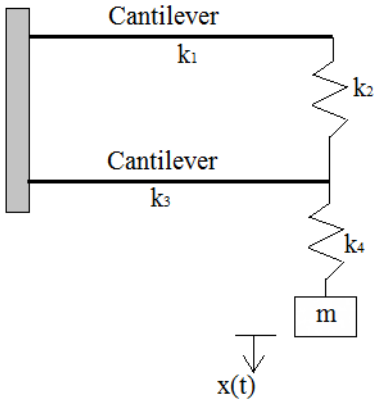
UNIVERSITY OF PETROLEUM AND ENERGY STUDIES
End Semester Examination, May 2018

Course: Rotordynamics and Condition Monitoring (MREQ 812)
Semester: II
Program: M.Tech. Rotating Equipment
Time: 03 hrs. **Max. Marks: 100**

Instructions: Assume any missing data

SECTION A

S. No.		Marks	CO
Q 1	Describe, with the aid of a sketch when necessary, each of the following: a) Spring force, damping force, inertia force, excitation b) Free vibration, forced vibration c) Steady state response, transient motion d) Periodic motion, frequency, period, beat frequency	**4**	**CO1**
Q 2	Solve the homogeneous equation $\ddot{x}+4\dot{x}+13x=0$ for the following initial conditions: $x(0)=1 \wedge \dot{x}(0)=0$	**4**	**CO1**
Q 3	Calculate the natural frequency of the system shown in Fig. 1. Assume that the cantilevers are of negligible mass and their equivalent spring constants are k_1 and k_3.  Fig.1: Figure for Q 3	**4**	**CO2**
Q 4	Describe briefly the concept of balancing in rigid and flexible rotors.	**4**	**CO2**
Q 5	The following data are given for a system with viscous damping: mass m = 4 kg, spring constant k = 5 kN/m, and the amplitude decreases to 0.25 of the initial value after five consecutive cycles. Find the damping coefficient of the damper.	**4**	**CO1**
	SECTION B		
Q 6	A rotating machine for research has an annular clearance of 0.8 mm between the rotor and the stator. The mass of the rotor is 36 kg with an unbalance of 3 X 10^{-3} kg-m. The rotor is mounted symmetrically on a round shaft, 300 mm in length and supported by two bearings. The operating speed ranges from 600 to 6000 rpm. If the	**10**	**CO3**

	dynamic deflection of the shaft is to be less than 0.1 mm, specify the size of the shaft.		
Q 7	A circular disk of 18 kg is mounted symmetrically on a shaft, 0.75 m in length and 20 mm in diameter. The mass center of the disk is 3 mm from its geometric center. The unit is rotated at 1000 rpm and the damping factor is estimated to be 0.05. Calculate the dynamic load on the bearings.	**10**	**CO3**
Q 8	A force *'$P_0 \sin \omega t$'* acts on a displacement *'$x_0 \sin (\omega t - \pi/3)$'*. If P_0 = 100 N, x_0 = 0.02 m, $\omega = 2\pi$ rad/s. Find the work done during (i) the first cycle (ii) the first second (iii) the first quarter second.	**10**	**CO1**
Q 9	Explain the design theory of vibration measuring instruments. OR Derive the frequency response of a spring-mass-damper system for base excitation case.	**10**	**CO3**
	SECTION-C		
Q 10	Consider the undamped system $M\{\ddot{x}\} + K\{x\} = \{Q(t)\}$. $\begin{bmatrix} 4 & 0 \\ 0 & 1 \end{bmatrix} \begin{Bmatrix} \ddot{x}_1 \\ \ddot{x}_2 \end{Bmatrix} + \begin{bmatrix} 24 & -4 \\ -4 & 6 \end{bmatrix} \begin{Bmatrix} x_1 \\ x_2 \end{Bmatrix} = \begin{Bmatrix} 8 \\ 0 \end{Bmatrix}$ a) Find the eigenvalues b) Evaluate the modal matrix [u]. c) Derive the uncoupled equations expressed in the principal coordinates. d) Express the uncoupled equations in the global/normal coordinates.	**20**	**CO3/ CO4**
Q 11	Describe the significance of condition monitoring in the area of rotordynamics. OR Describe the impact of vibration on human health.	**20**	**CO5**