

**Department of Mechanical and Aerospace Engineering**  
**The University Of Texas at Arlington**  
**Classical Methods of Control Systems Analysis and Synthesis**  
**ME 5303 - SPRING 2009**

**Instructor:** Dr. P. S. Shiakolas

**Office:** 315 D Woolf Hall, **Phone:** (817) 272-5715 **Email:** [shiakolas@uta.edu](mailto:shiakolas@uta.edu)

**Course Web Page:** <http://mars.uta.edu/me5303> (check regularly for announcements)

**Office Hours:** T R 11:00-12:00 noon and by appointment

**Prerequisites:** Graduate Standing or Consent of Instructor, Introductory Modeling and Simulation

**Text:** *Modern Control Engineering* by K. Ogata, 3<sup>rd</sup> or 4<sup>th</sup> Edition

**Course Syllabus and Grading Policy**

**Homework (10):** The purpose of the homework 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. Late homework will not be accepted. Some homework solutions might be provided so it will be your responsibility to attempt, solve and understand the assigned homework, and this is the reason that it is only 5%. Note HW will be assigned based on 4<sup>th</sup> edition.

**Semester Exam (35):** There will be only one comprehensive mid-semester exam. It **may** consist of two parts (an analytical and a computational). Note that part or the whole exam may be take-home. Any in-class exam will be closed book-notes-calculators. The distance learning students must make arrangements to take the exam at the same time as the on-campus students. The time of the exam will be announced later with anticipated timeframe the week before spring break.

**Final Exam (55):** The final exam will be comprehensive and may consist of two parts; an analytical and a computational. The final exam will be closed book-notes at the university scheduled time. The distance learning students must make arrangements to take the final at the same time as the on-campus students during finals week. 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 an illness or other approved reason, there will be only one comprehensive makeup exam the last week of the semester.

**Attendance:** It is your responsibility to attend the lectures and participate in the class discussion. I do not take attendance.

**Drop Policy:** According to university regulations.

**Guaranteed Grading Scale:** The guaranteed grading scale based upon the minimum percentage number of points obtained is shown below. Note that no incompletes will be given unless prior arrangements are made and in extreme circumstances

**90% - 100%: A, 80% - 89%: B, 70% - 79%: C, 60% - 69%: D, 0 - 60%: F**

**Software:** You may use any computer software that you like. For this class, **support** will be provided for MATLAB and limited for SCILAB. You could use other packages such as FreeMat, Octave, Mathematica, Maple, MATRIXx, etc. Make sure that you can have access to the software during the semester and you are proficient in it for the purposes of this class.

**Remember** that computer tools are there to help you to better understand certain concepts – **DO NOT** just learn how to exercise the software tools but make sure you understand the underlying concepts.

**Additional Reference Material – (In Science and Technology Library)**

Modeling and Controls related books are available in the engineering library.

MATLAB and Simulink resources are available in the engineering library and on the internet.

SCILAB (<http://www.scilab.org>) resources are available on the internet – some links at provided at the class web page.

**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.

**The sciences do not try to explain, they hardly even try to interpret, they mainly make models. By a model is meant a mathematical construct which, with the addition of certain verbal interpretations, describes observed phenomena. The justification of such a mathematical construct is solely and precisely that is expected to work.**

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**John Von Neumann**

### **Tentative Topics (not in a particular order)**

#### **System Representation**

- A. Differential Equations (Review)
- B. Transfer Functions (Review)
- C. Block Diagrams
- D. State Space (Review)

#### **System Transient Response Analysis**

- A. Pole, Zero Analysis
- B. Time Domain Response
  - Analytic (Review)
  - Numeric (Computational) - (Review)
- C. Frequency Domain Response
  - Frequency Response
  - Laplace Transform (Review)
- D. Stability

#### **Feedback Control Systems**

- A. Effects of Feedback Control
- B. Classical Control Action
  - 1. Proportional (P)
  - 2. Integral (I)
  - 3. Derivative (D)
  - 4. Combinations PI, PD, PID
  - 5. Analog implementation
- C. Error Analysis – Controller Design
  - 1. Initial and Final Value Theorems
  - 2. Static, Dynamic Error

- 3. Performance Indices

- 4. Controller Tuning

- D. Sensitivity Analysis

#### **Controller Design (Pole-Zero locations)**

- A. Root Locus Analysis
- B. Frequency Response Analysis
  - Bode Plot
- C. Compensation Analysis
  - Lead-Lag Compensation

#### **State Variable Feedback Systems**

- A. Controllability and Observability
- B. Optimal Control

#### **Digital Control Systems (time permitting)**

- A. z-Transform and Bilinear Approximation
- B. Sampling Rate
- C. Controller Implementation and Hardware Demonstrations

#### **Introduction to Advanced Control Concepts (time permitting)**

- A. Neural networks
- B. Fuzzy logic
- A. Estimation and Kalman filtering

### **Americans with Disabilities Act**

The University of Texas at Arlington is on record as being committed to both the spirit and letter of federal equal opportunity legislation; reference Public Law 93112-The Rehabilitation Act of 1973 as amended. With the passage of new federal legislation entitled Americans with Disabilities Act – (ADA), pursuant to section 504 of The Rehabilitation Act, here is renewed focus on providing this population with the same opportunities enjoyed by all citizens. As a faculty member, I am required by law to provide "reasonable accommodation" to students with disabilities, so as not to discriminate on the basis of that disability. Student responsibility primarily rests with informing faculty at the beginning of the semester and in providing authorized documentation through designated administrative channels.

### **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)