U.S.N.										

B.M.S. College of Engineering, Bengaluru-560019

Autonomous Institute Affiliated to VTU

January / February 2025 Semester End Main Examinations

Programme: B.E. **Semester: VII**

Branch: Aerospace Engineering **Duration: 3 hrs.**

Course Code: 22AS7PERDY **Max Marks: 100**

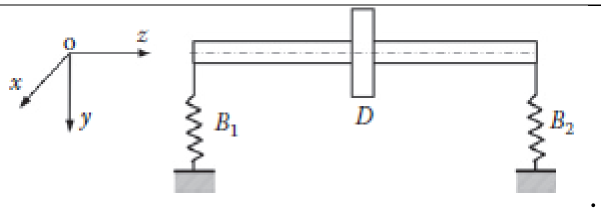
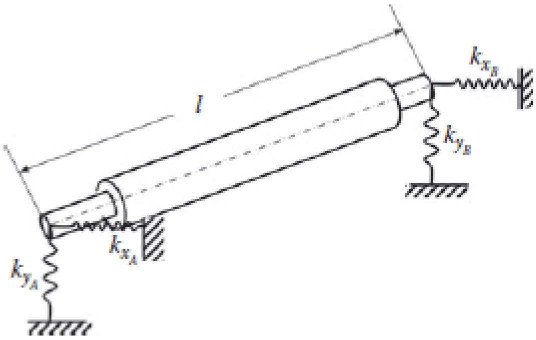
Course: Rotor Dynamics

Instructions: 1. Answer any FIVE full questions, choosing one full question from each unit.
2. Missing data, if any, may be suitably assumed.

Important Note: Completing your answers, compulsorily draw diagonal cross lines on the remaining blank pages. Revealing of identification, appeal to evaluator will be treated as malpractice.

			CO	*PO*	Marks
		UNIT - I			
1	a)	Explain the different methods of attenuation of vibration.	*CO1*	*PO1*	**12**
	b)	Derive the governing differential equation of motion and natural frequency of Jeffcott rotor model.	*CO1*	*PO1, PO2*	**08**
		OR			
2	a)	Define the following: i) Whirling of the shaft ii) Critical speed iii) Asynchronous whirl iv) Synchronous whirl v) Instability of rotor system vi) Anti-Synchronous whirl	*CO1*	*PO1*	**06**
	b)	Derive the governing differential equation of motion and natural frequency of single degree of freedom Un-damped free and forced rotor model.	*CO1*	*PO1, PO2*	**10**
	c)	Explain the Rankine rotor model concerning the different orbital motions of the mass.	*CO1*	*PO1*	**04**
		UNIT - II			
3	a)	List the Reynolds equation assumptions for calculating the performance of the hydrodynamic bearing.	*CO2*	*PO1*	**06**
	b)	Explain the guidelines for selecting a proper type of bearing.	*CO2*	*PO1*	**04**
	c)	List the types of rolling contact bearings and explain any two with neat sketches.	*CO2*	*PO1*	**10**
		OR			
4	a)	Explain with a neat sketch: i) Pressure dam bearings, ii) Rocker back tilt pad bearing, iii) Cross-coupling, iv) boundary friction, v) Lemon bore bearing.	*CO2*	*PO1*	**10**
	b)	Illustrate the failures in rolling contact bearing with neat sketches.	*CO2*	*PO1*	**10**

			UNIT - III			
	5	a)	Explain the influence of the rotational speeds and pressure differences on the seal's dynamic coefficients.	*CO3*	*PO1*	**10**
		b)	Write a note on the effects of negative stiffness.	*CO3*	*PO1*	**04**
		c)	Explain the effect of the L/D ratio on the seal's dynamic coefficients.	*CO3*	*PO1*	**06**
			OR			
	6	a)	Derive the governing equations for instability analysis due to rotary seals.	*CO3*	*PO1, PO2*	**12**
		b)	Explain with a neat sketch invention of the pocket damper seal.	*CO3*	*PO1*	**08**
			UNIT - IV			
	7	a)	Explain the whirl directions with respect to the shaft spin frequency with neat sketches.	*CO4*	*PO1, PO2*	**06**
		b)	The rotor of a jet aeroplane engine is supported by two bearings 2.14 m apart. The rotor assembly including compressor, turbine and shaft has a mass of 688 kg.If C.G being situated at 0.92 m from the left bearing and has radius of gyration 0.229 m.Determine the maximum bearing force on the aeroplane when it undergoes a pullout on a 1830 m radius curve at a constant speed of aeroplane 960 km per hour and engine rotor speed of 10,000 rpm, including the effect of centrifugal force due to the pull out as well as gyroscopic effect.	*CO4*	*PO1, PO2, PO3*	**04**
		c)	Derive the four critical speeds of a rigid rotor mounted on simple anisotropic springs as bearings.	*CO4*	*PO1, PO2*	**10**
			OR			
	8	a)	Derive the gyroscopic moments equation for motion of a rotor mounted on two bearings.	*CO4*	*PO1, PO2*	**08**
		b)	Determine the transverse natural frequencies of a system as shown in Figure 8b. The mass and the diametric mass moment of inertia of the rotor are 2.51 kg and 0.00504 kg-m^2, respectively. The total span of the shaft between the bearings is 508 mm, and the shaft is treated as rigid. (i) Bearings have equal flexibility in the horizontal and vertical directions kx = ky = k = 175 N/m. (ii) Solve the same problem as part (i) except that the bearings have different vertical and horizontal flexibilities: $k_{horizontal}$ = 175 N/m and $k_{vertical}$ = 350 N/m for each of the bearings.	*CO4*	*PO1, PO2, PO3*	**06**

			 **FIGURE 8b.** A long rigid rotor on flexible bearings.			
		c)	Find the critical speeds of a rotor system as shown in Figure 8c. The bearing stiffness properties are $k_{x\,A}$ =1.1 kN/mm, k_{yA} =1.8 kN/mm, $k_{x\,B}$ = 3.1 kN/mm, and k_{yB} = 3.8 kN/mm. The disc has m= 10 kg and I_d = 0.1 kg-m^2 and length of rotor l = 1 meter.  **FIGURE 8c.** A long rigid rotor on flexible bearings.	*CO4*	*PO1, PO2, PO3*	**06**
			UNIT - V			
	9	a)	Describe the process of run-out correction in vibration signal conditioning with brevity.	*CO5*	*PO1*	**06**
		b)	Explain with neat sketches of vibration signature analysis.	*CO5*	*PO1*	**06**
		c)	Illustrate vibration measurements through the creation of clear diagrams, including waterfall and Campbell diagrams, with a visual presentation.	*CO5*	*PO1*	**08**
			OR			
	10	a)	Explain with neat sketches, and visual presentation of vibration measurements- waterfall diagram.	*CO5*	*PO1*	**06**
		b)	Write a note on the electrical noise.	*CO5*	*PO1*	**04**
		c)	Illustrate the vibration-based identification of faults.	*CO5*	*PO1*	**10**

******