MAE 4310.002: INTRODUCTION TO AUTOMATIC CONTROL
Spring 2015
Revision d (02/09/2015)

Instructor(s): Baxter "Robert" Mullins, Jr., Ph.D.

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Office Hours: MW 12:00 PM – 1:30 PM
TT 4:00 PM – 5:00 PM

GTA Office Hours: Sukru Akif Erturk **(Rev d)**
MW 09:30 AM – 10:30 AM
Room: WH 323 C **(Rev e)**

Section Information: MAE 4310-002

Time and Place of Class Meetings: Nedderman Hall (NH) 229, TT 5:30PM – 6:50PM

Description of Course Content: Block diagram algebra, transfer functions, and stability criteria. The use of transient response, frequency response, and root locus techniques in the performance analysis, evaluation, and design of dynamic systems. Prerequisite: MAE 3314, MAE 3319 (or MAE 3405), and C or better in EE 2320.

Student Learning Outcomes: With the successful completion of this course, the student shall have basic understanding of how to develop and models physical systems, analyze system behavior, and develop simplified control techniques, the short falls of such models, and basic understanding of analysis techniques commonly used.

Required Textbooks and Other Course Materials:

- Nise, Norman S., "Control Systems Engineering, 6th ed.," John Wiley & Sons, Inc., 2010, ISBN 978-0470547564
- Software: MATLAB Student Edition by Mathworks Inc.

References:

- Distefano, J., et al., "Schaum's Outline of Feedback and Control Systems, 2nd Edition (Schaum's Outline Series)," McGraw-Hill, 2013.
- Frederick, D.K., and Chow, J., "Feedback Control Using MATLAB and the Control System Toolbox (Bookware Companion Series)," Cengage Learning, 1999.
- Melsa, J.L., and Schultz, D.G., "Linear Control Systems," McGraw-Hill Book Company, New York, 1969.
- Gupta, S.C., and Hasdorff, L., "Fundamentals of Automatic Control," R.E. Krieger Publishing Company, Malabar FL, 1970.
- Dorf, R.C., "Modern Control Systems, 3rd ed.," Addison-Wesley Publishing Company, Reading MA, 1980 (or other editions).
- Raven, F.H., "Automatic Control Engineering, 4th ed.," McGraw-Hill Book Company, New York, 1987.

- Ogata, K., "Modern Control Engineering," Prentice-Hall – older editions are better in detail, while recent versions have a good MATLAB® integration.
- Ogata, K., "Discrete-Time Control Systems," Prentice-Hall, New York, 1995 (2nd ed.)
- Bretscher, Otto, "Linear Algebra with Application, 5th ed.," Pearson, Boston, 2013.
- Hibbeler, R.C., "Engineering Mechanics: Statics and Dynamics, 13th ed.," Pearson, Boston, 2013.
- Other authors include Benjamin C. Kuo, Gene F. Franklin and J. David Powell, etc. - There are a number of good references with worked examples.

Descriptions of major assignments and examinations:

Exams:

- 10 min quizzes (End of chapter quizzes)
- Final Exam

Project(s):

- Individual project(s) shall be assigned. Assigned projects may vary from student-to-student but be of equivalent status. Due dates and times will be rigorously enforced.

Homework:

- Homework will be assigned on a class-by-class basis.
- Assigned homework is due the next class period from the assigned date at the beginning of the class.
- Use Engineering Paper for assigned homework problems – See example on Blackboard.
- Each problem will start on a new page.
- Late homework will not be accepted.
- All homework handed in for grade shall include a statement of the problem, a free body diagram (as appropriate), and an organized solution to the problem.

Other Requirements:

- Modeling software such as the student version of MATLAB® will be required in working some homework problems and the projects. Student version is available at the UTA Bookstore. Freeware SciLab® is an acceptable substitute and is available for download.
- Microsoft EXCEL® or other spreadsheet software (such as Apache OpenOffice freeware)

Attendance: At The University of Texas at Arlington, taking attendance is not required. Rather, each faculty member is free to develop his or her own methods of evaluating students' academic performance, which includes establishing course-specific policies on attendance. As the instructor of this section, I have elected to take attendance. Students taking this course are expected to attend every class, to arrive on time, and to stay in class until they are dismissed. Students who fail to adhere to the attendance policy can expect an impact on their grade. Students will not be penalized in the case of an emergency, or an incident beyond the student's control.

Other Requirements: Prerequisite: MAE 3314, MAE 3319 (or MAE 3405), and C or better in EE 2320.

Grading:

- Final Grade Weighting:

Projects:	40%	
Homework:	20%	
Quizzes:	40%	(3 lowest grades will be dropped)
Final Exam:	10%	(Will add to grade)

- Grade Allocation: Course grades will be assigned

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

In order to receive a passing grade ("C" for Engineering), the weighted average of the 10 minute exams, projects & homework, and the final examination must be 70 or above.

Students are expected to keep track of their performance throughout the semester and seek guidance from available sources (including the instructor) if their performance drops below satisfactory levels.

Homework & Project Policy:

- Assigned homework and projects are due at the beginning of the class meeting of the due date.
- Due dates and times will be rigorously enforced.
- Use Engineering Paper for assigned homework problems - One problem per page.
- Late assignments will not be accepted.

Exam Policy:

- A final examination will be given at the conclusion of the course.
- 10 minute quizzes will be given throughout the semester as topics are completed. Generally, these will occur about weekly.
- There will be **NO** make-up quizzes. Missed quizzes will receive a grade of zero.
- There will be **NO** make-up exams for unexcused absences.
- Missed exams/quizzes will receive a grade of zero unless the student has an excused absence.
- A student having an **UNEXCUSED** absence from the final exam will receive the course grade earned. A student having an **EXCUSED** absence from the final exam has two options:
    a. The student may elect to receive the course grade earned with the final exam grade equal to zero, or
    b. The student may elect to receive the grade of "I" (incomplete) and make arrangements to complete the course by taking the final examination at the end of the next semester.

  If the student chooses the second option, it is the student's responsibility to consult with the instructor regarding completion of the course requirements.

  NOTE: Excuses for absences from the final exam must be in writing with appropriate verification; e.g., note from your doctor, dentist, etc.

- The instructor must be notified at the beginning of the semester of any 'Special Needs EXAM' testing requirements. The student must be registered and approved for special testing allowances. If so, the student is responsible for obtaining and presenting the necessary forms to the instructor at least a week before the final. (Quizzes do not fall under this activity.)

Expectations for Out-of-Class Study: Beyond the time required to attend each class meeting, students enrolled MAE 4310, a 3-credit hour course, should expect to spend at least an additional 9 hours per week of their own time in course-related activities, including reading required materials, completing assignments, preparing for exams, etc. (The general rule of thumb is for every credit hour earned, a student should expect to spend 3-hours per week working outside of class.)

Grade Grievances: Any appeal of a grade in this course must follow the procedures and deadlines for grade-related grievances as published in the current University Catalog.

Drop Policy: Students may drop or swap (adding and dropping a class concurrently) classes through self-service in MyMav from the beginning of the registration period through the late registration period. 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, contact the Office of Financial Aid and Scholarships (http://wweb.uta.edu/aao/fao/).

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.

Title IX: The University of Texas at Arlington is committed to upholding U.S. Federal Law “Title IX” such that no member of the UT Arlington community shall, on the basis of sex, be excluded from participation in, be denied the benefits of, or be subjected to discrimination under any education program or activity. For more information, visit www.uta.edu/titleIX.

Academic Integrity: Students enrolled all UT Arlington courses are expected to adhere to the UT Arlington Honor Code:

> *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 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.*

UT Arlington faculty members 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.

Electronic Communication: UT Arlington has adopted MavMail as its official means to communicate with students about important deadlines and events, as well as to transact university-related business regarding financial aid, tuition, grades, graduation, etc. All students are assigned a MavMail account and are responsible for checking the inbox regularly. There is no additional charge to students for using this account, which remains active even after graduation. Information about activating and using MavMail is available at http://www.uta.edu/oit/cs/email/mavmail.php.

Student Feedback Survey: At the end of each term, students enrolled in classes categorized as “lecture,” “seminar,” or “laboratory” shall be directed to complete an online Student Feedback Survey (SFS). Instructions on how to access the SFS for this course will be sent directly to each student through MavMail approximately 10 days before the end of the term. Each student’s feedback enters the SFS

database anonymously and is aggregated with that of other students enrolled in the course. UT Arlington's effort to solicit, gather, tabulate, and publish student feedback is required by state law; students are strongly urged to participate. For more information, visit http://www.uta.edu/sfs.

Final Review Week: A period of five class days prior to the first day of final examinations in the long sessions shall be designated as Final Review Week. The purpose of this week is to allow students sufficient time to prepare for final examinations. During this week, there shall be no scheduled activities such as required field trips or performances; and no instructor shall assign any themes, research problems or exercises of similar scope that have a completion date during or following this week *unless specified in the class syllabus*. During Final Review Week, an instructor shall not give any examinations constituting 10% or more of the final grade, except makeup tests and laboratory examinations. In addition, no instructor shall give any portion of the final examination during Final Review Week. During this week, classes are held as scheduled. In addition, instructors are not required to limit content to topics that have been previously covered; they may introduce new concepts as appropriate.

Emergency Exit Procedures: Should we experience an emergency event that requires us to vacate the building, students should exit the room and move toward the nearest exit, which is located by the elevators – DO NOT USE THE ELEVATORS, but the stairway across from the elevators. When exiting the building during an emergency, one should never take an elevator but should use the stairwells. Faculty members and instructional staff will assist students in selecting the safest route for evacuation and will make arrangements to assist individuals with disabilities.

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. Resources include tutoring, major-based learning centers, developmental education, advising and mentoring, personal counseling, and federally funded programs. For individualized referrals, students may visit the reception desk at University College (Ransom Hall), call the Maverick Resource Hotline at 817-272-6107, send a message to resources@uta.edu, or view the information at www.uta.edu/resources.

Course Schedule

Spring Term - Regular Session, 2015 (16 meeting weeks: 15 instructional weeks + 1 final exam week)

First day of classes:	January 20, 2015
Census Date:	February 4, 2015
Spring Vacation	March 9-14, 2015
Last day to drop classes:	April 3, 2015 (submit requests to advisor prior to 4:00PM)
Last day of classes:	May 8, 2015
Final Exam	May 12, 2015 (Wednesday) 5:30PM-8:00PM

In your course schedule, be sure to indicate (to the extent possible) dates for all major work to be completed. (The definition of "major" is left to the discretion of each instructor.)

"*As the instructor for this course, I reserve the right to adjust this schedule in any way that serves the educational needs of the students enrolled in this course. – Baxter R. Mullins, Jr.*"

Topics covered:

- Introduction to concept of feedback control
- Modeling in the frequency domain
    - Laplace transforms

  - Transfer function
  - Analogs
  - Nonlinearities
- Modeling in the time domain
  - General state-space representation
  - Converting state space and transfer function
- Time response
  - Poles, zeros, and system response
  - First, second-order systems
  - Transfer function and state equation solution
- Reduction of multiple subsystems
  - Block diagrams
  - Signal flow graphs
  - Mason's rule
- Stability
  - Routh-Hurwitz criterion
- Steady-state errors
  - Steady-state errors
  - Sensitivity
- Root locus techniques
  - Properties of root locus
  - Sketching a root locus
  - Generalized root locus
  - Positive feedback systems
  - Pole sensitivity
- Design via root locus
- Frequency Response Techniques
  - Bode plots
  - Nyquist Diagrams
  - Gain Margin Phase Margin
  - Open loop/Closed loop frequency response
- Design via frequency response
  - Compensation
  - Gain adjustment
- Design via state space
  - Controller design
  - Controllability – Observability
  - Steady-state design
- Digital control systems
  - Modeling by digital computer
  - Z-transform

- S-plane and W-plane compensation

Emergency Phone Numbers: [Optional but strongly recommended] In case of an on-campus emergency, call the UT Arlington Police Department at **817-272-3003** (non-campus phone), **2-3003** (campus phone). You may also dial 911.

For non-emergencies, contact the UTA PD at 817-272-3381.