Spring
2020

SCUPI
Sichuan University - Pittsburgh Institute

MEMS 1014 Dynamic Systems

Instructor: Jangho Yoon, Ph.D
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Office hours: Tue: 12:30 – 01:30 PM
Class time: Wed : 01:50 - 04:25 PM
Class location: ZongHe B Room #B408

Catalog Description:

The course is designed to introduce students to the basics of modeling and analyzing dynamic systems. Topics covered include: Modeling and analysis of physical systems, time and frequency domain analysis; transient and steady state system response to various excitations, transfer function formulation, and state space model representations. Laplace. MatLab and Simulink will be used in this course. (3 credit hours)

Course Objective

The aim of this course is to:

- Develop equations of motion for first and second-order linear systems, including Mechanical, Electrical, Fluid & Thermal systems.
- Learn to convert system model representation between differential form, configuration form, transfer function form, and state-space form.
- Learn to analyze transient, steady-state, and total response.
- Learn to use Laplace transforms to solve ordinary differential equations, to find transfer functions, and to determine frequency response functions.
- Learn to solve for steady state forced response.

Prerequisites & Co-requisites:

MATH-0280 Matrices & Linear Algebra, ENGR-0031 Electric Circuit, MEMS-1015 Rigid-Body Dynamics, MEMS-1041 Mechanical Measurements.

Textbook:

Ramin S. Esfandiari and Bei Lu: Modeling and Analysis of Dynamic Systems. 3nd Edition, CRC Press, 2018

Reference:

Gene F. Franklin, J. David Powell and Abbas Emani-Naeini: Feedback Control of Dynamic Systems. 7th Edition, Pearson, 2015.

Topics Covered:

1. Applied Linear Algebra
2. Laplace Transform
3. Modeling and Computer Simulation of Dynamic Systems
4. Transfer Function Models
5. Time Response Analysis of Linear Dynamic Systems
6. Input-Output Stability and Transient Response Analysis
7. Lumped Parameter System Modeling

Grading Breakdown

Weekly Homework	10 %
In-Class Work	10 %
Two Term Exams	40 % (20 % each, TBA)
One Final exam	40 % (Final Week)

Grading Scale

While grades may be curved, there is no guarantee of any curve. However, in order to receive a grade of D or better, a student will have to reach 50 % of the total possible points. The grading scale is

$A \geq 90\%$		$A^- \geq 85\%$
$B^+ \geq 80\%$	$B \geq 76\%$	$B^- \geq 73\%$
$C^+ \geq 70\%$	$C \geq 66\%$	$C^- \geq 63\%$
$D^+ \geq 61\%$		$D \geq 60\%$

Homework and Exams

Only a few randomly chosen homework questions will be graded. Homework must be submitted before the designated due date.

NO Late homework will be accepted.

In each class, you will be assigned a number of problems to help you practice and learn the material. You will work on and complete these problems as a team or as an individual during the class period. This will be collected and graded.

There will be **two term exams** and **a final exam**. The final exam will be comprehensive. The exams in this course will be closed book and closed note. All the necessary formulas will be provided.

If you miss any exam, NO make-up will be given for the missing exam *without prior* arrangement. If you have a serious conflict with an exam time, you MUST discuss it with the instructor BEFORE the scheduled day for the exam to make an appropriate arrangement. Exams missed due to unpredictable events such as a family emergency and a traffic accident will be dealt with on a case-by-case basis if the student has a proper document(s) to prove it

*Students have **one week** after the any graded work including exams is returned and/or the grad of a work is posted on BB to dispute the grade*.

It is important that you show the work in an organized manner clearly showing your thought process in solving the assigned problem **with appropriate units**. If necessary, staple pages of your work together and do not write on the back of paper.

For homework, project and exam you will be penalized for any missed unit or wrong unit, and also be penalized for using an excessive number of significant figures
(e.g., $\pi = 3.1415926535897932385$ instead of $\pi = 3.14$).

Collaboration:

Collaboration between students is strongly encouraged for better understanding of the course material. Students are allowed to discuss homework problems and projects in terms of **methodologies**, but **not the solutions** of a problem, which means that each student MUST do the actual work independently. Inappropriate collaboration (also known as cheating) includes

- Using all or parts of homework, exams or projects from this year or any previous year
- Sharing of work such as graphs, equations, calculations or any other derived material that was not presented to the class
- Talking, passing information or using inappropriate materials during an exam Anyone found to be participating in inappropriate collaboration may be immediately failed from the course.

Office Hours:

Office hours are times I have specifically set aside to be available to students. During office hours, you can come to my office; you don't need an appointment. I may be available at other times; please email to schedule a time. Current office hours will be posted on the class website.

Be prepared to show me what work you have already done!

Attendance:

On-time attendance at all class activities is expected. Attendance itself will not be graded, but the student is responsible for any material that was covered, and any changes to the exam dates and homework assignments announced in class. Make-up work will only be accepted if prior arrangement has been made or if a valid emergency excuse (e.g., meteor strike) is accompanied by appropriate documentation.

Other Policies:

1. Please honor the following: do not come late; do not disturb the class by having conservation with others; turn off all cell phones and electronic gadgets.
3. Any questions regarding the grading discrepancy should be brought up a week of returning the homework or exam.
4. Instructor reserves the right to change the class syllabus to meet class needs.

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Highly Tentative Class Schedule

Week	Chapter	Topic
1	Ch. 1 ~ Ch. 2.1	Introduction and Complex Analysis
2	Ch. 2.2 ~ Ch. 2.3	Differential Equations & Laplace Transformation
3	Ch. 2.3 ~ Ch. 3.1	Laplace Transformation & Matrix Analysis
4	Ch. 4.1 & 4.3	Configuration form, State Space form & Transfer Function
5	Ch. 4.3 ~ Ch. 4.6	Relation between Transfer Function and State Space form, Block Diagram & Linearization of Nonlinear Model
6	Ch. 5.1 ~ Ch. 5.3	Introduction and Modeling of Mechanical Systems
7		**Exam I**
8	Ch. 5.4 ~ Ch. 5.6	Modeling of Mechanical Systems
9	Ch. 7.1 ~ Ch. 7.3	Fluid and Thermal Systems
10	Ch. 8.2	Transient Response and Steady-State Response
11	Ch. 8.3	Transient Response - 2^{nd} Order System
12	Ch. 8.5	Frequency Response & Solving the State Equation
13	Ch. 9.1& 9.2	Free & Forced Vibration
14	Ch. 9.1& 9.2 Ch. 9.4	Free & Forced Vibration Model Analysis
15		**Exam II**
16		**Review**
17		**Final**