

# GUJARAT TECHNOLOGICAL UNIVERSITY

## MECHANICAL (MACHINE DESIGN) (09)

ROTOR DYNAMICS

SUBJECT CODE: 2720914

SEMESTER: II

**Type of course:** Post Graduate

**Prerequisite:** Zeal to learn the Subject

**Rationale:** Rotating elements are found in majority of mechanical equipment. Their behaviour is quite different from element with motion along a linear path. It is essential to understand techniques required to analyse behaviour of such elements. The course aims to impart basic understanding for analysing rotating elements.

**Teaching and Examination Scheme:**

Teaching Scheme			Credits C	Examination Marks						Total Marks
L	T	P		Theory Marks		Practical Marks				
				ESE (E)	PA (M)	ESE (V)		PA (I)		
				PA	ESE	OEP	PA	RP		
3	0	2 <sup>#</sup>	4	70	30	20	10	10	10	150

**Content:**

Sr. No.	Content	Total Hrs	% Weightage
<b>1</b>	<b>Introduction to Vibration and the Laval-Jeffcott Rotor Model:</b> Co-ordinate systems, steady state rotor motion, elliptical motion, single degree of freedom systems, free and forced vibrations. The two degrees of freedom rotor system, geared systems, translational motion, natural frequencies and natural modes, steady state response to unbalance, the effect of flexible support.	<b>12</b>	<b>25%</b>
<b>2</b>	<b>Torsional Vibrations of Rotating Machinery:</b> Modelling of rotating machinery shafting - Multi degree of freedom systems - Determination of natural frequencies and mode shapes - Branched systems - Holzer method, Numerical methods for fundamental frequency.	<b>12</b>	<b>25%</b>
<b>3</b>	<b>Rigid Rotor Dynamics and Critical Speed:</b> Rigid disk equation - Rigid rotor dynamics- Rigid rotor on flexible rotor - The gyroscopic effect on rotor dynamics - Whirling of an unbalanced simple elastic rotor, Unbalance response, Orbital Analysis and Cascade Plots, simple shafts with several disks - Effect of axial stiffness - Determination of bending critical speeds - Campbell diagram.	<b>12</b>	<b>25%</b>
<b>4</b>	<b>Influence of Bearings on Rotor Vibrations:</b> Support stiffness on critical speeds- Stiffness and damping coefficients of journal bearings-computation and measurements of journal bearing coefficients -Mechanics of Hydro dynamic Instability- Half frequency whirl and Resonance whip- Design configurations of stable journal bearings.	<b>10</b>	<b>15%</b>
<b>5</b>	<b>Balancing of Rotors:</b> Single plane balancing, multi-plane balancing, balancing of rigid rotors, balancing of flexible rotors, Influence coefficient and modal balancing techniques for flexible rotors.	<b>8</b>	<b>10%</b>

**Reference Books:**

1. Rotor Dynamics, J. S.Rao, New Age International Publishers, New Delhi.
2. Vibration Problems in Engineering, S.Timoshenko, D H.Young and W. Weaver, John Wiley.
3. Introduction to Dynamics of Rotor – Bearing Systems, W J Chen and J E Gunter, Trafford Publishing Ltd.
4. Linear and Nonlinear Rotordynamics: A Modern Treatment with Applications, T. Yamamoto and Y.Ishida, John Wiley.
5. Vibratory Condition Monitoring of Machines, J. S.Rao, Narosa Publishing House.

**Course Outcome:**

After learning the course the students should be able to:

1. Develop of skill to analyse vibration in rotating machinery.
2. Acquires knowledge in rotor balancing.

**List of Experiments:**

1. Torsional vibration of single and two rotor systems.
2. Experiments based on Multi degree of freedom system.
3. Time and frequency domain analysis of vibratory system using MATLAB/Scilab/LabView.
4. Determine natural frequencies of MDOF by Programming.
5. Experiment on critical speed of shaft/rotor.
6. Experiment on rotor balancing.
7. Study on stiffness and damping coefficient of bearings.

**Design based Problems (DP)/Open Ended Problem:**

1. Develop a mathematical model to analyse a cracked model and validate the same experimentally.

**Major Equipment:**

1. Vib-Lab.
2. Bearings and Shafts with/without rotors.
3. FFT Analyser.
4. Accelerometers.
5. Analysis software.

**List of Open Source Software/learning website:**

1. <http://nptel.ac.in/syllabus/112103024/>

**Review Presentation (RP):** The concerned faculty member shall provide the list of peer reviewed Journals and Tier-I and Tier-II Conferences relating to the subject (or relating to the area of thesis for seminar) to the students in the beginning of the semester. The same list will be uploaded on GTU website during the first two weeks of the start of the semester. Every student or a group of students shall critically study 2 papers, integrate the details and make presentation in the last two weeks of the semester. The GTU marks entry portal will allow entry of marks only after uploading of the best 3 presentations. A unique id number will be generated only after uploading the presentations. Thereafter the entry of marks will be allowed. The best 3 presentations of each college will be uploaded on GTU website