FLORIDA INTERNATIONAL UNIVERSITY
Mechanical and Materials Engineering Department

Spring 2019 System Dynamics EML3222

Instructor: Professor Cesar Levy (levyez@fiu.edu)
Office: EC 3442
Telephone: 305-348-3643
Office hours: **M 10am-12pm and W 3pm-430pm or by appointment**

TA: TBD

COURSE OBJECTIVES
Understand the essentials of modeling Understand the lumped parameter concept Understand the similarities and differences between: a) linear mechanical systems b) rotational mechanical systems c) fluid systems d) electrical systems e) thermal systems Understand transformers and transducers Understand system graphs Understand how to get the equations of motion Understand how to solve the equations of motion using: closed form, numerical methods, transform methods, state variable-matrix methods
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 such as harmonic force or rotating unbalance

MME Program Educational Objectives
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.

MME Program Outcomes
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.
K. Ability to use the techniques, skills, and modern engineering tools necessary for engineering practice.
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. Essentials of Modelling--Capturing the gist of the real-life system
   Understand the essentials of modeling, lumped parameter concept
   - 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 - ¶ relationships
   - o Modelling of transformers and transducers
2. Understand the similarities and differences between:
   a) linear mechanical systems
   b) rotational mechanical systems
   c) fluid systems
   d) electrical systems
   e) thermal systems
3. Understand system graphs and produce system graphs
4. Understand how to get the state variable equations E1
5. Understand how to solve the state variable equations using:
   closed form, numerical methods, transform methods, state variable-matrix methods
   - o Numerical Methods (Euler and Runge-Kutta Methods)
   - o State Variables and Matrix Methods of Solution E2
6. What is vibrations and its importance
7. Equivalent Systems and Equations of Motion
8. Free Vibrations of M-K system, Energy Methods
9. SDOF with damping
10. Forced SDOF without damping
11. Forced SDOF with damping E3
12. Steady State Motion and Force Transmitted to Support

---

1. 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

- o Modelling of transformers and Transducers

2. Thru and Across Variables; systems equations; system graphs
3. Determination of governing equation for the system
4. 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 Numerical Methods (Euler and Runge-Kutta Methods)

5. 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.
6. Undamped Free Vibrations for a Single Degree of Freedom (SDOF) System: Spring-Mass System; Equivalent Springs and Masses; Energy Method--KE<->PE transfer.
7. 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.
8. Forced Vibrations (FV) of an SDOF System; Undamped and Damped Vibrations--magnification factor, resonance conditions; beats; force transmission; rotating unbalance.

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

Also notes to be obtained from department secretary ($15 set)

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

Other helpful information

HW's will be assigned some 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 THE HOMEWORK PROBLEMS 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. **Please arrive prior to the start of class or, at least, on time. 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. Not attending the class is not an acceptable excuse for missing/not knowing 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.

Grades will be determined on the basis of

3 Exams	23%, 22%, 25% each
Final Exam	30%

Grading Scheme: 93 and above	A	80 - 84	B	67 - 73	C
90 - 92	A-	77 - 79	B-	60 - 66	D
84 - 89	B+	74 - 76	C+	Below 60	F

This course is will meet M 1200-1250pm and W 1100-1250pm in EC1107. Project will be announced as we get closer to the completion of the modelling section of the course.

My office will be in EAS 3442.
My Office hours: **M 10am-12pm and W 3pm-430pm or by appointment**

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