SAINT LOUIS UNIVERSITY
MADRID

Division of Sciences & Engineering

ESCI-3110 Linear Vibrations

Professor: Francisco Prieto, Ph.D.
Semester: Fall 2016
Credit Hours: 3 credits
Lecture room: PAH-24
Email: fprieto@slu.edu
Office location: Padre Arrupe Hall, Science Office, first floor
Office hours: Tuesday, Thursday 11:00 – 12:00 and upon request
Add/Drop period: Last day to drop: Sept. 14. Last day to drop with W: October 28
Registration for Spring 2017: November 3
Prerequisites: MATH-3550 Differential Equations and ESCI-2150 Dynamics.

Course Objectives
1. Ability to determine the natural frequency and damping of linear dynamic systems.
2. Ability to model linear systems and to determine the transfer function
3. Ability to determine the dynamic response of systems under free and forced vibrations
4. Ability to determine eigen-values and eigen-vectors of systems with single or multiple degrees of freedom.
5. Use MATLAB to determine the solution of a vibrating system.

Engineering Program Objectives
A. An ability to apply knowledge of mathematics, science, and engineering.
B. An ability to design and conduct experiments, as well as to analyze and interpret data.
C. An ability to design a system, component, or process to meet desired needs within realistic constraints such as economic, environmental, social, political, ethical, health and safety, manufacturability, and sustainability.
D. An ability to function on multidisciplinary teams.
E. An ability to identify, formulate, and solve engineering problems.
F. An understanding of professional and ethical responsibility.
G. An ability to communicate effectively.
H. The broad education necessary to understand the impact of engineering solutions in a global, economic, environmental, and societal context.
I. A recognition of the need for, and an ability to engage in life-long learning.
J. A knowledge of contemporary issues.
K. An ability to use the techniques, skills, and modern engineering tools necessary for engineering practice.

Student Learning Outcomes

Program Objectives	Student Learning Outcomes	Assessment Method
A	A.1. Calculate the mathematical model of a mechanical system (equivalent mass, equivalent stiffness, equivalent damping coefficient). A.2. Calculate the Fourier coefficients of a periodic function. A.3. Derive the equation of motion of one-degree-of-freedom systems using the following methods: Newton's Second Law, conservation of energy, D'Alembert's Principle, virtual displacements. A.4. Solve a second-order differential equation using: standards methods, Laplace transform, matrix method, numerical methods. A.5. Calculate the natural frequency of one-degree-of-freedom systems with or without damping (viscous and Coulomb). A.6. Obtain the solution of a harmonically forced vibration system (rotating unbalance, support motion). A.7. Analyze and apply the solution of a harmonically forced vibration system for control of vibration. A.8. Obtain the solution of a system under general force conditions using the convolution integral method. A.9. Calculate and apply the shock response spectrum for the design of vibrating systems. A.10. Derive the equation of mutli-degree-of-freedom systems using Lagrange's equation. A.11. Derive the equation of mutli-degree-of-freedom systems using influence coefficients. A.12. Calculate the solution of two-degrees-of-freedom systems. A.13. Analyze the solution of two-degrees-of-freedom systems using the method of modal analysis.	Mid-term and Final Exam
C	C.1. Analyze and design a mechanical system that meets desired specifications.	Project rubric
D	D.1. Work effectively in a team environment when working in a project.	Team-work rubric
E	E.1. Represent graphically the problem of motion of a physical system using the free-body diagram technique. E.2. Identify the essential aspects of a problem, connect it to related areas of dynamics, formulate a strategy for solving the problem, apply appropriate techniques to arrive at a solution, test the correctness of the solution, and interpret the result. E.3. Show strong mathematical skills.	Mid-term and Final Exam
G	G.1. Communicate clearly and effectively the solution of a problem. G.2. Write a well-structured and clear project report.	Mid-term and Final Exam Project rubric
K	K.1. Apply MATLAB for the Fourier analysis of a periodic function. K.2. Apply MATLAB to find the solution of one-degree-of-freedom systems under free or forced vibration conditions. K.3. Apply MATLAB to calculate the shock response spectrum. K.4. Apply MATLAB to find the solution of multi-degree-of-freedom systems.	Project rubric

Course description:

This course is a study about oscillatory motion of elastic bodies with and without damping. It explores free and forced vibration of linear dynamic systems with single degree of freedom as well as multi degrees of freedom. An emphasis is given to modeling of dynamic system and to determine transfer function as well as system response. Properties of eigen-values, eigen-vectors, Lagrange method, and vibration of continuous systems are also included in the course.

Course Outline:

- Introduction to vibrations and free vibrations
- Response to Harmonic Excitation
- Response to generalized inputs
- Multi Degree of Freedom Systems, transfer functions, Eigen values and Eigen vectors
- Vibration response solutions using Laplace Transformations
- Modeling simple systems using Lagrangian Method
- Vibration Absorbers, Vibration Isolation
- Brief introduction to distributed parameter systems

Textbook:

Mechanical Vibrations, S.S. Rao, Prentice Hall, 4th edition.

Grading system: The grade will be obtained from the following areas:

Homework: **5 %**
Quiz: **10 %**
Project: **10 %**
First Mid-term Exam: **25 %**
Second Mid-term Exam: **25 %**
Final Exam: **25 %**

Grading Scales:

100 < A < 90%,
89% <A- < 87%
86% < B+ < 84%
83% < B < 80%
79% < B-< 77%
76% < C+ < 74%
73% < C < 70%
69% < C- < 66%
65% < D < 60%
F < 60%

University's Academic Integrity Statement

Academic integrity is honest, truthful and responsible conduct in all academic endeavors. The mission of Saint Louis University is "the pursuit of truth for the greater glory of God and for the service of humanity." Accordingly, all acts of falsehood demean and compromise the corporate endeavors of teaching, research, health care and community service via which SLU embodies its mission. The University strives to prepare students for lives of personal and professional integrity, and therefore regards all breaches of academic integrity as matters of serious concern.

The governing University-level Academic Integrity Policy can be accessed on the Provost's Office website at:
http://www.slu.edu/Documents/provost/academic_affairs/University-wide%20Academic%20Integrity%20Policy%20FINAL%20%206-26-15.pdf.
Additionally, SLU-Madrid has posted its academic integrity policy online:
 http://www.slu.edu/madrid/academics. As a member of the University community, you are expected to know and abide by these policies, which detail definitions of violations, processes for reporting violations, sanctions and appeals. Please direct questions about any facet of academic integrity to your faculty, the chair of the department of your academic program or the Academic Dean of the Madrid Campus.

Policies:
(1) Students are encouraged to participate in class discussions and to ask questions.
(2) Announcements may be made during the semester.
(3)Useful information for the course may be found on the web: https://myslu.slu.edu.
(4) Syllabus, reading and homework problems are subject to change.
(5) Students are responsible for all lecture material, handouts and assigned reading.
(6) **It is mandatory to attend all classes unless a reasonable excuse is given**. Any unexcused absences in excess of **3** will result in a lowered grade and even in automatic failure in the course.
(7) **Make up exams are not given**. Students who legitimately miss an exam, due to a doctor's visit or family emergency must provide written documentation of the circumstances. A letter from the university counselor is accepted. Exams that are missed illegitimately result in a score of F. Grades for these students will be based on the remaining exams. Missing more than one exam results in an F grade.
(8) In recognition that people learn in a variety of ways and that learning is influenced by multiple factors (e.g., prior experience, study skills, learning disability), resources to support student success are available on campus. Students who think they might benefit from these resources can find out more about:
- Course-level support (e.g., faculty member, departmental resources, etc.) by asking your course instructor.
- University-level support (e.g., tutoring/writing services, Disability Services) by visiting the Academic Dean's Office (San Ignacio Hall) or by going to http://www.slu.edu/madrid/learning-resources.

Students who believe that, due to a disability, they could benefit from academic accommodations are encouraged to contact Disability Services at +34 915 54 58 58, ext. 204, send an e-mail to counselingcenter-madrid@slu.edu, or to visit the Counseling Office (San Ignacio Hall). Confidentiality will be observed in all inquiries. Course instructors support student accommodation requests when an approved letter from Disability Services has been received and when students discuss these accommodations with the instructor after receipt of the approved letter.

(9) Title IX Statement
- Saint Louis University and its faculty are committed to supporting our students and seeking an environment that is free of bias, discrimination, and harassment. If you have encountered any form of sexual misconduct (e.g. sexual assault, sexual harassment, stalking, domestic or dating violence), we encourage you to report this to the University. If you speak with a faculty member about an incident of misconduct, that faculty member must notify SLU's Title IX deputy coordinator, Marta Maruri, whose office is located on the ground floor of Padre Rubio Hall, Avenida del Valle, 28 (mmaruri@slu.edu; 915-54-5858 ext. 213) and share the basic fact of your experience with her. The Title IX deputy coordinator will then be available to assist you in understanding all of your options and in connecting you with all possible resources on and off campus.
- If you wish to speak with a confidential source, you may contact the counselors at the SLU-Madrid's Counseling Services on the third floor of San Ignacio Hall (counselingcenter-madrid@slu.edu 915545858 ext.230) or Sinews Multipletherapy Institute, the off-campus provider of counseling services for SLU-Madrid (www.sinews.es; 91-700-1979) To view SLU-Madrid's sexual misconduct policy and for resources, please visit the following web address: http://www.slu.edu/Documents/Madrid/campus-life/SLUMadridSexualMisconductPolicy.pdf

(10) *Information regarding the collection of student work for assessment.*
In order to maintain quality academic offerings and to conform to accreditation requirements, SLU-Madrid regularly assesses its teaching, services and programs for evidence of student learning. For this purpose, SLU-Madrid keeps representative examples of student work from all courses and programs on file, including assignments, papers, exams, portfolios and results from student surveys, focus groups and reflective exercises. Copies of your work for this course may be kept on file for institutional research, assessment and accreditation purposes. If you prefer SLU-Madrid not to retain your work for this purpose, you must communicate this decision in writing to your professor.