ENGN4627 Robotics

Subject Details:

Australian National University
Department of Engineering
Second Semester 2005
Credit points: 6
Prerequisite: ENGN2221
Incompatible: ENGN6627

Course Components:

Lectures:
3 hours per week
Wednesday 1.00-2.00 pm in Physics Theatre
Thursday 11.00 am - 12.00 pm in Physics Theatre
Friday 9.00-11.00 am in Chemistry Theatre 1 *
(* first hour used, second hour used on an as required basis)

Assignments:
Six assignments will be set, due on:
Assignment 1 - Friday, 10am, August 5th
Assignment 2 - Friday, 10am, August 19th
Assignment 3 - Friday, 10am, September 2nd
Assignment 4 - Friday, 10am, September 30th
Assignment 5 - Friday, 10am, October 14th
Assignment 6 - Friday, 10am, October 28th

Tutorials:
Six tutorials in total will be provided. They will be held on the Friday and Monday prior to each assignment being due. The purpose of these sessions will be to answer any questions about lecture material, including those that relate to (but do not directly answer) the assignments.
Times: Friday, 10-11am in Ian Ross Seminar Room and Monday, 4-5pm in Forestry Room 103.

Laboratory and Project
One laboratory and one project to be set.

Non-contact:
Students must expect to spend a minimum of 3-4 hours of private study per week in addition to assignment and lab tasks.

Personnel:

Lecturer: Dr Jason Chen
Office: B354 building 115
Telephone 02-61.25.86.13,
Email: jason.chen@anu.edu.au
Office hours: Monday 16.00-17.00, Tuesday 16.00-17.00
(if you need to see me, please organise to do so during these hours - on Weds, Thurs and Fri's, see me after lectures).

Lab Technician: Mr Padma Chakma
Office: E202 building 32
Telephone: 54885 (6125 4885)
Email: padma.chakma@anu.edu.au

Syllabus ENG4627:

1. Robotics Overview
   - History of Robotics
   - What is a robot
   - Components of a robot
   - What are the key technologies in robotics
2. Spatial Descriptions and Transformations
   - Positions, orientations and Frames
   - Mappings
   - Operators
   - Transformations between frames of reference
3. Manipulator Kinematics
   - Link and link connection descriptions, Fixing frames to links. Denavit-Hartenberg conventions
   - Manipulator kinematics
   - Actuator space, joint space and Cartesian (task) space
4. Inverse Manipulator Kinematics
   - Solvability of manipulator kinematics
   - Manipulator subspaces
   - Algebraic verses Geometric solutions of inverse kinematics
5. Velocities and static forces: The joy of Jacobians
   - Linear and rotational velocity of rigid bodies
   - Motion of links of a robot
   - Velocity of links of a robot
   - Jacobians
   - Singularities
   - Static forces in manipulators
6. Manipulator Dynamics
   - Acceleration of a rigid body
   - Mass distribution
   - NewtonEuler equations
   - Iterative Newton-Euler dynamics
   - Iterative verses closed form
   - Lagrangian formulation of manipulator dynamics
   - Manipulator Dynamics in Cartesian space
7. Trajectory Generation
   - General consideration in path descriptions
   - Joint space schemes and Cartesian schemes

- Path generation at run time

8. Mechanical Design of Robots
   - Task Requirements and design
   - Kinematic configuration and workspace
   - Actuators and sensors
9. Linear Control
   - Feedback and closed loop
   - Control law partitions and structure
   - Trajectory tracking control
   - Analysis and performance issues
10. Non-linear Control
   - The control problem for manipulators
   - Lyapunov stability analysis
   - Adaptive control
   - Compliance and control

Assessment:

Assignments:
Due: As set out above.
Six assignments will be set, each worth 2.5%. Total 15%

Lego Robot-Design Project: 20% (3rd Teaching Session)
Due: Final Report due on Monday, 10am, 26th September.
A project in robot design, fabrication and programming using the LEGO Mindstorm hardware. This project will be done in groups of 3 people. The details of the task are on the web site.

Scorbot Manipulator Laboratory: 15% (4th Teaching Session)
Due: On or before Friday, 10am, 28th October.
A lab will be run in the mechatronics research lab on the Eshed scorbot robots. This lab will be completed in lab groups of 2 people. There are only 2 scorbots available, so labs will have to be run over several weeks with different groups working at different times. I will generate a booking sheet and groups can make bookings.

Exam 50%:
There will be an exam covering all material in the course and contributing 50% of your final mark.
Duration: 3 hours
Reading time: 15 minutes
Allowed material: 2 page handwritten notes, (double sided), calculator (if it fits in a shoe box its ok)

Textbooks:

The main textbook for the course is:

John Craig, "Introduction to Robotics: Mechanics and Control" Addison-Wesley

This is a good generic text on robotics. The course will follow this text relatively closely. Other texts in robotics with an emphasis on robotic manipulators are

M. Spong and M. Vidyasager, “Robot Dynamics and Control”, and

Saeed Niku, “Introduction to Robotics: Analysis, Systems, Applications”, Pearson Education.

There is no one good reference in mobile robotics. The following reference provides a starting place

Jones, Seiger, Flynn, “Mobile Robots: Inspiration to Implementation”, A.K. Peters.

And for those with an interest in fiction:

Isaac Asimov, “I, Robot”, “The Robots of Dawn”, “The rest of the Robots”

Web Site:

The web sit for the course will be off my home page. This site will be linked to the department course web site.

http://engnet.anu.edu.au/DEcourses/engn4627/

All documents prepared for the course will be posted on the web. All administrative arrangements will be posted on the web site.

Lecture Notes: Lecture notes will be posted on the web site. I will endeavour to have the lecture notes prepared one week prior the lecture being given. If you print-out these notes, please do so double sided and save a tree or two!

Assignment and Labs: Assignment and Lab sheets can be found on the web site.

Tutorial problems from past years: A set of problem sheets, with answers, covering various aspects of the course material will be posted on the web site. These are tutorial questions from past years and provide a good source of worked solutions to typical problems.

Practice Exam: A practice exam with solutions will be posted up on the web.