Department of Mechanical and Aerospace Engineering
The University Of Texas at Arlington
Introduction to Automatic Controls - ME 4310 – Summer 2014

Instructor: Dr. P. S. Shiakolas
Office: 315 D Woolf Hall, **Phone:** (817) 272-5715 **Email**: shiakolas@uta.edu
Course Web Page: Blackboard and http://mars.uta.edu/mae4310 (check regularly for announcements)
Office Hours: TBA and by appointment (appointment must be made through email)
GTA: TBD **Office:** **Office Hours:**
Prerequisites: MAE 3319 and/or MAE 3405
Text: *Modern Control Engineering* by K. Ogata, 5th Edition (4th Edition will suffice for theory but not HW problems)
Description of Course Content: Introduction to block diagram algebra, transfer functions and stability criteria. Use of transient response, root locus and frequency techniques in the performance, analysis, design, and evaluation of dynamic control systems. Introduction to state space techniques. (Experimental Demonstrations – time permitting).

Grading Policy – Expectations – Course Logistics

Assume no collaboration is allowed unless expressed permission is obtained from the instructor.
Anyone collaborating on PQ or HWs will be given a grade of zero on the particular assignment.
Anyone collaborating on an exam will be given a failing grade in the course.

Pop Quizzes (0.75 pt each): Pop quizzes (PQ) will be based on assigned reading, on material covered in previous lectures and /or material currently presented. A PQ might take place at any time during the lecture period. You will not be able to make up missed PQ so it important to attend the lectures.
Homework (1.0 pt each): The purpose of the homework (HW) is to provide practice exercises that apply the theory and concepts presented in class in order to identify and improve on any deficiencies that might exist. It could be either analytical and/or computational. You might be asked to demonstrate your work. Do not just mechanically follow the theory/equations and perform just the algebra *but try to understand the concepts employed and the results obtained*. HW is due at the beginning of class – once I start lecturing I reserve the right do not accept HW – so be on time. Late HW will not be accepted nor will you be able to make it up. HW problems will be assigned from 5th Edition of the textbook.
Semester Exam (20 pts): The semester exam will be comprehensive and may consist of two parts (an analytical and a computational). Note that part of or the whole exam may be take-home. The time of the exam will be announced later and will not necessarily last the whole class time. Tentatively, the midterm will take place after completing the Root Locus Theory and you will have at least one lecture lead time for preparation.
Final Exam (35 pts): The final exam will be comprehensive and may consist of two parts; an analytical and a computational. The exam will be given at the university scheduled time. It is your responsibility to find and know this information. If there will be a computational part, it could be given the last week of classes.
Makeup Exam: No makeup exams will be given unless I am notified in advance and approve of it. If you miss the semester exam due to approved reason, there will be only one comprehensive (all material covered) makeup exam the last week of the semester. There will be no makeup for the final exam except in extreme circumstances.
Exam Rules: Any in-class exam will be closed book/notes and all electronic devices must be switched off. You are allowed to bring with you simple engineering no programmable calculators.
Key Assignment(s): Students must submit and pass all key assignments as one of the requirements for obtaining a passing in the class. The key assignments will be announced on time.
Attendance Policy: It is your responsibility to attend the lectures, participate in class discussion and keep up-to-date with the course material. I do not re-teach missed lecture material during office hours. If you are habitually late, you will not be allowed in the classroom as this is disruptive to the other students.
Expectations for Out-of-Class Study: Beyond the time required to attend each class meeting, students enrolled in this course should expect to spend at least an additional 8-9 hours per week of their own time in course-related activities, including reading required materials, completing assignments, preparing for exams, etc.
Drop Policy: According to university regulations and schedule. After the late registration period, students must see their academic advisor to drop a class or withdraw. Undeclared students must see an advisor in the University Advising Center. Drops can continue through a point two-thirds of the way through the term or session. It is the student's responsibility to officially withdraw if they do not plan to attend after registering. Students will not be automatically dropped for non-attendance. Repayment of certain types of financial aid administered through the University may be required as the result of dropping classes or withdrawing. For more information see http://wweb.uta.edu/ses/fao.

Guaranteed Grading Scale: The guaranteed grading scale based upon the minimum percentage number of points earned is **A >= 90%, 90% >B >= 80%, 80% > C >= 70%, 70% > D >=60%, 60% > F**
Note that no incomplete grade will be given unless prior arrangements are made and only in extreme circumstances.

Grade Grievances: Any appeal of a grade must follow the procedures and deadlines for grade-related grievances as published in the current undergraduate catalog.
http://wweb.uta.edu/catalog/content/general/academic_regulations.aspx#10

Communication: Email communication will be through your official UTA email account. Material might be posted on Blackboard and/or web page. It is your responsibility to check your email, Blakcboard, and web page often.

Student Initiated Email Format: Email must have the subject heading MAE 4310 – SM 14: followed by the topic; i.e. MAE 4310 – SM 14: problem 4.3 question. Emails without the correct subject format and UTA email account as sender will not be answered and deleted. I usually answer email only once a day towards the end of the workday. If you email after 3:00 pm, you might not get a response until late the next day. Also, I do not answer emails on weekends.

Software: You may use any computer software that you like and there are a many available for simulation and controls; SCILAB http://www.scilab.org, MATLAB http://www.mathworks.com, Mathematica http://wolfram.com, LabVIEW http://www.ni.com, etc. Make sure that you have software access during the semester and you are proficient in it for the purposes of this class.

Remember use of computer tools is encouraged to help better understand concepts – **DO NOT** just learn how to exercise the software commands but make sure you understand the underlying theory and concepts employed.

Additional Reference Material: Modeling and Controls related books are available in the engineering library and software resources available on the internet – some links are provided on class web page. The class textbook is on reserve at the engineering library.

Miscellaneous: If you have a disability, any religious holidays that you need to observe or anything else that might interfere with this class and you would like for me to know about it, you must inform me in writing no later than the third class meeting.

Student Support Services: UT Arlington provides a variety of resources and programs designed to help students develop academic skills, deal with personal situations, and better understand concepts and information related to their courses. For individualized referrals, students may visit the reception desk at University College (Ransom Hall), call the Maverick Resource Hotline at 817-272-6107, email to resources@uta.edu, or view the information at www.uta.edu/resources.

GTA Duties: The GTA will be available to assist with your homework and answer questions. Note that **the GTA has expressed instructions do not** solve the homework for you. It is your responsibility to attempt the homework, bring with you your current attempts in solving the assigned problems and then ask for help. The GTA will hold both regular office hours and if needed recitation and software sessions. Should you need software help, make sure you have an electronic copy or printout of the exact commands used and associated errors if any.

Tentative Topics (not in a particular order)

System Representation

- Differential Equations (Rev)
- Transfer Functions (Rev)
- Block Diagrams
- State Space (Rev)

System Transient Response Analysis

- Pole, Zero Analysis
  - Time Domain Response
  - Analytic and Computational (Rev)
- Frequency Domain Response
- Laplace Transform (Rev)
- Stability

Feedback Control Systems

- Effects of Feedback Control
- Classical Control Actions
  - Proportional (P), Integral (I), Derivative (D) and Combinations PI, PD, PID
  - Analog implementation
- Error Analysis – Controller Design
  - Initial and Final Value Theorems
  - Static & Dynamic Error
  - Performance Indices & Controller Tuning
- Sensitivity Analysis

Controller Design (Pole-Zero locations)

- Root Locus Analysis
- Frequency Response Analysis - Bode Plot
- Compensation Analysis: Lead, Lag and combination

State Variable Feedback Systems – Modern Control

- Controllability and Observability
- Pole Placement Design
- Observer Design - Optimal Control (time permitting)

Hardware Controller Implementation and Demonstration

KEEP FOR YOUR RECORDS

Americans with Disabilities Act: The University of Texas at Arlington is on record as being committed to both the spirit and letter of all federal equal opportunity legislation, including the *Americans with Disabilities Act (ADA)*. All instructors at UT Arlington are required by law to provide "reasonable accommodations" to students with disabilities, so as not to discriminate on the basis of that disability. Any student requiring an accommodation for this course must provide the instructor with official documentation in the form of a letter certified by the staff in the Office for Students with Disabilities, University Hall 102. Only those students who have officially documented a need for an accommodation will have their request honored. Information regarding diagnostic criteria and policies for obtaining disability-based academic accommodations can be found at www.uta.edu/disability or by calling the Office for Students with Disabilities at (817) 272-3364.

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Academic Dishonesty
It is the philosophy of The University of Texas at Arlington that academic dishonesty is a completely unacceptable mode of conduct and will not be tolerated in any form. All persons involved in academic dishonesty will be disciplined in accordance with University regulations and procedures. Discipline may include suspensions or expulsion from the University. "Scholastic dishonesty includes but is not limited to cheating, plagiarism, collusion, the submission for credit of any work or materials that are attributable in whole or in part to another person, taking an examination for another person, any act designed to give unfair advantage to a student or the attempt to commit such acts." (Regents' Rules and Regulations, Part One, Chapter VI, Section 3, Subsection 3.2, Subdivision 3.22)

Instructors may employ the Honor Code as they see fit in their courses, including (but not limited to) having students acknowledge the honor code as part of an examination or requiring students to incorporate the honor code into any work submitted. Per UT System *Regents' Rule* 50101, §2.2, suspected violations of university's standards for academic integrity (including the Honor Code) will be referred to the Office of Student Conduct. Violators will be disciplined in accordance with University policy, which may result in the student's suspension or expulsion from the University.

University of Texas at Arlington Honor Code
The University of Texas at Arlington Honor Code can be found at **http://www.uta.edu/conduct/.**

> I pledge, on my honor, to uphold UT Arlington's tradition of academic integrity, a tradition that values hard work and honest effort in the pursuit of academic excellence.
>
> I promise that I will submit only work that I personally create or that I contribute to group collaborations, and I will appropriately reference any work from other sources. I will follow the highest standards of integrity and uphold the spirit of the Honor Code.

College of Engineering Ethics
The college of engineering ethics tutorial is at https://www.uta.edu/engineering/academics/ethicstutorial.php. You are required to go through the tutorial and sign and return the attached sheet indicating you carefully went over the material, you understand the implications of the presented material and that you will abide and follow the instructions. You must return this at the second class meeting. You will not be allowed in the class if you do not return this form.

By signing below, I affirmed that I have gone through the college of engineering ethics tutorial and that I will follow the instructions, guidance and rules given in the tutorial.

Name (Block letters) Student ID

Date Signature

A. Definitions

1. System: collection of matter contained within a real or imaginary boundary.
2. Inputs: variables prescribed by the environment or another system to the system of interest.
3. Outputs: Variables of interests produced by the system.
4. State Variables: the minimum set of variables required to define the state of the system (order of system = number of state variables, state variables non-unique: i.e. v and p=mv).
5. Plant: system to be controlled.
6. Controller: system that generates control action on the plant.

B. General closed loop system configuration

1. Nonlinear plant

$\dot{x} = f(x,u) \qquad y = g(x,u)$

2. Linear plant

$\dot{x} = Ax + Bu \qquad y = Cx + Du$

3. Open loop: Control not influenced by system outputs.
4. Closed loop: Control is a direct function of the system outputs.

C. Control task

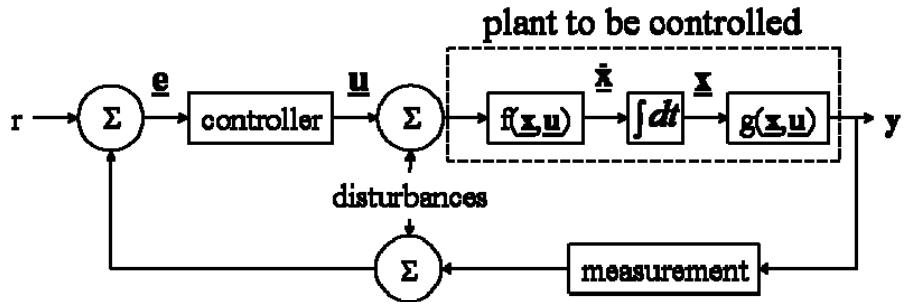
1. Formulate plant model (non-linear or linear)
2. Linearize if needed about operating point and represent system
   a. State equations
   b. Transfer functions
   c. Block diagrams
3. Specify steady state and transient performance measures
   a. Time domain
   b. Frequency domain
4. Synthesize a controller design to satisfy the performance measures

D. Features of closed loop control (compared to open loop)

1. Reduces sensitivity to disturbances
2. Reduces sensitivity to changes in plant parameters
3. Alters dynamic behavior of the closed loop system
4. Affects overall gain of the closed loop system
5. Affects stability

E. Types of feedback control systems

1. Linear versus nonlinear
2. Time invariant versus time varying
3. Continuous versus discrete time



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SIGN AND RETURN TO INSTRUCTOR BY SECOND CLASS MEETING

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