ECE 455 Syllabus

Course: ECE 455

Credit Hours: 3

Course Title: Computer Control of Robots

Course Description:

Robotics is a subject that attempts to have machines replicate the actions of humans; most commonly in the manufacturing domain. At its basic level, that of manipulation, robotics is not a new science, rather it is an amalgam of engineering and science disciplines from "classical" fields such as: mathematics, kinematics, kinetics, electric circuit theory, electronics, communications, control, and computing. At its highest level of abstraction; the level of synthesizing human reasoning and behavior, robotics deals with the intelligent connection of perception to action. This introductory course is valuable for students who wish to learn about robotics through a study of industrial robot systems analysis and design. This course is suited to students from engineering and science backgrounds that wish to broaden their knowledge through working on a subject that integrates multi-disciplinary technologies.

Prerequisite(s): ECE 435 or, Entry to the course through interview with the lecturer.

Textbook(s) and/or other required material:

The course will be taught using handout notes (http://crim.ece.ncsu.edu/egrant/notes/, handouts, and reserved reading. The lecture material will be supplemented using the following list of texts.
(1) Introduction to Robotics: Mechanics and Control, J. J. Craig, Addison-Wesley, ISBN 0-201-09528-9,
(2) Robot Modeling and Control, M. W. Spong, S. Hutchinson, and M. Vidyasagar, Prentice Hall, ISBN-10 0-471-64990-2
(3) Robot Manipulators: Mathematics, Programming, and Control, R. P. Paul, MIT Press, ISBN 0-262-16082-X
(4) Introduction to Robotics: Analysis, Systems, Applications, A. B. Niku, Prentice Hall, ISBN: 0-13-061309-6

Course objectives. By the end of this course, the student should be able to (use demonstrative verbs):

Describe the various elements that make an industrial robot system;Discuss various applications of industrial robot systems;Analyze robot manipulators in terms of their kinematics, kinetics, and control;Model robot manipulators and analyze their performance, through running simulations using a MATLAB-based Robot Toolbox;Select an appropriate robotic system for a given application and discuss the limitations of such a system;Program and control an industrial robot system that performs a specific task.

Topics covered:

A total of 39 lectures (in parentheses): Introduction(1.5);Transformations: Notation, vectors, planes, translation, rotation, inverse(4.5);Manipulator Kinematics: Link description, link connection, link frame assignment, Denavit-Hartenberg parameters, forward kinematics, manipulator space, joint space, Cartesian space(4.5);Inverse Kinematics: Solvability, manipulator sub-space, algebra vs. geometry, specific solutions, examples(3);Jacobian: Definition of the Jacobian, singularities, velocities and static forces(3);Dynamics: Dynamics of rigid bodies, velocity, acceleration, mass, Lagrange equations, Newton-Euler, iterative vs. closed form, structure of dynamic equations(7.5);Control: Manipulator Sensors, Actuators and Control Systems: Sensors: position, tactile, sonar, force sensors. Actuators: DC motors, stepper motors, pneumatic systems, hydraulic systems. Control Systems: Position control, force control, robot assembly tasks, force sensors, constraints, advanced position/force control(6);Trajectory Generation: General, space, joint, Cartesian, path generation, robot language, dynamic path generation(3);Robot Programming Languages(3);Revision(1.5).

Class/laboratory schedule (sessions per week and duration of each session):

Two 75-minutes lectures per week and one 2 hours and 50 minutes lab per week.

Contribution of course to meeting the requirements of Criterion 5 - other:

N/A

Contribution of course to meeting the requirements of Criterion 5 - math and basic sciences:

N/A

Contribution of course to meeting the requirements of Criterion 5 - engineering topics:

This course contributes 3 hours of engineering science.

Contribution of course to meeting the requirements of Criterion 5 - general education:

N/A

Relationship of this course to program learning outcomes:

Learning Outcome	Level of Instruction	Related Course Content
Outcome A	Major	Linear algebra: vectors and matrices, kinematics (geometry) and kinetics (forces and torques), Statics, Dynamics, Sensing, Control.
Outcome B	Basic	To understand and apply material from lectures and use this knowledge to conduct experiments, collect

Relationship of this course to program learning outcomes:

Learning Outcome	Level of Instruction	Related Course Content
		data, and evaluate the data. Laboratory experiments will be conducted in simulation and with a physical robotic system.
Outcome C	Intermediate	Understanding robot workspace. 3D operating space limitations that are imposed on an industrial robotic system because of its design and construction. This has a major impact on robot choice for a specific task.
Outcome D	Major	The course material is an amalgam of mathematics, electrical engineering, mechanical engineering.
Outcome E	Major	Problem solving, mainly through the use of tutorial sheets, is a major component of the course.
Outcome F	Major	Through the undertaking of regular assignments, laboratories, and tests, the students are made aware that they must do their own work. Teamwork is important, but so also are honesty and professional ethics
Outcome G	Intermediate	Through the

Relationship of this course to program learning outcomes:

Learning Outcome	Level of Instruction	Related Course Content
		submission of the laboratory reports. Through the submission and presentation of projects in the case of postgraduate students
Outcome H	Basic	Material related to the use of robots, what they are used for, which nations use them, robot populations worldwide.
Outcome I	Intermediate	The diverse syllabus is a clear indication of this outcome
Outcome J	Basic	Indications where state-of-the-art robot technology is used: e.g., space, medicine.
Outcome K	Basic	The use of the MATLAB robot Toolbox for certain laboratory experiments.

Person who last prepared this description and date of preparation:

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