Australian National University Department of Engineering

ENGN4627 – Robotics.

Subject details: *Second* semester *2007*
Credit points: *6*
Prerequisite: *ENGN2221,* **Incompatible**: ENGN6627 **Corequisite**: -
Lectures: *3 hours per week,* **Laboratories**: *To be announced.*
Students must expect to spend a minimum of 3-4 hours of private study per week.

Lectures: see http://timetable.anu.edu.au/
Laboratory Classes: scheduled individually.

Lecturer: *Dr Robert Mahony*
Subject Leader: *Dr Robert Mahony.*
Office: room *E234*, **Telephone** *02-61.25.86.13*, **Email**: Robert.Mahony@anu.edu.au
Office hours: Monday afternoon.

Synopsis: Background and history, frames of reference and transformations, manipulator kinematics, inverse manipulator kinematics, Jacobians velocities and forces, manipulator dynamics, manipulator design, linear control of robot mechanisms, some non-linear control concepts.

Assessment:
LEGO robotic design project: 30%
Scorbot Laboratory: 20%
Assignments: 10%
Exam: 40%

PLEASE NOTE THAT LABORATORY ACCESS IS ONLY AVAILABLE DURING BUSINESS HOURS.

Web Site: A web site for the course will linked to the department course web site and accessible through webCT. 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 post lecture notes prior to lectures and post notes post lecture with any corrections or modifications that have been made in the notes following the lectures.

Assignment Sheets: Five assignment sheets will be set during the course. Each assignment will be worth 2% of the final grade. Assignment problems will not be discussed in tutorials.

Problem Sheets: A set of problem sheets covering the course material will be prepared and posted on the web along with worked solutions. The problem sheets are not assessable, however, the exam question will be based on questions similar to those given in the problem sheets and assignments. A number of tutorials will be held during the year to allow feedback on the question sheets.

References:
Recommended text: Craig, *Introduction to Robotics: Mechanics and Control,* Addison-Wesley.

Other books that may be useful:

M. Spong, S. Hutchinson and M. Vidyasager, *Robot Modelling and Control*, Wiley

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

Sciavicco and Siciliano, *Modelling and Control of Robotic Manipulators*, Springer

J. Angeles, *Fundamentals of Robotic Mechanical Systems*, Mechanical Engineering Series.

Isaac Asimov, *I, Robot*, *The Robots of Dawn*, *The rest of the Robots*

Subject outline: ENG4627 – Robotics

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 & 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. 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.
- Newton-Euler 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.

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.
- Compliance and control.