MECH 589 Computer Control of Multi-Axis Machines

Credit will be given for only one of MECH 467 and MECH 589. MECH467 is a core course for students in the mechatronics option who take MECH366. Graduate students, who did not take MECH467, are not exposed to high level digital control course in their undergraduate curriculum. MECH589 provides advanced digital control of motion systems from MECH467 lectures, and the graduate students have to take additional advanced topics in recursive identification and adaptive control methods.

Course Delivery:

3 Hours lecture/week
2* Hours laboratory in alternate weeks
1.5 Hours/week tutorials

Learning Outcomes:

By the end of this course, students will be expected to be able to design a computer controlled mechatronics system comprised of sensors and actuators.

1. Response analysis of dynamic systems modeled in continuous and discrete time domain
2. Frequency domain analysis of dynamic systems
3. Design of digital control laws for mechatronics systems comprised of mechanical systems, actuators, sensors and electronic circuits.
4. Laboratory implementation of basic computer control principles .
5. Trajectory Generation for Multi-Axis Cartesian Machines
6. Linear and Circular Interpolation Techniques
7. Design of CNC systems

Course Schedule:

1. Review of dynamic modeling of actuators, sensors and mechanical systems in Laplace Domain.
2. Z Transforms, Discrete equivalent of continuous systems
3. Feedback Control System Characteristics
4. Transient Response of Systems in continuous and discrete domain
5. Frequency Response of Continuous and Discrete Systems
6. Discrete Time and Frequency Domain Identification of Dynamic Systems
7. Nyquist criterion
8. Root-Locus diagrams
9. P, Pi,PID Design in continuous and discrete domain using transfer function models
10. Pole Placement Control System Design in continuous and discrete domain using state-space and transfer function models
11. Absolute and Relative Stability of Feedback Control Systems in continuous and discrete domain
12. Regulation, target tracking and disturbance rejection
13. On line identification and adaptive control of mechatronics systems.
14. Active damping of structural vibrations in motion control systems.
15. Trajectory Generation for motion control systems
16. Multi-axis motion and interpolation
17. Design of a real time computer controller for a Multi-Axis machine.

Laboratories (examples):

- Modeling and identification of a ball screw driven table, electro-hydraulic system
- Digital Control System Design for a ball screw driven and Electro-Hydraulic Systems
- Real time computer control system design for a two axis, linear motor driven table

Assessment Strategies:

The course will be assessed based on three laboratory projects. Each laboratory project consists of pre-lab analytical modeling proven with MATLAB – SIMULINK environment in tutorial sessions, experimental proof on the laboratory set-up and concluded with full technical reports. The course will have a close book midterm and final exams. The students must pass from the exams in order to pass the course.

Grading Scheme:

25% Laboratory projects
25% Midterm exam
50% Final exam

Resources:

Tutorials will be held in PACE laboratory using MATLAB Simulink
Experiments will be held in Mechatronics laboratory using a ball screw drive, electrohydraulic drive and two axis linear motor driven tables controlled by dSpace DSP system.
Two Teaching assistants are needed to oversee the laboratory and tutorial sessions (with MECH 467)

References:

Y. Altintas, Manufacturing Automation, Cambridge University Press, 2012.

Textbooks:

Lecture Notes are freely distributed to the class.
Y. Altintas, Computer Control of Mechatronics Systems, Lecture Notes for MECH 467 and MECH589.