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**FIRST SEMESTER 2021-2022**

# Course Handout Part II

Date: 24-08-2022

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.* : **DE G611**

## Course Title : **DYNAMICS & VIBRATIONS**

## Instructor-in-Charge : Sabareesh G R

## Instructor for lab : Dr Punnag Chatterjee, Mr Narayana

**Course Description**: Steady and transient Vibration of single and multi degree freedom systems. Systems with distributed mass and elasticity. Nonlinear and self-excited vibrations, structural damping, Random vibrations, vibration analysis, vibration control - reduction, isolation and vibration absorbers.

**Scope and Objective of the Course:**

The course covers advanced topics in dynamics and 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 dynamics and vibrations. Advanced topics like Non-linear system analysis are included in **Part A** (Vibrations). The analysis of increasingly complex system has been instrumental in the development of advanced concepts like Lagrange and variation calculus, which forms the core of **Part B** (dynamics).

**Textbooks:**

1. "Advanced dynamics for Engineering Application", EDD Notes by N N SHARMA
2. "Elements of Vibration analysis", Leonard Meirovitch, McGraw-Hill, Singapore, 2000.

**Reference books**

1. "Classical Dynamics",Donald T. Greenwood, Prentice Hall Inc. Englewood Cliffs, 1977
2. "Lagrangian and Hamiltonian mechanics" M.G. Calkin, World Scientific, Singapore, 1996
3. "The Theory of classical dynamics", J.B. Griffiths, Cambridge University Press, 1985.
4. "Vibration Theory and application", William T. Thomson, CBS Publications, 3rd Ed., 1988.
5. "Mechanical Vibrations - Theory and Application" Francis S. Tse, Ivan E. Morse and Rolland T.Hinkle, Allyn and Bacon Inc. London, 1983.

**Course Plan:**

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| --- | --- | --- | --- |
| **Lecture No.** | **Learning objectives** | **Topics to be covered** | **Text Book** |
| 1-3 | Introduction to the concept of Vibration- Steady | Review of Basics, Equivalent spring and mass elements | TB 2, RB 4 |
| 4-6 | Single DOF Vibrations | Review of Single DOF free damped and undamped Vibrations & forced Vibrations | TB 2, RB 4 |
| 7-9 | Higher DOF Vibrations | Two DOF, Modal vectors Eigenvalue Problems | TB 2, RB 4 |
| 10-12 | Extension to Multi DOF Vibrations | Lumped Parameter models | TB 2, RB 4 |
| 13 | Structural and Coulomb damping | Different types of damping and energy dissipated in damping | TB 2, RB 4 |
| 14-16 | Vibration control - reduction, Vibration isolation, Vibration absorbers | Understanding vibration control, Methods for Isolation of Vibration, Methods for Absorbing vibration | TB 2, RB 4 |
| 17-21 | Transient Vibrations | Impulse Excitation, Arbitrary Excitation, Laplace Transform formulation | TB 2, RB 4 |
| 22-25 | Finite Element method Equation of motion using FEM | General Discussion, Stiffness and Flexibility coefficients | TB 2, RB 4 |
| 26-27 | Continuous Systems | Vibrating String, Longitudinal vibration of rods, torsional vibration of rods | TB 2, RB 4 |
| 28-29 | Introduction to Nonlinear systems and Self-excited  vibrations | General consideration, Limit Cycles, Jump Phenomenon | TB 2, RB 4 |
| 30-31 | Random vibrations | Bending vibration of Bars Boundary conditions | TB 2, RB 4 |
| 32-35 | Vibration Analysis | Machinery Vibration Analysis, Techniques and Methods | TB 2, RB 4 |
| 36-37 | Review Newtonian Mechanics | Newton’s law, Principle of virtual work, D Alembert’s Principle  Examples | TB 1  RB :1,2 |
| 38-41 | Lagrange Mechanics Formulation and application of Lagrange Mechanics | Lagrange Mechanics  Engineering Application | TB 1  RB : 1,2 |
| 42 | Introduction to Hamiltonian Mechanics | Hamilton’s equation, Langrage equation for impulsive forces | TB 1  RB : 1,2 |
| 43 | Formulation of Hamiltonian Mechanics | Formulation for Hamiltonian Principle, Application of Hamilton’s principle | TB 1  RB : 1,2 |

**Evaluation Scheme:**

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| --- | --- | --- | --- | --- |
| Component | **Duration** | **Weightage** | **Date & Time** | **Nature of component** |
| Mid-Semester Test | 90 min | 25% | 31/10 3.30 - 5.00PM | CB |
| Project |  | 10% |  | OB |
| Term paper |  | 10% |  | OB |
| Practical |  | 20% |  | OB |
| Comprehensive Examination | 180 min | 35% | 19/12 AN | CB |

**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**

**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.

**Dynamics and Vibration Laboratory- List of Experiments**

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| --- | --- | --- | --- |
| **Lab No** | **Experiment/Simulation** | **Schedule** | **Mode** |
| 1 | Introduction Lab | Week 1 |  |
| 2 | Study of response of critically damped system, under damped and overdamped system | Week 2 | Matlab |
| 3 | Modal& Harmonic Analysis of I Section beam | Week 3 | ANSYS |
| 4 | Modal & Harmonic Analysis of Pentagonal plate | Week 4 | ANSYS |
| 5 | Modal & Harmonic Analysis of pressure vessel | Week 5 | ANSYS |
| 6 | Analysis of Torsional Vibration using ANSYS and Matlab | Week 6 | ANSYS/Matlab |
| 7 | Study of Static and Dynamic Balancing | Week7 | Experiment |
| 8 | Calculation of frequency of undamped free vibration of equivalent spring mass system | Week 8 | Experiment |
| 9 | Study the modes of vibration and measure the frequency using Whirling of Shaft Apparatus | Week 9 | Experiment |
| 10 | Study of fault diagnosis in gearbox of wind turbine | Week 10 | Experiment |
| 11 | Study of fault diagnosis in 4-cylinder SI engine | Week 11 | Experiment |
| 12 | Study of FRF of plates using Electrodynamic Shaker | Week 12 | Experiment |

**INSTRUCTOR-IN-CHARGE**