TEXAS A&M UNIVERSITY
DEPARTMENT OF MECHANICAL ENGINEERING
SPRING 2018

MEEN 431  Advanced System Dynamics and Controls

Unified framework for modeling, analysis, synthesis, design and simulation of mechanical systems with energy exchange across multiple domains; study of mechanical, electrical, hydraulic and thermal subsystems; Newtonian mechanics, rigid body dynamics, multiple degrees of freedom vibrations and control system design. Three credit hours (3-0).

Instructor:
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http://alum.mit.edu/www/wjkim, webpage

TA:       Grader:
Sai Krishna Kanth Hari          Mario Heredia
425 ENPH
hskkanth@tamu.edu; e-mail        marioh09@tamu.edu, e-mail

Lectures:
MWF 11:30 AM–12:20 PM at 111 HELD

Office Hours:
Dr. Kim:  MF 12:30 PM–1:45 PM at 223 MEOB, or by appointment
TA:     TR 1:00 PM–2:00 PM at 302 ENPH, or by appointment
Grader: by appointment

Textbooks (required):


References:


All references can be checked out for two hours from the Reserved Books Desk at Evans Library.
On-Line Course Material:

A course web page is being established at eCampus.tamu.edu. You should be able to access the web page if you are registered for the course. All course-related material you will need, e.g. supplementary notes and examples, homework sets, solutions, and other useful materials will be placed.

Learning Outcomes and Course Objectives:

To build upon the fundamentals of analytical dynamics and feedback control to:

- Understand the phenomenon of vibration
- Understand limitations of feedback and controller design
- Prediction of dynamics behavior of mechanical systems by analytical methods and computer simulation
- Synthesize/design mechanical systems to achieve desired performance goals

Prerequisites:

- MEEN 364, Dynamic Systems and Controls
- Working familiarity with Matlab/Simulink is expected.

Grading:

- Mid-term exams for 30% total
- Design project for 25%
- Final exam for 30%
- Homework for 15% total

Exams:

There will be two mid-term exams. The comprehensive final exam will be held as scheduled in the University Schedule of Classes.

- Exam 1: in-class, Monday, February 26
- Exam 2: in-class, TBA
- Final exam: 10:30 AM–12:30 PM, Tuesday, May 8

Homework:

There will be about a dozen homework sets, and they are due at the beginning of class of the due dates. No late homework will be accepted. All written work must be clear and professionally done with the necessary steps leading to the solution clearly marked. Homework solutions will be made available on the course web site. Only part of the homework problems will be selected randomly for grading. The intention of the homework assignments is to check for the work of the individual. Each student is required to turn in his/her solutions to the homework assignments. However, students are allowed to form groups or consult other students to discuss the problems.

Project:

A design project is to be assigned. You are allowed to work in groups of three. A typed report will be required, and no late project report will be accepted. Specific instructions will be provided with the project assignment.
Policy on Grading Complaints:

If you feel a mistake was made in grading any material, please first contact the person doing the grading within a week after the graded paper is distributed. If you are not satisfied with the resolution of the matter then talk to me. After the one week discussion period, we will not review your work or change grades. Make your complaint to me in writing and via e-mail. Be specific about your complaints. Please note I do not negotiate my partial-credit policy with students.

Grading Policy:

- A: 90–100
- B: 80–89
- C: 70–79
- D: 60–69
- F: less than 60

Absences:

Work missed due to absences will only be excused for University-approved activities in accordance with TEXAS A&M UNIVERSITY STUDENT RULES (see http://student-rules.tamu.edu/rule7.htm). Specific arrangements for make-up work in such instances will be handled on a case-by-case basis. In accordance with recent changes to Rule 7, please be aware that in this class any “injury or illness that is too severe or contagious for the student to attend class” will require “a medical confirmation note from his or her medical provider” even if the absence is for less than 3 days (see 7.1.6.2 injury or illness less than three days).

Academic Integrity:

Aggie Honor Code: “An Aggie does not lie, cheat, or steal, or tolerate those who do.”

Upon accepting admission to Texas A&M University, a student immediately assumes a commitment to uphold the Honor Code, to accept responsibility for learning and to follow the philosophy and rules of the Honor System. Students will be required to state their commitment on examinations, research papers, and other academic work. Ignorance of the rules does not exclude any member of the Texas A&M University community from the requirements or the processes of the Honor System. For additional information please visit: aggiehonor.tamu.edu.

On all course work, assignments, and examinations at Texas A&M University, the following Honor Pledge shall be preprinted and signed by the student:

"On my honor, as an Aggie, I have neither given nor received unauthorized aid on this academic work."

Signature of Student
**ADA Statement:**

The Americans with Disabilities Act (ADA) is a federal anti-discrimination statute that provides comprehensive civil rights protection for persons with disabilities. Among other things, this legislation requires that all students with disabilities be guaranteed a learning environment that provides for reasonable accommodation of their disabilities. If you believe you have a disability requiring an accommodation, please contact Disability Services, currently located in the Disability Serviced building at the Student Services at White Creek complex on west campus or call 845-1637. For additional information visit [http://disability.tamu.edu](http://disability.tamu.edu).

Following is a tentative schedule. The pace will be adjusted as the semester progresses.

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<th>Week</th>
<th>Contents</th>
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<td><strong>Multi-DOF Systems</strong></td>
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<td>1</td>
<td>Review—DOF, planar kinematics, FBD, Newtonian mechanics, EOM, 1-DOF vibrations</td>
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<tr>
<td>2</td>
<td>Multi-DOF vibrations, free and forced vibrations, modal analysis</td>
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<tr>
<td><strong>Dynamics and System Modeling</strong></td>
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<tr>
<td>3</td>
<td>Rotation transformations, Euler angles, rotating-frame formula</td>
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<td>4</td>
<td>Rigid-body kinematics, angular momentum, inertia matrix</td>
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<td>5</td>
<td>Rigid-body kinetics, work-energy principle</td>
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<td>6</td>
<td>Lagrangian mechanics</td>
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<td>7</td>
<td>Modeling of interconnected systems, energy exchange across multiple domains</td>
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<td>8</td>
<td>Causalities, constitutive laws, derivation of state equations</td>
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<td><strong>Advanced Controls</strong></td>
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<td>9</td>
<td>Review—Transfer function, performance specifications, Routh stability criterion</td>
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<td>10</td>
<td>Controller design, integrator anti-windup</td>
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<td>11</td>
<td>Sensitivity, feedback, and stability</td>
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<td>12</td>
<td>PID autotuning, frequency response, loop-shaping design of compensators</td>
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<td>13</td>
<td>Nyquist stability criterion, ideal Bode characteristics</td>
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<td>14</td>
<td>State-space design, pole placement, state feedback, state observers</td>
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*Final exam on Tuesday, May 8, 10:30 AM–12:30 PM*