Theory & Practice of Rotor Dynamics - Web course

COURSE OUTLINE

The present course material is an outcome of an elective course on “Rotor Dynamics” offered to undergraduate, graduate and post-graduate students at IIT Guwahati over last nine years. Moreover, it contains materials of some of the project works done by graduate students and case studies of industrial problems.

The very purpose of this course material is to give a basic understanding of the rotor dynamics phenomena with the help of simple rotor models and subsequently the modern analysis methods for real life rotor systems.

The modeling and analysis of rotor-bearing dynamics are now reached a mature state. In broad sense this area covers several categories namely modeling, analysis, identification and condition monitoring of rotor-bearing systems. The finite element (FE) method has been used extensively for modeling and analyses of rotors for the transverse and torsional vibrations.

Till today, the condition monitoring of rotor-bearing systems based on vibrations mainly concerned with the feature based fault detection and diagnostics. As a result of this the methods available so far are not reliable and fail-safe up to the expectation of fellow engineers working in the fields.

For model based condition monitoring of the rotor-bearing systems, identification methods for system parameters are under development. For the identification of rotor system parameters the literature available is not so rich and a lot of possibilities have been appeared in the literature.

This background will be helpful in the identification of rotorbearing system parameters and its use in futuristic model based condition monitoring and fault diagnostic and prognostics. The present course material compiles some of the available literature in a systematic and lucid form so as to boost research in the developing area of the rotor dynamics.

Lecture materials are supplemented by numerical examples and exercise (objective type and numerical descriptive type) problems. It is expected that with this course material, students will get sufficient exposure and motivation for doing research in the Theory and Practice of Rotor Dynamics and allied areas.

Contents: Flexural and torsional vibrations: critical speeds of shafts. Equivalent discrete systems. Geared and branched systems. Gyroscopic effects. Rotor-bearing interactions. Effects of anisotropic bearings. Fluid film bearings: Steady state characteristics of bearings. Rolling element bearings: Stiffness calculations. Instability in rotors. Unbalanced response of an asymmetric shaft. Rigid and flexible rotors balancing. Bearing dynamic parameters estimation. Measurement & digital processing techniques. Condition monitoring of rotating machineries.

COURSE DETAIL

Sl. No	Topic	Hours

NP-TEL

NPTEL

http://nptel.iitm.ac.in

Mechanical Engineering

Pre-requisites:

- Mechanical Vibrations (undergraduate level)
- Finite Element Methods (for added advantage)

Additional Reading:

- Bureau of Indian Standard codes on Rotor Balancing

Hyperlinks:

- http://www.nptel.iitm.ac.in/courses/Webcourse-contents/IIT-%20Guwahati/ve/index.htm

Coordinators:

Prof. Rajiv Tiwari
Department of Mechanical EngineeringIIT Guwahati

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9.	Sub-Critical Phenomenon in Rotors	1
10.	FEM Analysis of Rotors	4
11.	Measurement & Signal Processing Techniques	3
12.	Condition Monitoring of Rotors	2

References:

1. Admas M. L. Jr, 2001, Rotating Machinery Vibration: From Analysis To Troubleshooting, Marcel Dekker, Inc., New York.
2. Biezeno, C. and Grammel, R, 1959, Engineering Dynamics, Vol III. of Steam Turbines, D. Van Nostrand Co., Inc., New York.
3. Chen, W. J., Gunter, E. J. (2005). Introduction to Dynamics of Rotor-Bearing Systems. ISBN 1-4120-5190-8
4. Childs D., 1993, Turbomachinery Rotordynamics: Phenomena, Modeling and Analysis. Research Studies Pub., A Wiley-Interscience Publication, NY.
5. Darlow M.S., 1989, Balancing of High-Speed Machinery, Springer-Verlag.
6. Dimentberg F.M., 1961, Flexural Vibrations of Rotating Shafts, Butterworths, London.
7. Dimargonas A.D. and Paipetis S.A., 1983, Analytical Methods in Rotor Dynamics, Applied Science Publications, London.
8. Ehrich(ed.), F.F., 1992, Handbook of Rotordynamics, McGraw-Hill.
9. Genta, G., 1999, Vibration of Structures and Machines, 3rd edition, Springer.

10. Genta, G., 2005, Dynamics of Rotating Systems, Springer, NY.

11. Goodwin M.J., 1989, Dynamics of Rotor-Bearing Systems, Unwin Hyman, Sydney.

12. Krämer E., 1993, Dynamics of Rotors and Foundations, Springer-Verlag, New York.

13. Lalanne, M., and Ferraris, G., 1998, Rotordynamics Prediction In Engineering, Wiley: NY.

14. Lee C.-W., 1993, Vibration Analysis of Rotors, Kluwer Academic Publishers, London.

15. Lipovszky, G., Solyomvari, K. and Varga, G., Vibration Testing of Machines and their Maintenance, Elsevier, 1990

16. Loewy R.G. and Piarulli, V.T., Dynamics of Rotating Shafts, The Shock and Vibration Information Center, 1969

17. Mahrenholtz O. (editor), 1984, Dynamics of Rotors; Stability and System Identification, International Center for Mechanical Science, NY.

18. Mitchell, J.S., 1993, Introduction to Machinery Analysis and Monitoring, Penn Well Books.

19. Muszynska, A, 2005, Rotordynamics, Series: Dekker Mechanical Engineering, Vol. 188, CRC Press.

20. Rao J.S., 1996, Rotor Dynamics, Third ed., New Age, New Delhi.

21. Rao, J. S., 2000, “Vibratory Condition Monitoring of Machines,” Narosa Publishing House, New Delhi.

22. Rieger N.F., 1977, Vibrations of Rotating Machinery, The Vibration Institute, Clarendon Hills, Illionis.

23. Rieger N.F., 1986, Balancing Of Rigid And Flexible Rotors, Shock and Vibration Information Center.

24. Robert B.M., 2003, Rotating Machinery: Practical Solutions to Unbalance and Misalignment, CRC Press.

25. Schneider, H., 1991, Balancing Technology, 4th ed., Carl Schenck Ag.,

26. Schweitzer G, Bleuler, H, and Traxler, A., 1994, Active Magnetic Bearings, VDF Hochschulverlag AGan der ETH, Zurich.

27. Tondl A., 1965, Some Problems of Rotor Dynamics, Chapman & Hall, London.

28. Vance J.M., 1988, Rotordynamics of Turbomachinery, John Wiley & Sons, Inc., NY.

29. Yamamoto, T., Ishida, Y., 2001, Linear and Nonlinear Rotordynamics: A Modern Treatment with Applications, Wiley, NY.

30. Wowk, V., 1995, Machinery Vibration: Balancing, McGraw-Hill.

31. Wowk, V., 1991, Machinery Vibration: Measurement and Analysis, McGraw-Hill.