



Birla Institute of Technology & Science, Pilani

Hyderabad Campus

FIRST SEMESTER 2020-2021

Course Handout Part II

Date: 17-08-2020

In addition to Part-I (General Handout for all courses appended to the time table) this portion gives further specific details regarding the course.

Course No. : ME F343
Course Title : Mechanical Vibrations
Instructor-in-Charge : Dr. Brajesh Kumar Panigrahi

Scope and Objective of the Course: This course is designed to acquaint the students with topics in vibrations. The emphasis is on application to common engineering situations. The main aim of the course is to prepare students to tackle complex and frontier technological problems in vibrations. The analysis of increasingly complex system has been instrumental in the usage of concepts like Lagrange equations and generalized coordinates. Introductory topics in control systems are included in the last part of the course.

Textbooks:

1. T1. "Theory of Vibrations with Applications", William T. Thomson, Marie Dillon Dahleh and Chandramouli Padmanabhan, Pearson, Sixth Ed.
2. T2. "Modern Control Engineering", Katsuhiko Ogata, Pearson, 5th Edition

Reference books

1. R1. "Mechanical Vibrations", Singiresu S Rao, Pearson, 4th Ed.
2. R2. "Mechanical Vibrations - Theory and Application", Francis S. Tse, Ivan E. Morse and Rolland T. Hinkle, Allyn and Bacon Inc. London, 1983.
3. R3. "Elements of vibration analysis", Meirovitch, L, Mc graw Hill, U.S.A, 1986.

Course Plan:

| Lecture Nos. | Learning Objectives | Topics to be covered | Chapter |
|--------------|--|---|--------------------|
| 1-3 | Brief review of fundamental concepts of vibration | Introduction to Vibration: Basic concepts of Vibration, Oscillatory Motion, Harmonic motion, Periodic Motion, Elementary parts of Vibrating systems, Degree of freedom, Discrete and continuous systems | T-1-CH-1, R1-CH-1 |
| 4-6 | Understand the causes and reasons for vibration and why vibrations die out. Analysis of simple vibrating systems | Vibration analysis, spring mass and damping elements in a vibrating system, Types of damping, Complex number notation, Harmonic analysis | T-1-CH-1, R-1,CH-1 |



| Lecture Nos. | Learning Objectives | Topics to be covered | Chapter |
|--------------|---|---|--------------------------------------|
| 7-10 | Modeling of vibrating systems natural and undamped. Effect of damping on systems in vibration, Other types of damping and energy loss | Single dof free undamped vibration systems ,Single dof free damped vibration systems , Coulomb damping | T-1-CH-2, R-1 CH-2 |
| 11-17 | Forced system analysis. Need for Vibration isolation and critical speed and resonance Construction and functioning of measuring instruments | Single dof forced vibration systems, Vibration isolation, support motion, rotary unbalance, whirling of shafts, sharpness of resonance Structural damping, energy dissipated by damping, equivalent viscous damping Vibration measuring instruments | T-1-CH-3, R-1-CH-3 |
| 18-20 | Transient versus steady systems and analysis | Transient vibration of single dof systems, Laplace and finite difference methods | T-1CH-4, R-1-CH-4 |
| 21-26 | Two and more dof systems modeling and analysis, Matrix methods and forced multi dof systems | Multi dof free vibration systems, Normal modes, initial conditions, coordinate coupling, decoupling Matrix formulation, Eigen values and vectors, Multi dof forced harmonic vibration, Orthogonality relations Vibration absorber | T-1CH-5, R-1-CH-5,6 |
| 27-32 | Energy methods and Generalized coordinates and use of Lagrange's mechanics | Energy method, Rayleigh Method, Virtual work methods, Lagrange Mechanics, Generalized Coordinates | T-1CH-6 R-1CH-7 |
| 33-36 | Classical Methods | Rayleigh method, Rayleigh-Ritz method, Dunkerley's Equation | T-1CH-10 R-1CH-8 |
| 37-43 | Vibration of continuous systems, FEM Control theory concepts, | Vibration of string, rods, bars and beams Stiffness Matrix and flexibility influence coefficients Introduction to control systems | T-1CH-8,11 R-1CH-6,8 T-2-CH1&2 |

Evaluation Scheme:

| Component | Duration | Weightage (%) | Date & Time | Nature of Component |
|-----------|----------|---------------|---|---------------------|
| Test 1 | 30 min | 10 | During Class Hours (between Sept.10 –Sept. 20) | Open Book |
| Test 2 | 30 min | 15 | During Class Hours (between Oct 09 –Oct 20) | Open Book |
| Test 3 | 30 min | 15 | During Class Hours (between Nov.10 – Nov.20) | Open Book |



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|--------------------|---------|----|--------------------------------|-----------|
| *Quiz | - | 10 | To be announced by IC | Open Book |
| Tutorials | - | 20 | To be announced by IC | Open Book |
| Comprehensive Exam | 120 min | 30 | As announced in the Time Table | Open Book |

Chamber Consultation Hour: To be announced in the class room.

*Surprise quiz will be conducted during lecture classes.

Notices: All notices concerning this course will be displayed on CMS only, students are advised to visit regularly CMS for latest updates.

Make-up Policy: Make-up shall be given only to the genuine cases with prior intimation. No make-up will be given for the surprise tests.

Academic Honesty and Integrity Policy: Academic honesty and integrity are to be maintained by all the students throughout the semester and no type of academic dishonesty is acceptable.

Dr. Brajesh Kumar Panigrahi
ME F343

