ELKE 405 Automatic Control Systems 4(4 0 0)

Prof. Dr. İsmail H. Altaş,
Phone : 462 377 2971
E-mail : ihaltas@ktu.edu.tr
URL : www.altas.org
Office : Electrical and Electronics Engineering Building, Room 201.13.

Class : Tuesdays and Wednesdays between 08:00 and 10:00 in Halis Duman Auditorium.

Calendar Description

Concepts of modeling, and analysis of systems in time and frequency domains, feedback and feed forward controllers, stability criteria, design of controllers. Design in time and frequency domains. Root locus analysis and design, Stability of control systems. The concept of Routh-Hurwitz stability, Nyquist stability criterion, and Bode plots. PID controllers: analysis and design. Optimal control systems, robust control systems, nonlinear control systems, stability in nonlinear control systems, adaptive control, intelligent control. Prerequisite: There is no official prerequisite for this course;

Prerequisites

Although there is no official prerequisite for this course; it is highly recommended to attend the course *ELK 304 Introduction to Control Systems* before admitting this course because it is assumed that the students are familiar with the following topics.

- Required mathematical background for analysis and design of control systems (Laplace Transforms, complex variables, differential equations, matrices, linear algebra, difference equations, z-transform, linearization)
- Transfer functions, block diagrams, signal flow graphs
- Mathematical modeling of physical systems
- State variables and state space modeling
- Transient analysis and state transition matrix
- Stability of linear systems
- Basic ontrol actions

Course Contents

1. Mathematical models of systems: differential equation, state-space, transfer function
2. Analysis in the time and frequency domain: first and second order system specifications
3. Stability: definition and review of Routh Hurwitz criterion
4. Open and closed loop system: stability, sensitivity, tracking and disturbance rejection
5. Feedforward and feedback control structures
6. Typical feedback controllers such as proportional (P), proportional and integral (PI), proportional, integral and derivative (PID), variants of PID, lead and lag compensators, state-feedback controller and state-feedback with integral action.
7. Close loop frequency response and its relationship to open loop frequency response: Nyquist criterion and Bode plots
8. Principles of design of control system in the time and frequency domain: Bode diagrams, root locus
9. Optimal control systems
10. Robust control systems
11. Nonlinear control systems
12. Adaptive control systems
13. Intelligent control systems
14. Matlab/Simulink examples for all topics

Simulation Examples

Fuzzy logic simulators "***Fuzzy Logic Controller***" and "***Virtual Control System Lab***", which I developed together with one of my previous students *Hakan Aydar*, will be used to visualize system modeling and simulation processes as two auxiliary tools for the course. Besides, MATLAB/SIMULINK will be used for most of the examples and different system simulation. Some of the simulation examples are given below.

1. Speed control of a permanent magnet direct current (PMDC) motor
2. A tracking controller for moving objects
3. A door position control system
4. Additional examples from industry and other sources

Labs

The lab sessions of this course are included in the courses ELKE 407 - 408 Electrical Machines, Power Systems and Control Lab I and II

1. Closed loop speed control systems
2. Closed loop position control systems
3. Temperature control systems
4. Speed control of a DC motor using microcomputers
5. Process control using programmable logic controllers (PLC's)
6. Asynchronous motor control using PLC
7. PC parallel port interfacing for PC based digital control

However, the followings are planned to be included as simulation examples in this course.

1. Matlab/Simulink and Real Time Workshop
2. System analysis using MATLAB
3. Simulation and analysis of systems using Analog Computer
4. Experimental determination of transfer function of physical systems

Course Evaluation, Test/Quiz/Project/Final Exam Schedule

There will be a midterm test during the 8th week of the term. Exact date, place and time will be announced by departmental office as well as on the course web site. A project based assignment will be given in place of the second midterm test along with three quizzes. Every student will have a different physical system to study and simulate for control purposes. The last submission date for this project is the last day of the lectures. All students must submit the term project not later than the last day of the lectures. Otherwise, the grade will be zero. The weightings for the test, midterm, assignments, quizzes, projects, and exams will be as follows:

Assignments	:	0%	Assignments will not be evaluated
Labs	:	0%	Read the "Lab" section above
Quiz 1	:	4%	1st week
Quiz 2	:	4%	5th week
Midterm test	:	30%	8th week
Quiz 3	:	4%	11th week
Project		8%	Submission is the last day of lectures
Final	:	50%	To be announced
Total	:	100%	

All tests, quizzes, and exams are closed book type. Whatever the grades from midterm, quizzes and term project are, the grade from the final exam must be 45. Anybody who gets a grade lower than 45, will have directly a mark FF and will fail the course. Students are suggested to read the Undergraduate calendar very carefully, especially the regulations about the grades. Calculators with simple four operators, trigonometric functions, and a few memories are allowed to be used in exams. Others with high programmable capacities are not allowed. **All cell phones must be turned off (powered off) and put away (not on the desk or any visible place). Other actions will be considered as cheating.**

Text

Lecture notes

References (Highly Recommended Books)

1. G.F.Franklin, J.D. Powell and A. Emani-Naemi, Feedback Control of Dynamic Systems. Prentice-Hall, 2006.
2. R.C.Dorf and R.H. Bishop, Modern Control Systems, Prentice Hall Inc., 2001
3. K. Ogata, Modern Control Engineering, Prentice Hall, 1997
4. B. J. Kuo, Automatic Control Systems, Prentice Hall, 1995
5. N. S. Nise, Control Systems Engineering, 4th Edition, Wiley, 2004

E-Mail Group

An e-mail group will be established for communicating with the students who admitted this course. I will create this e-mail group to send some important information and announcements by e-mail to notify the students and remind them to check the website if necessary.

Some Calendar Regulations and Alpha-Numeric Conversion

Please refer to Undergraduate Student Office website www.ktu.edu.tr for the latest information about regulations related to grading system. The followings are just a reminder for the students who are attending this course. **Please remember that this is not an official document.**

- The weighting for the final exam is 50%. Students must get a minimum grade of 45 out of 100 from the final exam. Anybody who gets a grade lower than 45, will have directly a mark FF and will fail the course.
- Students who think that the mark from midterm and/or final exam is lower than expected value, they should apply to the Departmental Office or *Undergraduate Students Affair Office* with a written statement indicating the argument.
- The alpha-numeric conversion of the marks at KTU is given below:

81	100	AA	4.0	In order to pass a course a minimum grade CC is required. The grade DC may be counted as a passing grade if the GPA is 2.0 or higher.
76	80	BA	3.5	
70	75	BB	3.0	
60	69	CB	2.5	
50	59	CC	2.0	
45	49	DC	1.5	
40	44	DD	1.0	
30	39	FD	0.5	
0	29	FF	0.0	

Additional Requirements

- Attendance in 70% of lectures is compulsory.
- Having lecture notes in classroom during the lectures is required.
- Cell phones must be powered off during the lectures and all exams.
- Required documents to take deferred exams.

Additional Notes

Additional information about the term project will be given during the lecture. Some important details will be published on the course website. Therefore, it will be good for the students to check the course site regularly and join the ***ELKE 405 Automatic Control Systems*** e-mail group.