

**The University of Texas at Tyler
Department of Electrical Engineering**

**Course: EENG 4316 – Digital Control Systems
Syllabus**

Catalog Description:

Theory and application of classical and modern discrete-time control systems. Analysis and design of discrete-time and hybrid control using z-transforms, root locus, frequency domain and state variable compensation techniques. On-line implementation by digital computers will be studied.

Prerequisites: EENG 4308 and MATH 3305 or permission of the instructor

Credits: 3

Text(s): Introduction to Applied Digital Control Second Edition
Gregory P. Starr Department of Mechanical Engineering
The University of New Mexico November 2006

Reference: G.F. Franklin, J.D. Powell, M. Workman, Digital Control of Dynamic Systems, third edition, Addison Wesley, 1998.

Additional Material: Software: **MATLAB®**-Please check with IT on how or if MATLAB® would be available for students to download on their personal laptops

Instructor's Lecture Notes

Course Instructor: Joseph Kamto

Class Time: **6:00-8:50 PM MO.**
Location: HEC 0A 218/Ratliff Building Nord 02007
Instructor: Joseph Kamto
jkamto@uttyler.edu

Topics Covered: (paragraph of topics separated by semicolons)

Introduction to digital control (review), Emulation of Analog Controllers, Sampling and Reconstruction, Stability Analysis Techniques, Digital Controller Design, Digital Filter Structures and Quantization Effects, Adaptive Inverse Control

Evaluation Methods: (only items in dark print apply):

1. Examinations / Quizzes
2. Homework
3. Report
4. Computer Programming
5. Project
6. Presentation
7. Course Participation
8. Peer Review

¹Numbers in brackets refer to method(s) used to evaluate the course objective.

Course Objectives¹: By the end of this course students will be able to:

In digital control (mostly everything is digital nowadays) we have a computer which samples the error signal (or more likely forms the error itself) and uses some kind of algorithm to compute the control force which is sent to the plant.

Our task is to model such sampled-data systems and learn how to come up with a good control algorithm.

Relationship to Program Outcomes (only items in dark print apply)

This course supports the following Electrical Engineering Program Outcomes, which state that our students will:

1. have the ability to apply mathematics, science, and engineering principles in the practice of electrical engineering; [3]
2. have the ability to use modern engineering tools and techniques in the practice of electrical engineering; [11,12]
3. have the ability to analyze electrical circuits, devices, and systems; [4,7,8,9]
4. have the ability to design electrical circuits, devices, and systems to meet application requirements; [5,6]
5. have the ability to design and conduct experiments, and analyze and draw conclusions from experimental results;
6. have the ability to identify, formulate, and solve problems in the practice of electrical engineering using appropriate theoretical and experimental methods; [1,2]
7. have effective written, visual, and oral communication skills; [4,5,6]
8. possess an educational background to understand the broader context in which engineering is practiced, including:
 - a. knowledge of contemporary issues related to science and engineering;
 - b. the impact of engineering on society;
 - c. the role of ethics in the practice of engineering;
9. have the ability to contribute effectively to multi-disciplinary engineering teams; [1,4]
10. have a recognition of the need for and ability to pursue continued learning throughout their professional careers. [10]

²Numbers in brackets refer to course objective(s) that address the Program Outcome.

Contribution to Meeting Professional Component: (in semester hours)

Mathematics and Basic Sciences:	0.5	Hours
Engineering Sciences and Design:	2.5	Hours
General Education Component:	0	Hours

Prepared by

Joseph Kamto

Date

08/02/2019

UNIVERSITY POLICIES AND ADDITIONAL INFORMATION THAT MUST APPEAR IN EACH COURSE SYLLABUS

UT Tyler Honor Code

Every member of the UT Tyler community joins together to embrace: Honor and integrity that will not allow me to lie, cheat, or steal, nor to accept the actions of those who do.

Students Rights and Responsibilities

To know and understand the policies that affect your rights and responsibilities as a student at UT Tyler, please follow this link:

<http://www.uttyler.edu/wellness/rightsresponsibilities.php>

Campus Carry

We respect the right and privacy of students 21 and over who are duly licensed to carry concealed weapons in this class. License holders are expected to behave responsibly and keep a handgun secure and concealed. More information is available at: <http://www.uttyler.edu/about/campus-carry/index.php>

UT Tyler a Tobacco-Free University

All forms of tobacco will not be permitted on the UT Tyler main campus, branch campuses, and any property owned by UT Tyler. This applies to all members of the University community, including students, faculty, staff, University affiliates, contractors, and visitors.

Forms of tobacco not permitted include cigarettes, cigars, pipes, water pipes (hookah), bidis, kreteks, electronic cigarettes, smokeless tobacco, snuff, chewing tobacco, and all other tobacco products.

There are several cessation programs available to students looking to quit smoking, including counseling, quitlines, and group support.

For more information on cessation programs please visit: www.uttyler.edu/tobacco-free.

Grade Replacement/Forgiveness and Census Date Policies

Students repeating a course for grade forgiveness (grade replacement) must file a Grade Replacement Contract with the Enrollment Services Center (ADM 230) on or before the Census Date of the semester in which the course will be repeated. Grade Replacement

Contracts are available in the Enrollment Services Center or at <http://www.uttyler.edu/registrar>. Each semester's Census Date can be found on the Contract itself, on the Academic Calendar, or in the information pamphlets published each semester by the Office of the Registrar.

Failure to file a Grade Replacement Contract will result in both the original and repeated grade being used to calculate your overall grade point average. Undergraduates are eligible to exercise grade replacement for only three course repeats during their career at UT Tyler; graduates are eligible for two grade replacements. Full policy details are printed on each Grade Replacement Contract.

The Census Date is the deadline for many forms and enrollment actions of which students need to be aware. These include:

- Submitting Grade Replacement Contracts, Transient Forms, requests to withhold directory information, approvals for taking courses as Audit, Pass/Fail or Credit/No Credit.
- Receiving 100% refunds for partial withdrawals. (There is no refund for these after the Census Date)
- Schedule adjustments (section changes, adding a new class, dropping without a “W” grade)
- Being reinstated or re-enrolled in classes after being dropped for non-payment
- Completing the process for tuition exemptions or waivers through Financial Aid

State-Mandated Course Drop Policy

Texas law prohibits a student who began college for the first time in Fall 2007 or thereafter from dropping more than six courses during their entire undergraduate career. This includes courses dropped at another 2-year or 4-year Texas public college or university.

For purposes of this rule, a dropped course is any course that is dropped after the census date (See Academic Calendar for the specific date).

Exceptions to the 6-drop rule may be found in the catalog. Petitions for exemptions must be submitted to the Enrollment Services Center and must be accompanied by documentation of the extenuating circumstance. Please contact the Enrollment Services Center if you have any questions.

Disability/Accessibility Services

In accordance with Section 504 of the Rehabilitation Act, Americans with Disabilities Act (ADA) and the ADA Amendments Act (ADAAA) the University of Texas at Tyler offers accommodations to students with learning, physical and/or psychological disabilities. If you have a disability, including a non-visible diagnosis such as a learning disorder, chronic illness, TBI, PTSD, ADHD, or you have a history of modifications or accommodations in a previous educational environment, you are encouraged to visit: <https://hood.accessiblelearning.com/UTTyler> and fill out the New Student application. The Student Accessibility and Resources (SAR) office will contact you when your application has been submitted and an appointment with Cynthia Lowery, Assistant Director of Student Services/ADA Coordinator. For more information, including filling out an application for services, please visit the SAR webpage at <http://www.uttyler.edu/disabilityservices>, the SAR office located in the University Center, # 3150 or call 903.566.7079.

Student Absence due to Religious Observance

Students who anticipate being absent from class due to a religious observance are requested to inform the instructor of such absences by the second class meeting of the semester.

Student Absence for University-Sponsored Events and Activities

If you intend to be absent for a university-sponsored event or activity, you (or the event sponsor) must notify the instructor at least two weeks prior to the date of the planned absence. At that time the instructor will set a date and time when make-up assignments will be completed.

Social Security and FERPA Statement

It is the policy of The University of Texas at Tyler to protect the confidential nature of social security numbers. The University has changed its computer programming so that all students have an identification number. The electronic transmission of grades (e.g., via e-mail) risks violation of the Family Educational Rights and Privacy Act; grades will not be transmitted electronically.

Emergency Exits and Evacuation

Everyone is required to exit the building when a fire alarm goes off. Follow your instructor's directions regarding the appropriate exit.

If you require assistance during an evacuation, inform your instructor in the first week of class. Do not re-enter the building unless given permission by University Police, Fire department, or Fire Prevention Services.

Student Standards of Academic Conduct

Disciplinary proceedings may be initiated against any student who engages in scholastic dishonesty, including, but 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.

- i. "Cheating" includes, but is not limited to:
 - ✓ copying from another student's test paper;
 - ✓ using, during a test, materials not authorized by the person giving the test;
 - ✓ failure to comply with instructions given by the person administering the test;
 - ✓ possession during a test of materials which are not authorized by the person giving the test, such as class notes or specifically designed "crib notes". The presence of textbooks constitutes a violation if they have been specifically prohibited by the person administering the test;
 - ✓ using, buying, stealing, transporting, or soliciting in whole or part the contents of an unadministered test, test key, homework solution, or computer program;
 - ✓ collaborating with or seeking aid from another student during a test or other assignment without authority;
 - ✓ discussing the contents of an examination with another student who will take the examination;
 - ✓ divulging the contents of an examination, for the purpose of preserving questions for use by another, when the instructors has designated that the examination is not to be removed from the examination room or not to be returned or to be kept by the student;
 - ✓ substituting for another person, or permitting another person to substitute for oneself to take a course, a test, or any course-related assignment;
 - ✓ paying or offering money or other valuable thing to, or coercing another person to obtain an unadministered test, test key, homework solution, or computer program or information about an unadministered test, test key, home solution or computer program;
 - ✓ falsifying research data, laboratory reports, and/or other academic work offered for credit;
 - ✓ taking, keeping, misplacing, or damaging the property of The University of Texas at Tyler, or of another, if the student knows or reasonably should know that an unfair academic advantage would be gained by such conduct; and misrepresenting facts, including providing false grades or

- resumes, for the purpose of obtaining an academic or financial benefit or injuring another student academically or financially.
- ii. "Plagiarism" includes, but is not limited to, the appropriation, buying, receiving as a gift, or obtaining by any means another's work and the submission of it as one's own academic work offered for credit.
 - iii. "Collusion" includes, but is not limited to, the unauthorized collaboration with another person in preparing academic assignments offered for credit or collaboration with another person to commit a violation of any section of the rules on scholastic dishonesty.
 - iv. All written work that is submitted will be subject to review by plagiarism software.

UT Tyler Resources for Students

- UT Tyler Writing Center (903.565.5995), writingcenter@uttyler.edu
 - UT Tyler Tutoring Center (903.565.5964), tutoring@uttyler.edu
 - The Mathematics Learning Center, RBN 4021, this is the open access computer lab for math students, with tutors on duty to assist students who are enrolled in early-career courses.
- check your applicable catalog)

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Outline

Below is a detailed schedule for the semester.

Some deviations may occur, but adherence to this schedule will guarantee that we cover the material.

<u>Grading Policy</u>	Homework	25%	Grade Assignment	A	90%
	Exam 1/ Exam 2	25%		B	80%
	Exam Midterm	25%		C	70%
	Final Examination	25%		D	60%

Week	Sections	Remarks
1	1.1,1.2 2.2,2.3 2.3,2.4 2.5,2.6,2.7	Introduction Difference equations and Z-transforms Transfer functions and dynamic response s-plane, z-plane, and frequency response
2	3.1,3.2 3.2 3.3,3.4,3.5,3.6 HW due	Simulation using integration rules and pole-zero mapping Comparison of simulation methods HW solution discussed
3	September 23	Exam1
4	4.1,4.2 4.2,4.3 4.3,4.4 4.4,4.5 HW due	Sampling modeled as impulse modulation Frequency spectra of sampled signals (aliasing) Desampling (signal reconstruction) Block diagrams HW solution discussed
5	8.1,8.2 8.3,8.4,8.5	System ID—models and data organization System ID using least-squares
6	HW due 5.1 5.2,5.3 5.4 HW due	HW solution discussed Intro. to transform-based pole placement Design in s-plane, map to z-plane (sampling ignored) Design in z-plane (sampling considered) HW Solution
7	October 14	Midterm Exam
8	5.6 5.6,5.7 5.7	The use of Simulink in modeling systems Effect of derivative and integral control action PID-style controllers
8	HW due	HW solution discussed
9	6.1,6.2 6.2,6.4	Continuous system modeling using state variables MATLAB tools for state-space analysis
10	November 11	Exam2
11-13	HW due/7.1,7.2 7.3 7.4 7.5 HW Due 7.4,7.5 7.6 HW due 7.8	HW discussion, Solution to the discrete-time state equation State feedback control law, controllability State prediction estimator design HW due Recap of state feedback control law and estimator Combining state feedback law and estimator HW solution discussed Addition of reference input for SISO systems
14	7.9,7.10 HW due (optional)	Addition of reference input for MIMO systems HW solution discussed
16	December 9	Final Exam