GENERAL INFORMATION

General Description (3 credits):
Mathematical modeling, analysis, measurement and control of dynamic systems; extensions of modeling techniques of MEEN 363 to other types of dynamic systems; introduction to feedback control, time and frequency domain analysis of control systems, stability, PID control, root locus; design and implementation of computer-based controllers in the lab.

Prerequisites:
ENGR 215, MEEN 260, MEEN 363

Course Content:
Engineering Science – 2/3 or 2 hr
Engineering Design – 1/3 or 1 hr

Instructors:

Dr. Alan Palazzolo  
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125 Mechanical Engr. Office Bldg.  
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Dept. of Mechanical Engineering  
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Course Assistants:

Ms. Kalissa Adkins  
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Mr. Isaac Hollkamp  
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Mr. Woongsun Jeon  
E-mail: jeon1007@neo.tamu.edu

Mr. Dustin Tingey  
E-mail: dtingey@gmail.com

Mr. Tingey is the lecture TA.
Time and Place:

Lectures:

**Sections 501 - 503** (Instructor: Dr. W.-J. Kim)
Monday & Wednesday 9:10 AM - 10:00 AM
CHEN 106

**Sections 504 - 506** (Instructor: Dr. A. Palazzolo)
Tuesday & Thursday 9:35 AM - 10:25 AM
CHEN 102

Laboratories:

**Section 501** (TA: Mr. Jeon)
Monday 1:50 PM - 4:40 PM
ENPH 302

**Section 503** (TA: Mr. Hollkamp)
Tuesday 2:20 PM - 5:10 PM
ENPH 302

**Section 505** (TA: Mr. Hollkamp)
Thursday 11:10 AM - 2:00 PM
ENPH 302

**Section 502** (TA: Ms. Adkins)
Tuesday 8:00 AM - 10:50 AM
ENPH 302

**Section 504** (TA: Mr. Jeon)
Wednesday 1:50 PM - 4:40 PM
ENPH 302

**Section 506** (TA: Ms. Adkins)
Wednesday 8:00 AM - 10:50 AM
ENPH 302

Office Hours:

Dr. Kim – MW 10:00 AM - 11:00 AM
Dr. Palazzolo – MW 1:30 PM - 2:30 PM
Ms. Adkins – T 1:00 PM - 2:00 PM and F 12:30 PM - 1:30 PM
Mr. Hollkamp – MW 11:00 AM - noon
Mr. Jeon – T 11:00 AM - noon and R 2:00 PM - 3:00 PM
Mr. Tingey – M noon - 1:00 PM and R 8:30 AM - 9:30 AM

You may attend any instructor’s or TA’s office hours. All TAs’ office hours will be held at the MEEN 364 lab (ENPH 302). All instructors’ office hours will be held at their offices or the classrooms. Additional help is available by scheduling an appointment with instructors or with any of the lab and lecture TAs. The easiest way to reach me is via e-mail.

Textbook:

The course textbook is


Additionally, some material regarding modeling of dynamic systems will be presented from

On-line Course Material:

All course material will be available at http://wonjongkim.tamu.edu/MEEN364. Please, check the site frequently, e.g. at least weekly.

Use of Computer Software:

This course will introduce you to and make extensive use of two software tools: (1) MATLAB/SIMULINK and (2) LabVIEW. The former will be extensively used for solving the homework problems, and for performing all of the control-related labs. The latter will be used in all of the measurement-related labs.

IMPORTANT NOTE: The software tools you will be introduced to in this course are intended to help you solve the various numerical problems you encounter in this course. Such problems would otherwise require extensive number crunching. Even though one could perform symbolic calculations with some of these tools, I highly recommend against it. You could use the symbolic calculators of MATLAB to check some of the mathematics you perform by hand. However, I expect you to know how to do mathematics by hand and you will have to show your skills in the tests. Review notes on various aspects of mathematics needed in this course will be made available on the course web page.

Student Evaluation:

Student grades will be computed as follows:

- Homework 10 %
- Exam I 20 %
- Exam II 20 %
- Final Exam - Comprehensive 30 %
- Laboratory Reports - Group 10 %
- Pre-Lab Reports (3%), Lab Quizzes (5%), & Lab Safety (2%) - Individual 10 %

Total 100 %

Grading Policy:

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

Common Exams:

There will be two common exams on February 20, 2013 and April 3, 2013. Both exams will take place in the 7 PM - 9 PM time period. The exams will include problems and perhaps short answer/multiple choice questions. Exams will be based on individual work and they will be closed book and closed notes. Information you might need from certain tables in the textbook will be made available to you.

NO CALCULATORS WILL BE ALLOWED IN THE COMMON EXAMS AND THE FINAL.
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/rule07). 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).

Policy on Make-up Exams:

Make-up exams will be given only for those with University-excused absences from the regular exams. Contact the instructor as soon as you are aware of the absence so that a make-up exam can be scheduled BEFORE the actual exam takes place. Make-up exams will be scheduled by the instructor.

Final Exam:

The final exam will be given as scheduled in the Spring 2013 schedule of classes as follows:

<table>
<thead>
<tr>
<th>Sections</th>
<th>Monday, May 6, 2013; 8:00 AM - 10:00 AM</th>
</tr>
</thead>
<tbody>
<tr>
<td>sections</td>
<td>Sections 501 - 503</td>
</tr>
<tr>
<td>sections</td>
<td>Sections 504 - 506</td>
</tr>
<tr>
<td>Sections</td>
<td>Friday, May 3, 2013; 12:30 PM - 2:30 PM</td>
</tr>
</tbody>
</table>

The final will be a comprehensive exam.

Homework Assignments:

Homework will be usually e-mailed to you or posted on the course web page on Thursday, and it will be due at 4:00 PM on the following Thursday to your instructor’s office. 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. At most one of the homework problems will be selected for grading randomly and it will carry 80% of the grade for that homework set. The remaining problems will receive a checkmark, if a solution is present, and they will receive 20% of the grade for that homework set.

There may be a weekly, one-hour problem-solving session conducted by the teaching assistants. Attendance is voluntary, but I highly recommend that you to attend because most of the example problems, and homework related Q & A will be handled during this session.

Homework is intended to show your individual work. Each student is required to turn-in his or her solutions to the homework assignments. However, you are allowed to form groups or join each other on discussions regarding the problems. Please, read the section on plagiarism below.

Pre-lab Assignments, Lab Quizzes and Laboratory Reports:

Pre-lab assignments will be due at the beginning of the lab sessions. These are not group assignments; each of you must turn in a pre-lab assignment for grading.

Attendance in the labs is mandatory. All students repeating MEEN 364 must repeat the laboratory component. You are strongly advised to come to the labs fully prepared, by reading the relevant material given to you in the lab description and by reviewing the relevant material from the
lectures. Lab reports will be the results of your group's effort. One lab report should be turned in per group.

More details regarding pre-labs, lab quizzes and lab reports will be given to you by your lab instructor.

**Lab Safety Acknowledgment (LSA):**

As each student enrolled in a qualifying laboratory course at TAMU is required to sign an LSA form, each student should log onto HOWDY, select “My Record” tab, then go to the “Registration” section. From the, the student selects “Lab Safety Acknowledgment” and the proper term. This will result in a list of the laboratory safety forms for the classes in which he/she is registered that require a form. The student should read the form and click to acknowledge.

Also refer to the document titled, *Laboratory Safety: Basic Student Guideline*. You are asked to sign and return the safety contract to your TA by the first lab.

**Use of e-mail:**

You are required to check your neo e-mail regularly (at least daily) and stay in touch with the announcements that appear on the class web site. You must make available to the instructor the most reliable e-mail address you have, and/or any changes to it, as soon as possible.

**Peer Evaluations:**

You might be asked to provide peer evaluation of each lab group member at the end of the semester. Each group member might be asked to evaluate the contribution of every other group member. These evaluations might be considered in determining the numerical score each group member will receive for the lab reports, and whether such score should deviate from the score given to the group.

**Policy on Grading Complaints:**

If you feel a mistake was made in grading any material involving (1) points not added or not recorded properly, (2) points taken-off for an answer that is not 100% correct, or (3) for giving partial credit, please, first talk to person doing the grading within a week after the graded paper was distributed. If you are not satisfied with the resolution of the matter then talk to me. Please, make your complaint to me is in writing and via e-mail. Please, be specific about your complaints.

**Americans with Disabilities Act (ADA) Policy 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, in Cain Hall, Room B118, or call 845-1637. For additional information visit http://disability.tamu.edu.
Academic Integrity Statement:

Plagiarism consists of passing off as yours the work that belongs to someone else. As such, you will be committing plagiarism if you present someone else's work as your own, even with the other person's consent. Be aware that such conduct is against University rules and could have serious consequences. If you have questions about this subject, please consult the Texas A&M University Student Rules, under the section "Scholastic Dishonesty."

**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
MEEN 364 DYNAMIC SYSTEMS AND CONTROLS
LECTURES OUTLINE

Course Credit: 2 hrs engineering science; 1 hr engineering design
Lectures: 2 weekly lectures 0:50 hrs each
Prerequisites: ENGR 215, MEEN 260, MEEN 363
Course Textbook: Feedback Control of Dynamic Systems, 6th Edition,
by G. F. Franklin, J. D. Powell, and A. E.-Naeini
Reference Book (primarily for modeling): Dynamic Modeling and
Control of Engineering Systems, 3rd Edition,
by B. T. Kulakowski, J. F. Gardner, and J. L. Shearer

PART 1. MODELING OF DYNAMIC SYSTEMS

Week 1 - January 14 – January 18, 2013
Lecture 1: Modeling of mechanical systems; translational systems
Lecture 2: Examples of modeling translational mechanical systems; formulation of state-space representation

Week 2 - January 21 – January 25, 2013
Lecture 3: Modeling of mechanical systems; rotational and mixed systems
Lecture 4: Examples of modeling of rotational and mixed mechanical systems; formulation of the state-space representation (no separate lecture notes)

Week 3 - January 28 – February 1, 2013
Lecture 5: Elementary electrical and electromagnetic system components; associated governing laws
Lecture 6: Modeling of electromechanical systems; principles of motor operation

Week 4 - February 4 – February 8, 2013
Lecture 7: Elementary fluidic and thermal system components; associated governing laws
Lecture 8: Modeling of process systems (thermal and fluid); modeling transport delays (See Lecture Notes #7)

Week 5 - February 11 – February 15, 2013
Lecture 9: Linearization and scaling; operating points and impedance matching
Lecture 10: Laplace transforms

PART 2. ANALYSIS OF DYNAMIC SYSTEMS

Week 6 - February 18 – February 22, 2013
Lecture 11: Transfer functions and block diagrams; poles and zeros; relation between transfer functions and state-space
Lecture 12: Dynamic response of linear systems; transient response of first-order dynamic systems

EVENING EXAM I – February 20, 2013; 7 - 9 PM; Room ZACH 104B (Sections 501–503)
and Room CHEN 104 (Sections 504–506)
Week 7 - February 25 – March 1, 2013
Lecture 13: Transient response of second-order dynamic systems; system damping and natural frequency (See Lecture Notes #12)
Lecture 14: Time-domain specifications (See Lecture Notes #12)

Week 8 - March 4 – March 8, 2013
Lecture 15: Transient response of systems and impact of additional poles and zeros (See Lecture Notes #12)
Lecture 16: Frequency domain analysis; Bode plots for first-order systems

PART 3. FEEDBACK CONTROL SYSTEMS

Week 9 - March 18 – March 22, 2013
Lecture 17: Bode plots for second-order systems (see Lecture Notes #16)
Lecture 18: Properties and characteristics of feedback; open-loop vs closed-loop transfer functions; sensitivity; steady-state error; disturbance rejection

Week 10 - March 25 – March 29, 2013
Lecture 19: Properties and characteristics of feedback; open-loop vs closed-loop transfer functions; sensitivity; steady-state error; disturbance rejection (Cont’d)
Lecture 20: PID Controllers; performance of feedback control systems

Week 11 - April 1 – April 5, 2013
Lecture 21: System type and tracking; stability of equilibrium and determination of stability; Routh-Hurwitz criterion (brief exposure); use of eigenvalues in stability analysis
Lecture 22: Introduction to root-locus; design steps

EVENING EXAM II - April 3, 2013; 7 - 9 PM; Room RICH 106 (Sections 501–506)

Week 12 - April 8 – April 12, 2013
Lecture 23: Examples on root-locus design (see Lecture Notes #22)
Lecture 24: Use of root-locus for PID controller design

Week 13 - April 15 – April 19, 2013
Lecture 25: Control system design specification; frequency-domain specifications; phase and gain margins
Lecture 26: Compensation and design of lead-lag controllers; gain and phase margins

Week 14 - April 22 – April 26, 2013
Lecture 27: Compensation and design of lead-lag controllers; gain and phase margins (Cont’d)
Lecture 28: Use of Bode plots in dynamic compensation

FINAL EXAM - COMPREHENSIVE
Sections 501-503 Monday, May 6, 2013; 8:00 AM - 10:00 AM; Room CHEN 106
Sections 504-506 Friday, May 3, 2013; 12:30 PM - 2:30 PM; Room CHEN 102
MEEN 364 DYNAMIC SYSTEMS AND CONTROLS
LABS OUTLINE

Course Credit: 2 hrs engineering science; 1 hr engineering design
Labs: 1 weekly lab 3 hrs each
Prerequisites: ENGR 215, MEEN 260, MEEN 363

NOTE: ALL LABS RELATED TO MEASUREMENTS WILL BE PERFORMED USING LabVIEW; ALL LABS RELATED TO MODELING AND CONTROL WILL BE PERFORMED USING MATLAB, SIMULINK AND/OR LabVIEW

Week 1 - January 14 – January 18, 2013
Lab 1: Review tutorial and use of Matlab; introduction and use of LabVIEW for constructing virtual instruments (for Section 501 only)

Week 2 - January 21 – January 25, 2013
Lab 1: Review tutorial and use of Matlab; introduction and use of LabVIEW for constructing virtual instruments (for Section 502, 503, 504, 505, and 506)

Week 3 - January 28 – February 1, 2013
Lab 2: Pendulum-slider system simulation; use of Matlab, Simulink and Real-Time Workshop for modeling, analysis and control of dynamic systems

Week 4 - February 4 – February 8, 2013
Lab 3: 2-DOF mechanical system; free vibration measurements and comparisons with responses predicted from modeling

Week 5 - February 11 – February 15, 2013
Lab 4: Modeling of DC motor and calibration

Week 6 - February 18 – February 22, 2013
NO LAB

Week 7 - February 25 – March 1, 2013
Lab 5: Modeling of liquid level system (coupled tanks) and parameter identification (calibration)

Week 8 - March 4 – March 8, 2013
Lab 6: Implementation of DC motor speed controllers; impact of uncertainty

Week 9 - March 18 – March 22, 2013
Lab 7: Experiment on forced vibration measurements; vibration spectrum of cantilever beam
Week 10 - March 25 – March 29, 2013
Lab 8: Design of controller for liquid level control (coupled tanks); simulations

Week 11 - April 1 – April 5, 2013
NO LAB

Week 12 - April 8 – April 12, 2013
Lab 9: Implementation of liquid level (coupled tanks) controller

Week 13 - April 15 – April 19, 2013
Lab 10: Design of feedback controller for DC motor position control; simulations

Week 14 - April 22 – April 26, 2013
Lab 11: Implementation of DC motor position controller