Vibrations and Aeroelasticity

Code	Credit Hours
AE-337	3-0

Course Description

The goal of this course is to enable students to determine the effects of vibrations on the performance and safety of the system with fundamental application of vibration theory, and to provide adequate background for more advanced studies required for the wider applications of the subject in various fields of engineering. In first part the equation of motion of a 1-DOF system are derived and applied for solving problems. Later the responses of un- damped and viscously damped systems subjected to harmonic forces are studies followed by responses of multi-DOF systems to various types of loading. Introduction to basic topics of aeroelasticity. The last part of the course covers "Introduction to Aero-elasticity".

Textbook (s):

1. Singiresu, S. Rao. Mechanical vibrations. Boston, MA: Addison Wesley, Latest Available Edition, PrenticeHall
2. Physics by Aviation Maintenance Technician Certification Series, Latest Available Edition

Reference Book (s):

1. Hodges, Dewey H., and G. Alvin Pierce. Introduction to structural dynamics and aeroelasticity. Vol. 15. cambridge university press, 2011.
2. Kelly, S. Graham. Mechanical vibrations: theory and applications. Cengage learning,2012.

Prerequisites

- Engineering Dynamics
- Linear Algebra and ODE

ASSESSMENT SYSTEM:

Quizzes	10%
Assignments	10%
Mid Terms	30%
ESE	50%

Teaching Plan

Lec No	Description	Ref
1-4	Fundamentals of Vibration Historical background, importance andbasic concepts of vibration.	Text 1 Chp 1 1.1-1.7
	Classification of vibration and analysis procedure.	
	Spring elements, spring constants of elastic elements, combination of springs.	
5-8	Mass or inertial element	Text 1 Chp 1 1.8-1.10
	Damping elements	
	Simple Harmonic Motion	
9-15	Free vibration of undamped. Translation system.	Text 1 Chp 2 2.2-2.6
	Free vibration of Undamped Torsional system.	
	Response of 1^{st} order systems and Rayleigh's Energy Method	
	Free Vibration with viscous damping.	
16-18	Examples using MATLAB	2.12
19	MID TERM EXAM	
20-22	Free Vibration with Coulomb damping.	Text 1 Chp 2 2.9, 2.11
	Stability Analysis	
23-27	Introduction	Text 1
	Response of Undamped system under Harmonic Force.	Chp 3
	Response of Damped system under Harmonic Force.	3.1-3.7
28-33	Response of Damped system under Harmonic Motion of the base.	
	Response of Damped system under Rotating Unbalance.	
	Examples using MATLAB	3.15
34-36	Introduction to Transient Vibration forSDOF Systems (Introduction only)	Ref 2 Chp 5 51, 5.2

37-39	Response under general periodic force(Introduction only)	Text 1 Chp 4 4.2 Ref 2 Chp 5 5.6-5.7
40-44	Introduction and EOM to 2-DoF Vibration Systems	Text 1 Chp 5 5.1-5.6
	Free Vibration of Undamped System.	
	Coordinate Coupling and Principal Coordinate.	
	Forced Vibration Analysis procedure.	
	Semi-Definite Systems, Transfer Function Approach and Solutions using Laplace Transform, Modal Analysis	Text 1 Chp 5 5.7, 5.9-5.10
44-45	Vibration Isolation	Text 1 Chp 9 9.10
46	Introduction to Aero-elasticity & Loaddistribution and Divergence	Text 1 Chp 8 8.1-8.2
47	Control effectiveness and reversal	Ref 1 Chp 3 & 4 3.3, 4.1, 4.2, 4.3
	Flutter and Flutter prevention	