INSTITUTE OF AERONAUTICAL ENGINEERING

(Autonomous)
Dundigal, Hyderabad -500 043.

AERONAUTICAL ENGINEERING

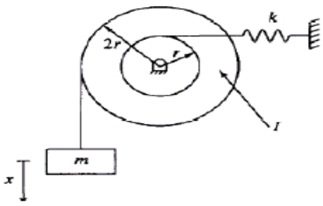
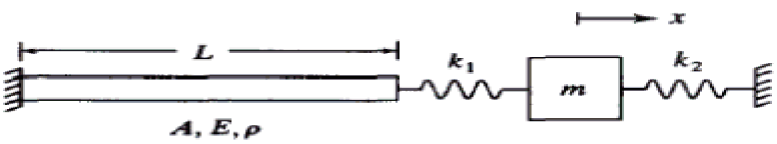
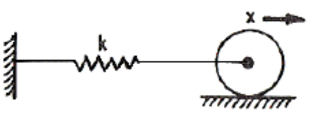
ASSIGNMENT QUESTIONS

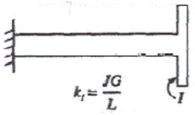
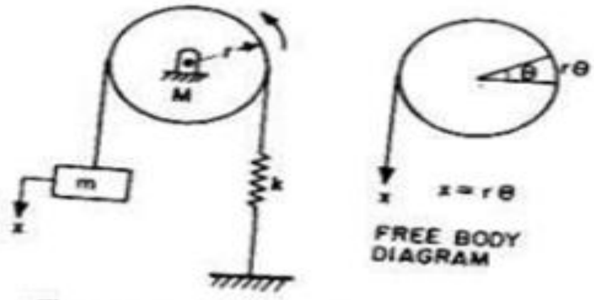
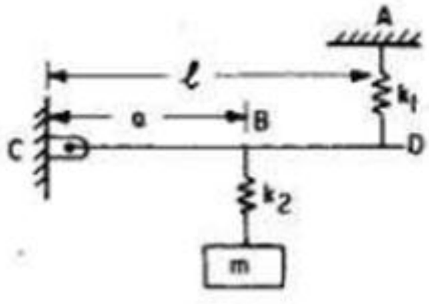
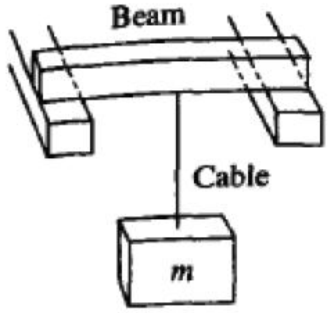
Course Name	:	**MECHANICAL VIBRATIONS AND STRUCTURAL DYNAMICS**
Course Code	:	**R15-A72122**
Class	:	**IV B. Tech I Semester**
Branch	:	**Aeronautical Engineering**
Year	:	**2018 – 2019**
Course Coordinator	:	**Mr. GSD Madhav, Assistant Professor, Dept of AE.**
Course Faculty	:	**Ms. Y Swetha, Assistant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

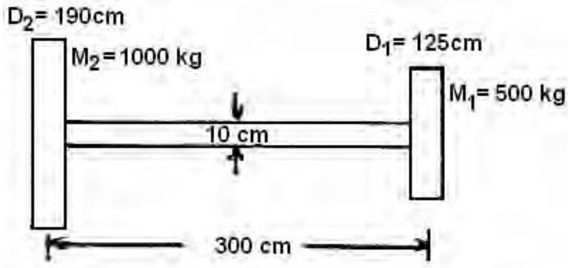
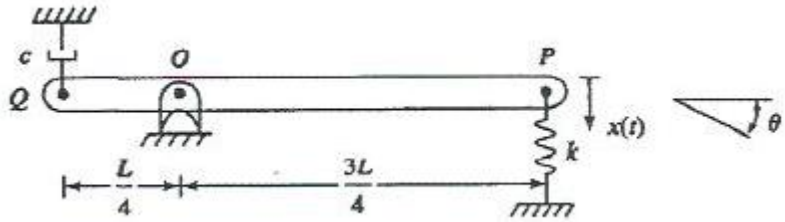
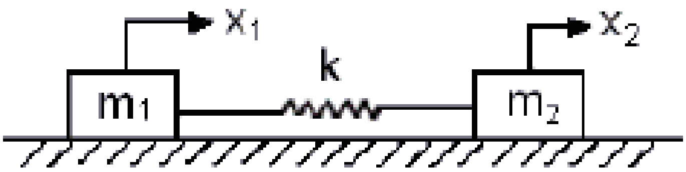
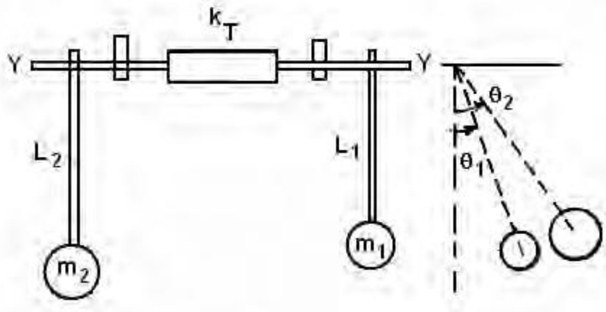
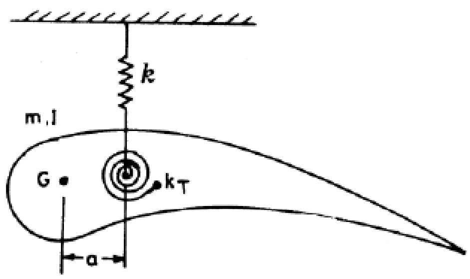
OBJECTIVES:

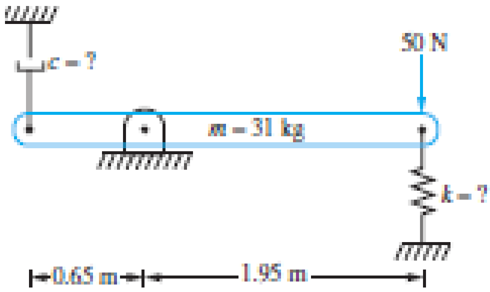
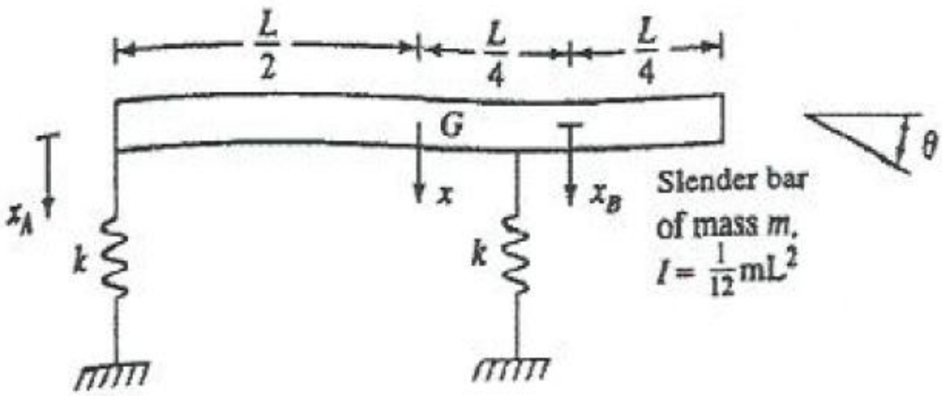
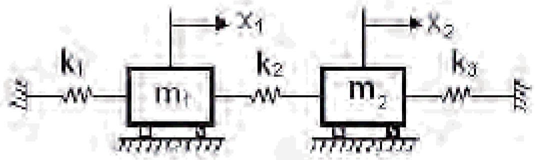
To meet the challenge of ensuring excellence in engineering education, the issue of quality needs to be addressed, debated and taken forward in a systematic manner. Accreditation is the principal means of quality assurance in higher education. The major emphasis of accreditation process is to measure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

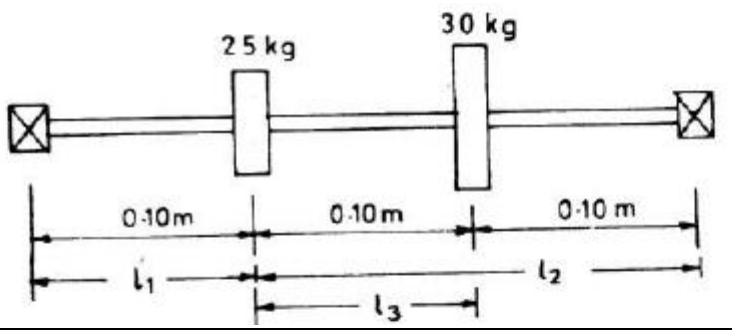
In line with this, Faculty of Institute of Aeronautical Engineering, Hyderabad has taken a lead in incorporating philosophy of outcome based education in the process of problem solving and career development. So, all students of the institute should understand the depth and approach of course to be taught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

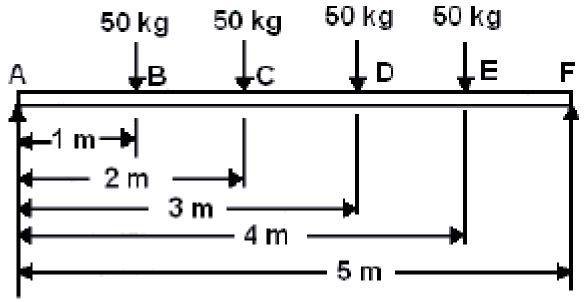
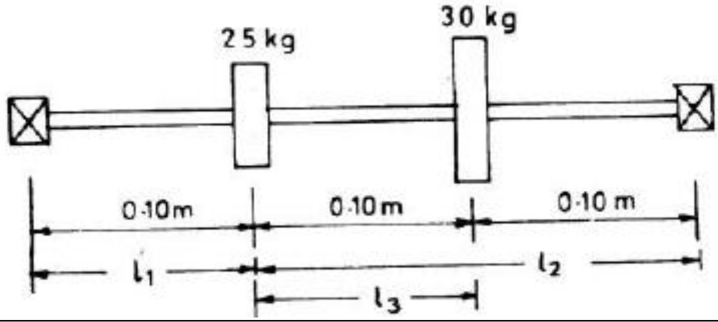
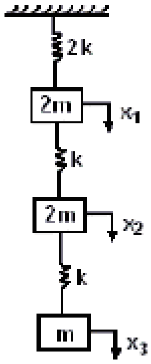
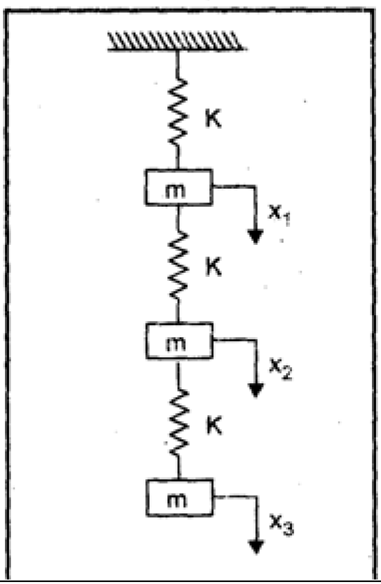
S.No	ASSIGNMENT-1 UNIT-1 FREE VIBRATION OF SINGLE-DEGREE-OF-FREEDOM-SYSTEM	Blooms taxonomy Level	Course Outcome
1.	Determine the frequency of oscillations for the system shown in fig. Also determine the time period if m = 4 kg and r = 80 mm.  	Understand	1
2.	Find the equivalent stiffness, frequency 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  	Remember	1
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	2

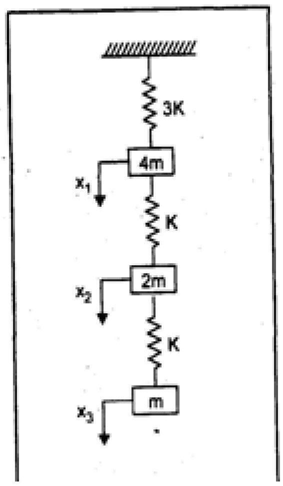
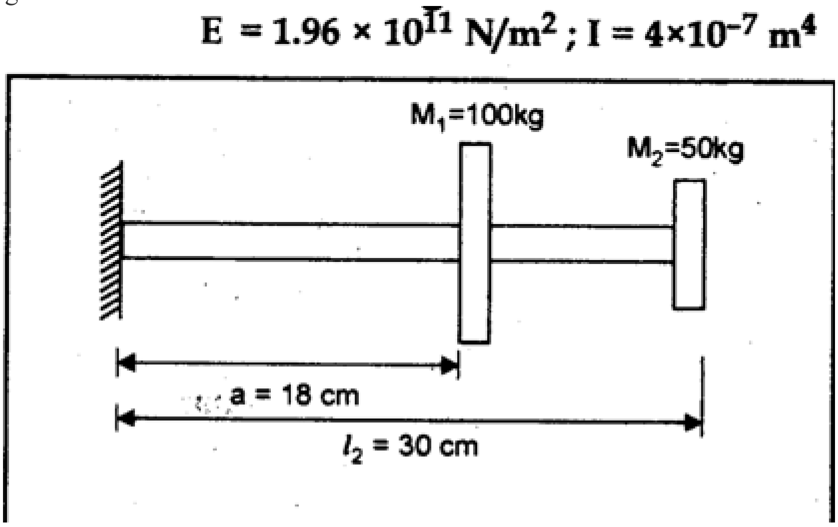
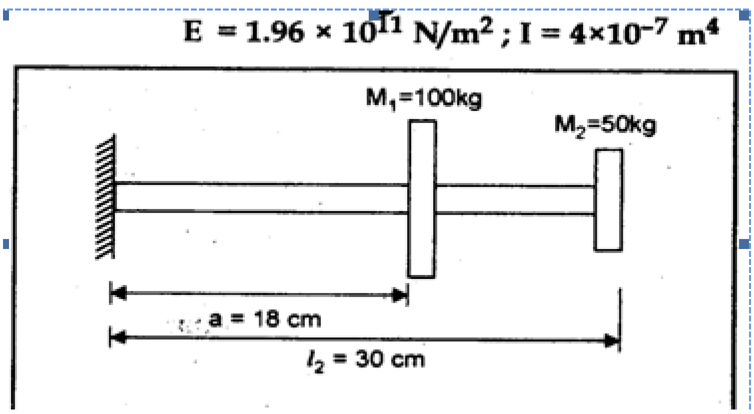
4.	A wheel is mounted on a steel shaft (G=83×10^9 $\frac{N}{m^2}$) of length 1.5m and 0.80 cm. The wheel is rotated 5^0 And released. The period of oscillation is observed as 2.3s. Determine the mass moment of inertia of the wheel.  	Understand	3
5.	Determine the natural frequency of spring mass system as shown in the figure.  	Remember	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.	Remember	4
7.	Explain the equivalent stiffness concept. Determine the equivalent stiffness of thebeam 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	5
8.	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 shown in fig G = 0.83 x 10^{11}N/m^2.	Remember	3

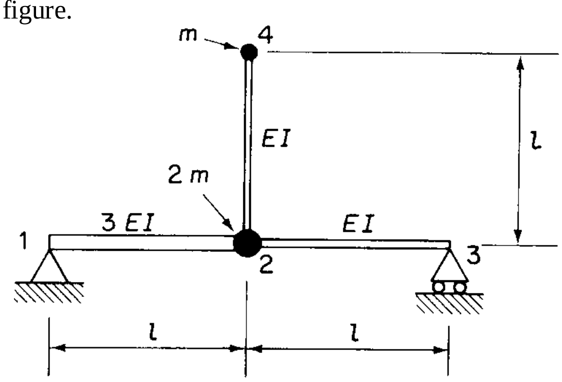
			
9.	A slender rod of length L and mass m is pinned at O as shown in figure below. A spring of stiffness K is connected to the rod at point P while a dashpot of damping coefficient c is connected to the rod at point Q. Assuming small displacements; Derive a linear differential equation governing the free vibration of this system. Use x_t the displacement of the point P, measured from the systems equilibrium position as the generalized coordinate. 	Understand	3
10.	Solve the problem shown in figure. m1=10kg, m2=15kg and k = 320 N/m. 	Remember	4
	UNIT – 2 **VIBRATION UNDER HARMONIC FORCING CONDITIONS**		
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 	Remember	4

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.  (a)	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	5
5.	Derive the governing equation for continues vibration of a slender axial bar of length L, cross- sectional area A and density ρ.	Remember	5
6.	Derive the solution for wave equation of Torsional vibration and give the displacement boundary conditions for various end conditions	Remember	6
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	6
8.	A bar of uniform cross-section having length l is fixed at both ends. 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.	Understand	7
9.	A bar of length L fixed at left one end is pulled at the other end with a force P. The force is suddenly released. Investigate the vibration of the bar.	Remember	7
10.	Determine the modes of vibrations for the system shown in figure  	Understand	7
UNIT – 3 **VIBRATION UNDER GENERAL FORCING CONDITIONS**			
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	Understand	1

	$X_1 = \begin{bmatrix} 1 \\ 1.43 \\ L \end{bmatrix}$ $X_2 = \begin{bmatrix} 1 \\ -8.42 \\ L \end{bmatrix}$ Calculate the principal coordinates of the system..		
2.	Derive the governing equation for continues vibration of a slender axial bar of length L, cross- sectional area A and density ρ.	Remember	1
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.	Understand	2
4.	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 mmunder the weight of the rotor. Find the critical speed of the shaft.	Understand	2
5.	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	3
	ASSIGNMENT –II **UNIT – 3** **VIBRATION UNDER GENERAL FORCING CONDITIONS**		
6.	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	3
7.	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.	Remember	4
8.	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	4
9.	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	5
	UNIT- 4 **TWO-DEGREE- AND MULTI-DEGREE-OF-FREEDOM SYSTEMS**		
1.	Determine the frequency of vibrations for the system shown in figure using stodola method.  	Understand	2
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.	Remember	3
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	3
4.	A shaft of negligible weight 6 cm diameter and 5 meters long is simply supportedat the ends and carries four weights 50 kg each at equal distance over the lengthof the shaft as shown in Figure. Find the frequency of vibration by Dunkerley'smethod. Take E = 2 x 106 kg / cm2 if the ends of the fixed.	Remember	4

			
5.	Determine the frequency of vibrations for the system shown in figure using Stodola method. 	Remember	4
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	Understand	5
7.	Using matrix method determine the natural frequencies of the system shown in Fig 	Understand	5
8.	Determine the natural frequencies of the system shown in Fig. 6.2. using matrix method. 	Understand	5

9.	Determine the fundamental frequency and first mode of the system shown in Fig. 6.3 using matrix Iteration method.  	Understand	5
10.	Find the lowest natural frequency of vibration for the system shown in Fig. 6.6 by Rayleigh's method  	Understand	6
UNIT-5 **CONTINUOUS SYSTEMS**			
1.	Discuss briefly about inertial coupling	Understand	3
2.	Find the lowest natural frequency of vibration for the system shown in Fig. 6.6 by Rayleigh's method.  	Understand	4
3.	Briefly explain the approximate methods for frequency analysis	Understand	5
4.	Describe the Rayleigh Ritz method for vibration analysis	Understand	5
5.	Explain briefly about Aero elasticity	Understand	2
6.	Three massless beams 12, 23 and 24 each of length l are rigidly joined together 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 that of 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 Frequencies of the vibration	Remember	4

	in the plane of the figure. 		
7.	What is collars triangle and aero elastic tailoring? Explain.	Understand	3
8.	Explain static and dynamic aero elastic phenomena	Understand	4
9.	Discuss about aero elastic instabilities and their preventions	Understand	4
10.	Define a)wing divergence b)control reversal c)wing flutter d)flutter speed	Understand	5

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