# Nonlinear Control - ELEC9732

Session II 2016

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| **Instructor:** | Prof Victor Solo | Office: MSEB |
| **E-Mail:** | v.solo@unsw.edu.au | [use subject: ELEC 9732] |
| **UOC:** | 6 | |
| **Class Times:** | Tuesday, 6pm-9pm | Room: TBA |
| **Prerequisites:** | Undergraduate Control Course | |
| **Office Hours:** | Thursday, 4pm-5pm | EE Building Room 216 |

**Aims:** Provide an introduction to nonlinear systems analysis and an introduction to nonlinear control design.

**Assessment**:

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| Homework | | 30% |
| Final Exam (Take-home) | | 40% |
| Project | (Report + talk) | 30% |

Homeworks are to be completed on your own. You may discuss with other students.
But you cannot copy from them or any other source.
NB. No details of working $\Rightarrow$ no marks.
Exams are to be completed on your own. You cannot discuss with others.
And you cannot copy from any source.
The work that you hand in (and any related working) must be yours alone.

**Project** :

The project is intended to be a piece of work bigger than any homework could be. This gives the student a chance to go into a topic in some detail.
It will consist of repeating simulations in a research paper + background material: mathematical description of system; system analysis; control design.
1-2 students per group. No more than two groups per project.
One independent report from each student + oral presentation.
Use IEEE-CDC style (max 6-10pp) for the report; you must cite the original papers used.

All projects involve SIMULINK modelling.

Available projects are (see web page):

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| Hovercraft modelling and control | Double Inverted Pendulum |
| Bicycle modelling and control | Teleoperation |
| Spherical Pendulum | Surface vehicle |
| Stirred Tank Reactor | Optimal Attitude Control |

or - A relevant project of interest proposed by the student and approved by the instructor.

**Resources**:

**Software:** Matlab

**Textbook:** none.

**References:** in Library Open Reserve

**i** JJ Slotine, W Li (1991). Applied Nonlinear Control (Prentice Hall)

**ii** H Khalil (1996,2002) Nonlinear Systems (Prentice Hall)

**iii** S Sastry (1999) Nonlinear Systems (Springer).

**iv** A Isidori (1995) Nonlinear Control (Springer).

**Timetable for Homeworks, Project, Exam**

| Item | Dates(week) | Late Homeworks are penalized. |
|---|---|---|
| HW 1 | out - week 4 | due - week 6, School Office |
| HW 2 | out - week 6 | due - week 8, School Office |
| HW 3 | out - week 8 | due - week 10, School Office |
| Project | Email 2 topics in order of preference: due Tuesday | August 18(week 4) |
| | One page proposal due Friday August 19(week 4) | (specify division of work if 2 students |
| | Talks held week TBA | |
| | report due - Tuesday October 18(week 12) | 4pm, School Office |
| Final Exam | out - Tuesday October 18(week 12) | due - Friday October 28th, 4pm |

**Teaching Strategies**

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| Lectures | to give the basic material in written form, and to highlight the importance of different sections and help with the formation of schema. |
| Assignments | to give practice in problem solving, and to assess your progress. |
| Examination | the final test of competency. |

**Learning Outcomes**

At the end of the course the student will be familiar with basic aspects of nonlinear systems and control, from both an analysis and a design point of view. The student will be able to use this knowledge to solve basic problems in nonlinear systems anaysis and nonlinear control design.

**Academic Honesty and Plagiarism**

Plagiariam means copying. You cannot copy other peoples work of any kind; you cannot copy from any source. Plagiarism is a serious offence and (severe) penalties will apply; see http://www.lc.unsw.edu.au/plagiarism

**Administrative Matters**

For special needs, equity and diversity, occupational heath and safety, enrolment, rights, and general expectations of students; see http://scoff.ee.unsw.edu.au/.

| Week | Topic |
|---|---|
| 1 | Introduction |
| 2 | Nonlinear Ordinary Differential Equations |
| 3 | Phase Plane Methods |
| 4 | Lyapunov Stability |
| 5 | Input/Output Stability |
| 6 | Describing Functions |
| 7 | Nonlinear Control - Introduction |
| 8 | Feedback Linearization |
| 9 | State Feedback Linearization |
| 10 | Gain Scheduling |
| 11 | Sliding Mode Control |
| 12 | Backstepping Design Method |