Philadelphia University

Faculty of Engineering - Department of Mechanical Engineering

Summer Semester 2023/2024

Course Information

Title: Mechanical Vibrations (620414)

Prerequisite: Dynamics (620212) + Linear Algebra (??)

Credit Hours: 3 credit hours (8 weeks per semester, approximately 44 contact hours)

Textbook: Mechanical Vibrations by S. S. Rao, 5th edition

References: Theory of vibration with applications by W. T. Thomson, 5th edition

Description: The course is one of the important requirements for Mechanical Engineering student. It helps the student to understand the vibration phenomena by transforming the physical model into a mathematical model and solve it by using the appropriate mathematical and numerical methods. Then, to find the response of vibrating system to external excitations and interpret the results.

Instructor: **Dr . muhammad gogazeh**
Office: Mechanical Engineering building, room E61206 , ext. : 2543
Office hours: Sun., mon , Wed., Thurs.: 10:00-11:00

Course Topics:

Week	Topic
1	Fundamentals of vibration systems: • Definitions • Vibration system elements • Equivalent systems • Harmonic analysis
2,3,	Free vibration of single degree of freedom system : • Equation of motion for un-damped system • Equation of motion for damped system • Energy method • Torsional vibration
4,5	Forced vibration of single degree of freedom system : • Equation of motion • Vibration due to rotating unbalance • Transmissibility • Vibration measuring instruments
6,7,8	Two Degrees of Freedom System: • Free vibration: Natural frequencies and Mode shapes. • Coordinates couplings • Forced vibration • Lagrange's Equation

	• Vibration absorbers
11,12,13	Multi-degree of freedom System: • Eigenvalues and Eigenvectors, Orthogonality principle • Modal matrix, Decoupling of equations of motion. • Forced response • Torsional systems
14,15	Vibration of one dimensional continuous systems: • Vibration of string • Longitudinal vibration of rods • Torsional vibration of shafts • Transverse vibration of beams
16	• Review • Solution of selected vibration problems using MATLAB software

Course Learning Outcomes and Relation to ABET Student Outcomes:

Upon successful completion of this course, a student should be able to:

1. Classify the different vibrating systems [a, e, k]
2. Understand the concept of Degrees of Freedom of a vibrating system. [a, e, k]
3. Construct and solve the differential equation of motion of free vibration of damped and un-damped single degree of freedom systems [a, e, k].
4. Choose between Newton's 2nd law method or Energy method when constructing the equations of motions of vibrating systems [a, e, i, k]
5. Understand the concept of natural frequency (damped and un-damped) and how to obtain it for a given simple system [a, e, i, k].
6. Construct and solve the equation of motion of a damped single degree of freedom system subjected to harmonic load [a, e, i, k].
7. Ability to find the natural frequencies and the corresponding mode shapes (Eigenvalues and Eigenvectors) of vibrating systems that have more than one degree of freedom [a, e, i, k].
8. Design a passive vibration absorber [a, c, e, i, k].
9. Analyze vibrations of one dimensional continuous systems [a, e, i, k].
10. Construct a computer program to solve a given vibration problem using MATLAB software [g, k].

Assessment Instruments:

Evaluation of students' performance (final grade) will be based on the following categories:

Exams: Two written exams will be given. Each will cover about 3-weeks of lectures

Quizzes: 10-minute quizzes will be given to the students during the semester. These quizzes will cover material discussed during the previous lecture(s).

Homework: Problem sets will be given to students. Homework should be solved individually and submitted before the due date.

Copying homework is forbidden, any student caught copying the homework or any part of the homework will receive zero mark for that homework

Participation: Questions will be asked during lecture and the student is assessed based on his/her response

Final Exam: The final exam will cover all the class material.

Grading policy:

First Exam	20%
Second Exam	20%
Home works, Quizzes and participation	20%
Final Exam	40%
Total:	100%

Attendance policy:

Absence from classes and/or tutorials shall not exceed 15%. Students who exceed the 15% limit without a medical or emergency excuse, acceptable to and approved by the Dean of the relevant college/faculty, shall not be allowed to take the final examination and shall receive a mark of zero for the course. If the excuse is approved by the Dean, the student shall be considered to have withdrawn from the course.

February, 2024