Birla Institute of Technology & Science, Pilani
Hyderabad Campus

SECOND SEMESTER 2021-2022

Course Handout Part II

Date: 16-01-2023

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 : Dr. Sabareesh G R
Instructors : Dr Punnag Chatterjee
Tutorial Instructors : Dr.Sabareesh, Dr Punnag C, Dr. Kundan Singh, P Narayana, Gururaja

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:

Lecture No.	Learning objectives	Topics to be covered	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	T-1-CH-1,2

		analysis, spring mass and damping elements in a vibrating system, Types of damping	
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:

Component	Duration	Weightage	Date & Time	Nature of component
Mid-Semester Test	90 min	30%	16/03 4.00 - 5.30PM	CB
Project		15%		OB
Quiz/Tutorial test		15%		OB
Comprehensive Examination	180 mins	40%	16/05 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.

INSTRUCTOR-IN-CHARGE