

**SECOND SEMESTER 2021-2022**

# Course Handout Part II

Date: 15-01-2022

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 F319**

## Course Title : **VIBRATIONS AND CONTROL**

## Instructor-in-Charge : Sabareesh G R

## Instructors : Dr Arshad Javed

**Scope and Objective of the Course:**

This course is designed to acquaint the students with topics in vibrations and control. The emphasis is on application to common engineering situations. The course will cover topics on Small oscillations of linear dynamical systems, free and forced vibrations of single and multi-degree-of-freedom systems, normal modes and orthogonality relations, generalized coordinates, and Lagrange's equations, matrix formulation, eigen-value problem, and numerical solutions, transient response of one-dimensional systems. Introduction to continuous system, vibration measurement and analysis, closed loop control, conventional and non-conventional control strategies, transfer function, dynamic response, and stability criteria, state space approach and exposure to simulation tools.

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**Textbooks:**

T1. "Theory of Vibrations with Applications", William T. Thomson, Marie Dillon Dahleh and Chandramouli Padmanabhan, Pearson, Sixth Ed.

T2. “Modern Control Engineering”, Katsuhiko Ogata, Pearson, 5th Edition

**Reference Books**:

R1. "Mechanical Vibrations", Singiresu S Rao, Pearson, 4th Ed.

R2. "Mechanical Vibrations - Theory and Application", Francis S. Tse, Ivan E. Morse and Rolland T. Hinkle, Allyn and Bacon Inc. London, 1983.

R3. “Control Systems Engineering”, I.J. Nagrath, M Gopal, New Age International, 2006.

**Course Plan:**

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| **Lecture No.** | **Learning objectives** | **Topics to be covered** | **Chapter in the Text Book** |
| 1-4 | Small oscillations of linear dynamical systems | 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, Vibration analysis, spring mass and damping elements in a vibrating system, Types of damping | T-1-CH-1,2 |
| 5-9 | Free and forced vibrations of single degree of freedom systems | Single dof free undamped vibration systems ,Singledof free damped vibration systems , Single dof forced vibration systems, Vibration isolation, support motion, rotary unbalance,  energy dissipated by damping, equivalent viscous damping | T-1-CH-3, |
| 10-13 | Free and forced vibrations of multi degree of freedom systems | Multi dof free vibration systems, Normal modes, initial conditions, coordinate coupling, decoupling | T-1, CH-5 |
| 14-17 | Normal modes and orthogonality relations, Generalized coordinates | Matrix formulation, Eigen values and vectors, Multi dof forced harmonic vibration, Orthogonality relations  Vibration absorber , Generalized Coordinates | T-1, CH-5 |
| 18-19 | Eigen-value problem and numerical solutions | Eigen value formulation and associated Numericals | T-1, CH-5 |
| 20-22 | Lagrange's equations Formulation and transient response | Lagrange Mechanics formulation and numericals. Transient response of one-dimensional systems. | T-1, CH-4,  Class Notes |
| 23-25 | Introduction to continuous system | Vibration of string, rods, bars and beams  Stiffness Matrix and flexibility influence coefficients | T-1, CH-8 |
| 26-28 | Vibration measurement and analysis | Vibration measuring instruments and  Structural Health Monitoring | Class Notes |
| 29-30 | Closed loop system, Conventional and non-conventional control strategies control | Introduction of modes of control systems, open loop, closed loop, two mode control system, Servomechanism, application and examples of control systems | T2- Ch.1, 2 |
| 31-34 | Mathematical model of systems. Transfer function, dynamic response, | System and signal models. Transfer function. Algebra of block diagram Modeling of mechanical systems. | T2-Ch. 3, 4  R2-Ch.2 |
| 35-38 | Stability criteria | Concept of Stability, Conditions for stability, Stability criteria, Analysis of first order and second order systems, Example of Mechanical systems | T2-Ch. 5, 6  R2-Ch.6 |
| 39-40 | State space approach | State-space representations of  Transfer-function systems, transformation of system models, examples and case studies. | T2-Ch. 9  R2-Ch.12 |
| 41-42 | Exposure to simulation tools | Examples and case studies on MATLAB platform. | Class notes |

**Evaluation Scheme:**

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| Component | **Duration** | **Weightage** | **Date & Time** | **Nature of component** |
| Mid-Semester Test | 90 min | 30% | 16/03 3.30pm to5.00pm | OB (if online)  CB (if offline) |
| Project |  | 15% |  | OB |
| Quiz/Tutorial test |  | 15% |  | OB |
| Comprehensive Examination | 120 mins | 40% | 23/05 FN | OB (if online)  CB (if offline) |

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

**Notices:** All the notices regarding the course will be displayed on the CMS.

**Make-up Policy: Only for genuine cases with prior permission**

**INSTRUCTOR-IN-CHARGE**