

FLORIDA INTERNATIONAL UNIVERSITY  
Mechanical and Materials Engineering Department

Summer 2019

System Dynamics

EML3222

Instructor: Professor Cesar Levy (levyez@fiu.edu)

Telephone: 305-348-3643

OFFICE HRS: **M and W 11-1pm and by appointment only**

**TA: Ehsan Izadpanahi only for the vibrations part of the course. He will announce office hours.**

<b>COURSE OBJECTIVES</b>
Understand Undamped SDOF systems $d^2x/dt^2 + \omega^2x = 0$ and its relation to a vibrating system
Understand Damped SDOF systems-viscous (underdamped, critically damped and overdamped) and coulomb friction and their differences
Understand Forced Motion due to external input
Understand the essentials of modeling
Understand the lumped parameter concept
Understand the similarities and differences between: <ul style="list-style-type: none"><li>a) linear mechanical systems</li><li>b) rotational mechanical systems</li><li>c) fluid systems</li><li>d) electrical systems</li><li>e) thermal systems</li></ul>
Understand transformers and transducers
Understand system graphs
Understand how to get the equations of motion
Understand how to solve the equations of motion using: <ul style="list-style-type: none"><li>closed form, numerical methods, transform methods, state variable-matrix methods</li></ul>

<b>MME Program Educational Objectives</b>
Broad and in-depth knowledge of engineering science and principles in the major fields of MME for effective engineering practice, professional growth, and as a base for life-long learning.
The ability to utilize analytical and experimental methods and modern computer technology for decision-making and engineering design and to solve realistic engineering problems.
The ability to work effectively with others in a team while simultaneously maintaining independent and creative thought.
The ability to communicate effectively and to articulate technical matters using verbal, written, and graphic techniques.
An adequate background to pursue graduate studies in engineering and other fields.
A sense of professional and social responsibility, including a commitment to protect both occupational and public health and safety, developed through consideration of moral, social, and ethical paradigms related to the engineering profession and practice.

<b>MME Student Outcomes</b>
A. Ability to apply knowledge of mathematics, science, and engineering.
C. Ability to design a system, component, or process to meet desired needs.
E. Ability to identify, formulate, and solve engineering problems.
F. Understanding of professional and ethical responsibility.
I. Recognition of the need for, and an ability to engage in, life long learning.
J. Knowledge of contemporary issues.

K. Ability to use the techniques, skills, and modern engineering tools necessary for engineering practice.
L. Knowledge of probability and statistics, including applications to mechanical Engineering.
M. Knowledge of mathematics and of basic and engineering science necessary to carry out analysis and design appropriate to M&M Engineer.
N. Ability to apply advanced mathematics through multivariable calculus and differential equations.

**PREREQUISITES:** EGN3321, EMA3702, EML2032 with a grade of C or better. Students not having the required passing grade in the prerequisite courses should drop EML3222 during the drop/add period. Violators will be dropped out automatically later on during the semester. This may result in their loss of course tuition.

## COURSE CONTENT

### Topics

1. What is vibrations and its importance
2. Equivalent Systems and Equations of Motion
3. Free Vibrations of M-K system, Energy Methods
4. SDOF with damping Q1
5. Forced SDOF without damping
6. Forced SDOF with damping Q2
7. Other Systems-Fluidic, thermal
8. Understand the essentials of modeling, lumped parameter concept
9. Understand the similarities and differences between:
  - a) linear mechanical systems
  - b) rotational mechanical systems
  - c) fluid systems
  - d) electrical systems
  - e) thermal systems
10. Understand transformers and transducers
11. Understand system graphs Q3
12. Understand how to get the equations of motion
13. Understand how to solve the equations of motion using:
  - closed form, numerical methods, transform methods, state variable-matrix methods Q4

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1. Importance of Vibrations; Basic Concepts--period, amplitude, circular frequency, units; Classification of Vibrations-- random, periodic, harmonic, aperiodic; Vibrational Analysis Procedures; Quick Review of Dynamics--Kinetics and Principle of Linear and Angular Motion of a Particle, Mass Center and a System of Particles.

2. Undamped Free Vibrations for a Single Degree of Freedom (SDOF) System: Spring-Mass System; Equivalent Springs and Masses; Energy Method--KE<->PE transfer.

3. Damped Free Vibrations for an SDOF System; Spring-Mass-Dashpot System; Overdamped, Underdamped, Critically Damped System, damped frequency, damping factor, general solutions, Quick Review of second order linear constant coeff. Diff. Eqs.; Coulomb Damping, frequency displacement decrease, differences between coulomb and viscous damping.

4. Forced Vibrations (FV) of an SDOF System; Undamped and Damped Vibrations--magnification factor, resonance conditions; beats; force transmission; Duhamel's Integral; Response of a Damped System.

5. Essentials of Modelling--Capturing the gist of the real-life system

- o Modelling of mechanical systems by
  - springs, masses, dampers, v - F relationships

- o Modelling of electrical systems by  
inductance, capacitance, resistances,  $v - i$  relationships
  - o Modelling of fluidic systems by  
inertance, capacitance, resistances,  $p - Q$  relationships
  - o Modelling of thermal systems by  
capacitance, resistances,  $T - q$  relationships
6. Thru and Across Variables; systems equations; system graphs
  7. Determination of governing equation for the system
  8. Solution of the governing differential equation --
    - o State Variables and Matrix Methods of Solution
    - o Closed form solutions (reduction of order and variation of parameter methods)
    - o Laplace Transform Method
    - o Numerical Methods ( Euler and Runge-Kutta Methods)

**Textbook:** Introduction to System Dynamics by Derek Rowell and David Wormley, Prentice-Hall, 1<sup>st</sup> Edition ISBN 978-0132108089, 1996

\*\*\* ALSO NOTES WILL BE DISTRIBUTED IN CLASS \*\*\*

#### **Other helpful information**

HW's will be assigned and some special assignments will be collected for grading. Website will provide solutions to many problems two lessons after they are assigned. However, it is to your advantage to do it since similar problems will appear on the exams and final exam.

Important information:

1. **You are required to send me an email using an email address from which you can receive class information.**
2. **If you come in late, find a seat quickly and quietly.**
3. **Please turn off your cellphones in class.** They are an unnecessary interruption to both your fellow students and to the instructor. **Turn off your cellphones especially during quizzes/exams. Anyone caught using their cellphone/text messaging during quiz/exam will fail the quiz/exam.**
4. **Cheating of any kind especially during quizzes/examinations will result in automatic failure of the exam/quiz. Cheating during final exam will result in failure of the course and possible expulsion from the university.**

**Please note:** *Florida International University is a community of faculty, staff and students dedicated to generating and imparting knowledge through 1) excellent teaching and research, 2) the rigorous and respectful exchange of ideas, and 3) community service. All students should respect the right of others to have an equitable opportunity to learn and honestly demonstrate the quality of their learning. Therefore, all students are expected to adhere to a standard of academic conduct, which demonstrates respect for themselves, their fellow students, and the educational mission of the University. All students are deemed by the University to understand that if they are found responsible for academic misconduct, they will be subject to the Academic Misconduct procedures and sanctions, as outlined in the Student Handbook.*

5. **No make up quizzes/exams will be given.** Exceptions are if you are sick (provide a note from your doctor), or if you are being called up for military duty (provide a copy of your orders).
6. **No attendance will be taken. HOWEVER, if you do not come to class, it is your responsibility to get the material you've missed and to learn the material.**

7. **If you don't understand something in class-ASK.** You may also come to my office during office hours. You may call me at my office and, if I am not in the middle of something, we can discuss your question.

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Grades will be determined on the basis of

4 Exams	15, 15, 20, 20% each
Final exam	30%

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Grading Scheme: 94 and above	A	80 - 84	B	67 - 73	C
90 - 93	A-	77 - 79	B-	60 - 66	D
84 - 89	B+	74 - 76	C+	Below 60	F

**We will be meeting 2 times a week W 130-305pm and F 130-305pm in room EC1104 during summer A and EC1112 during summer B**

My office will be in EAS 3442 and

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The Drug-Free Schools and Communities Act Amendments of 1989 and the Drug-Free Workplace Act of 1988 (collectively the "Act"), require that Florida International University (FIU) maintain a program to prevent the use of illicit drugs and abuse of alcohol by students, faculty, and staff. Under the Act, FIU is also required to annually distribute the following information about its drug and alcohol program to all students, faculty, and staff. Please read this notification carefully. Click [here](#) for a more detailed version of this notification.

**POLICY:** The university is committed to maintaining a safe, productive, and drug-free work and educational environment. As such, FIU strictly prohibits the unlawful manufacture, distribution, dispensation, possession, trade, sell, or offer for sale of a controlled substance or alcohol, or otherwise engaging in the unlawful use of controlled substances or alcohol on campus. No person may report to classes, work, or related assignments "under the influence" of controlled substances, alcohol, or prescription drugs taken illegally. Furthermore, all employees are required to notify the university of any criminal drug statute conviction for a violation occurring in the workplace no later than five (5) days after such conviction. Click [here](#) to read the complete Drug-Free Campus/Workplace Drug and Alcohol Abuse Prevention Policy, which can be found in the University Policies and Procedures Library.

**SANCTIONS:** Any student, faculty or staff found to have abused drugs and/or alcohol in the workplace or campus shall be subject to disciplinary action in accordance with university regulations, policies and any applicable collective bargaining agreement.

**DRUGS:** The unlawful possession, use, distribution, dispensation, manufacture, or sale of Controlled Substances is governed by [federal law](#), [Florida law](#), university regulation ([FIU-2501 Student Code of Conduct](#)), and [university policy](#).

**ALCOHOL:** The use, possession, or distribution of beverages containing alcohol on university property, including residence halls, is governed by [Florida law](#) and university regulations ([FIU-2505 Alcoholic Beverages](#), [FIU-2501 Student Code of Conduct](#)).

**HEALTH RISKS:** Drugs have different effects on each individual, depending on their age, size and sex. The manner in which a particular drug interacts with a person can cause temporary or permanent damage to a person's body and brain, and can lead to addiction or death. Description of drugs and effects can be found in the [DEA Drug Fact Sheets](#).

Alcohol is a depressant which leads to the loss of control over judgment, resulting in a loss of inhibitions. It affects physical coordination, causing blurred vision, slurred speech and loss of balance. Click [here](#) for a summary of health problems and conditions associated with excessive drinking over time.

**RESOURCES:** Click [here](#) for a list of on-campus and community resources for drug and alcohol prevention and assistance.

For additional information, please contact Dr. Kate Kominars, Director of the Office of Employee Assistance and Chair of the Alcohol and Drug Abuse Prevention Task Force, at 305-348-2469 or [kominars@fiu.edu](mailto:kominars@fiu.edu).

**THIS IS A PRELIMINARY SCHEDULE--ALL CHANGES WILL BE ANNOUNCED IN CLASS.**