Spring
2021

SCUPI
Sichuan University - Pittsburgh Institute

MEMS 1014 Dynamic Systems

Instructor:	Jangho Yoon, Ph.D
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Office hours:	Tue & Thu: 12:30 – 01:30 PM and Wed: 01:00 – 02:00 PM, or by appointment
Class time:	Mon: 01:50 - 04:25 PM
Class location:	Teaching Building A Room #503

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-0012 Engineering Computing
MEMS-0031Electrical Circuits
MEMS-1015 Rigid-Body Dynamics

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. Lumped Parameter System Modeling
4. Modeling and Computer Simulation of Dynamic Systems
5. Transfer Function Models
6. Time Response Analysis of Linear Dynamic Systems
7. Input-Output Stability and Transient Response Analysis
8. Vibration Analysis

Grading Breakdown

Weekly Homework	10 %
Class notes	10 %
Two Term Exams	40 % (20 % each, April 26 & Jun 7)
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, Class notes and Exams

There will be homework assigned on weekly base, and it must be submitted to Black Board on time. Homework must be handwritten otherwise there will be 50% penalty. **Late homework will be accepted with 40% penalty for the first 12 hours delay, 75% for the next 12 hours and 100% for thereafter** unless an arrangement is made with the instruction well ahead of the due date. One lowest homework scores will be dropped from your grade at the end of semester.

After each class you need to submit your note that you took for lecture including the exercise problems you worked on during class which may be graded for correctness. You have until 09:00 PM of each lecture day unless instructed otherwise. The note must be handwritten, and it is highly recommended to use the posted lecture note as a template. **NO late submission will be accepted without prior arrangement.** Two lowest scores will be dropped from your grade at the end of semester.

There will be **two term exams** and **one final exam**. The final exam will be comprehensive. The exams in this course will be closed book and closed note.

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 problems. Instructor cannot give credits for the answer(s) that is(are) not readable and/or understandable.

All assigned problems must be solved **with appropriate units**. Otherwise, you will be penalized for any missed unit or wrong unit. You will 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:

Please honor the following: do not come late; do not disturb the class by having conservation with others; do not work on any class materials.

Those students who fail to follow these policies may be asked to leave the class.

The instructor also reserves the right to extend credit for alternative assignments, projects, or presentations, and to make changes to this syllabus as needed.

All changes will be announced via Blackboard and/or in class

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Highly Tentative Class Schedule

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