vibration membranes.	Understand	14
5	What is the significance of wave velocity?	Understand	15
6	State the possible boundary conditions at the end of a string.	Understand	15
7	What is main difference in the nature of the frequency equations of a discrete system and a continuous system?	Understand	15
8	Why is the natural frequency given by Rayleigh's method always larger than the true value of ω_1?	Understand	15
9	What is the difference between Rayleigh's method and Rayleigh-Ritz method?	Understand	15
10	Why does the natural frequency of the beam become lower if the effects of shear deformation and rotary inertia are considered?	Understand	15
Part - B (Long Answer Questions)			
1.	Three massless beams 12, 23 and 24 each of length l are rigidly joinedtogether in one plane at the point 2, 12 and 23 being in the same straight line with 24at right angles to them (see Fig). The bending stiffness of 12 is 3EI while thatof 23 and 24 is EI. The beams carry masses m and 2m concentrated at the points 4and 2, respectively. If the system is simply supported at 1 and 3 determine the natural Frequenciesof the vibration in the plane of the figure. 	Understand	15

2.	Find the lowest natural frequency of vibration for the system shown in Fig. 6.6 by Rayleigh's method. $E = 1.96 \times 10^{11}\ N/m^2$; $I = 4\times10^{-7}\ m^4$  Fig. 6.6	Understand	13
3.	If the string of length l, fixed at both ends is plucked at its midpoint as shown in the figure and then released, determine its subsequent motion.  	Understand	15
4.	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.  	Understand	15
5	Find the natural frequencies and the free vibration solution of a bar fixed at one end and free at the other.	Understand	15
6	Find the natural frequencies of a bar with one end fixed and a mass attached at the other end as in figure.  	Understand	15
7	A bar of uniform cross-sectional area A, density ρ, modulus of Elasticity E and length l is fixed at one end and free at the other end. It is subjected to an axial force F_0 at its free end as shown in the figure. Study the resulting	Understand	15

	vibrations of the force is suddenly removed. 		
8	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 	Understand	15
9	Determine the natural frequencies of vibration of a uniform beam fixed at x=0 and simply supported at x=l.	Understand	15
10	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. 	Understand	15
Part - C (Problem Solving and Critical Thinking Questions)			
1.	Find the natural frequencies of a simply supported beam subjected to an axial compressive force.	Understand	12
2.	Determine the effects of rotary inertia and shear deformation on the natural frequencies of a simply supported uniform beam.	Understand	12
3.	Find the free-vibration solution of a rectangular membrane of sides a and b along x-axes and y-axes respectively.	Understand	13

4.	Find the fundamental frequency of transverse vibration of the non-uniform cantilever beam shown in the figure using the deflection shape $W(x) = (1-x/l^2)$.	Understand	11
5.	Find the natural frequencies of the tapered cantilever beam by using Rayleigh-Ritz method.  		11
6.	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.	Understand	15
7	A stretched cable of length 2m has a fundamental frequency of 3000Hz. Find the frequency of the third mode. How are the fundamental and third mode frequencies changed if the tension is increased by 20%.	Understand	15
8	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	15
9	A cable of length l and mass ρ per unit length is stretched under a tension P. One end of the cable is fixed and the other end is connected to a pin, which can move in a frictionless slot. Find the natural frequencies of vibration of the cable.	Understand	15
10	A cord of length l is made to vibrate in a viscous medium. Derive the equation of motion considering the viscous damping force.	Understand	15

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HOD, AE