

ELEMENTS OF MECHANICAL VIBRATION

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PRE-REQUISITES : Basic exposure to Engineering Mechanics and Engineering Mathematics would be useful

INTENDED AUDIENCE : Senior Undergraduate / Post-graduate, doctoral students in aerospace or mechanical engineering, practicing engineers from industry willing to get a sound foundation in vibration engineering

INDUSTRY SUPPORT : All the industrial rotating machinery have vibration and noise issues, and there are many critical vibration problems in most aerospace systems including engines and transmissions. Strong foundation and understanding of variety of aspects of the vibration phenomenon is very crucial to analysis and interpretation of issues observed in practical machinery and structures. The course is intended to address fundamental understanding of the vibration theory with emphasis on solution of many practical problems, analysis and interpretation.

COURSE OUTLINE :

It is hard to imagine any mechanical/aerospace system that is not subjected to dynamic excitation force. The time-varying forces excite these machines/structures and manifests in their vibratory motion. The vibratory motion greatly influences the stresses and hence the durability and residual life of these complex systems, apart from generating undesired noise. The task for an engineer in designing these systems is ensuring a desired life. It is therefore necessary to develop insights into the vibration phenomenon, so that the issue of undesired vibration levels is addressed at the design stage itself. This course addresses the fundamentals of vibration theory with simple but practical examples with an emphasis on seeing the larger picture and interpreting the outcome of vibration analysis from the context of machinery or structural design. At the end of the course the student will be able to understand the process of modelling any practical vibratory system, its analysis and interpreting the results.

ABOUT INSTRUCTOR :

Prof. Darpe has been teaching at IIT Delhi since 2004. His main subjects are Mechanical Engineering Drawing, Graphic Science, Vibration Engg., Noise Engg., Rotor Dynamics and Condition Monitoring. His research interests include Machinery Health Monitoring, Dynamics of Rotors, and Diagnostics/Prognostics. He has been project investigator for various R&D and consultancy projects collectively valued over 13 Crore funded by defence R&D labs, private industry and government funding agencies in the areas of Vibration, Noise and Dynamics. He has published extensively (57 papers) in reputed international journals and has taught Vibration Engineering course several times to the undergraduate and post-graduate students at IIT Delhi. The course “Vibrations and Noise Engineering” has been one of the popular courses with excellent feedback from the students.

COURSE PLAN :

Week 1: Need and significance of vibration analysis, basic process, approaches for modelling a mechanical system
Week 2: Single DOF system, Free vibration response, Newtonian and Energy approaches for the governing equations of motion
Week 3: Various damping mechanisms and ways to include them in the mathematical model
Week 4: Response to transient excitation, use of Convolution integral
Week 5: Forced Vibration: harmonic and periodic excitation, Whirling of rotors, Campbell Diagram
Week 6: Base excited system, Vibration Isolation and Transmissibility
Week 7: Two DOF system: Natural frequencies, Concept of Mode shape, Response to initial conditions
Week 8: Vibration response analysis (Free/forced), design of vibration absorber, Design of automotive torsional damper, Vibration isolation in 3 DOF system
Week 9: MDOF system, eigenvalues and eigenvectors, Orthogonality of mode shapes, and its use in modal analysis approach to finding the vibration response (free/forced)
Week 10: Transfer Matrix methods for large DOF systems, Holzer and Myklestad-Prohl Methods
Week 11: Modelling a vibratory system as a continuous system (distributed parameter model); cases of string, bar, rod, beam, Introduction to use of FEA approach to solve vibration problem
Week 12: Introduction to vibration-based condition monitoring, Introduction to Random vibration