IMPERIAL

Module Specification

Basic details

UID

Cohorts covered — Earliest cohort / Latest c

Long title: Stability and Control of Non-linear Systems

New code: ELEC70091

New short title

Brief description of module *(approx. 600 chars.)*: The main aim of this module is to introduce the concepts and theoretical techniques needed to study the stability and stabilization of nonlinear control systems, with particular attention being paid to Lyapunov-based analysis, robustness to exogenous disturbances and design of control feedback laws.

300 characters

Available as a standalone module/ short course? No

Statutory details

	ECTS	CATS	Non-credit
Credit value	5	10	N

HECOS codes

FHEQ level: L7

Allocation of study hours

	Hours	
Lectures	20	
Group teaching	0	*Incl. seminars, tutorials, problem classes.*
Lab/ practical	0	
Other scheduled	0	*Incl. project supervision, fieldwork, external visits.*
Independent study	105	*Incl. wider reading/ practice, follow-up work, completion of assessments*
Placement	0	*Incl. work-based learning and study that occurs overseas.*
Total hours	125	
ECTS ratio	25.00	

Project/placement activity

Is placement activity allowed? No

Module delivery

Delivery mode	Taught/ Campus	Other	
Delivery term	Term 1	Other	

Ownership

Primary department: Department of Electrical and Electronic Engineering

Additional teaching departments: 0

Delivery campus: South Kensington

Collaborative delivery

Collaborative delivery? No

External institution	
External department	
External campus	

Associated staff

Role	CID	Given name	Surname
Module Leader		David	Angeli
		0	0
		0	0
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		0	0
		0	0
		0	0
		0	0
		0	0

Learning and teaching

Module description

Learning outcomes	By the end of the module you will be able to: - Analyse the dynamical behaviour of nonlinear systems - Appraise the qualitative layout of solutions of bidimensional systems - Assess the stability and robustness of a nonlinear system subject to exogenous disturbances - Devise feedback controllers for nonlinear control systems - Interpret behaviour of numerical simulations of nonlinear systems
Module content	The module will cover the following key topic areas: Bidimensional systems and phase plane analysis Lyapunov stability theory and linearization based methods Input-to-State Stability and Small Gain Theorem Dissipativity and Passivity of isolated and interconnected systems Control Synthesis and Feedback Linearization
Learning and Teaching Approach	Owing to the presence of nonlinearities, a substantial amount of new technical tools are needed. Classes will normally introduce the new tools by illustrating them through examples and giving proofs of key results, to add insight. Most of the course is about continuous time systems modelled by differential equations. Alongside lectures you will do one coursework to further your understanding of phase portraits, numerical simulation, robustness and passivity using a model of a robotic arm.
Assessment Strategy	3 hour open book exam (75%) and one coursework (25%), handed out after 7 lectures, dealing with phase-portraits, qualitative behaviour of nonlinear systems, understanding of robustness, passivity and their implications in practical applications.
Feedback	Formative feedback is given through comments and remarks on the coursework delivered within 2 weeks of submission. Moreover, formative feedback is provided in an on-going basis as students are welcome to ask for in person clarifications during class or afterwards. Exams solutions are provided in blackboard.
Reading list	Supplementary reading material: [1] E. D. Sontag, Mathematical control theory : deterministic finite dimensional systems 2nd ed New York : Springer

systems, 2nd ed. New York : Springer.
[2] S. Sastry, Nonlinear systems : analysis, stability, and control. New York : Springer.
[3] A. J. van der. Schaft, L2-gain and passivity techniques in nonlinear control. London: Springer.
[4] A. Isidori, Nonlinear Control Systems, 3rd edition. London, UNITED KINGDOM: Springer.
[5] A. Isidori, Nonlinear control systems, 3rd ed. Berlin : Springer.
[6] A. Isidori, Nonlinear control systems II /. London :: Springer.
[7] H. K. Khalil, Nonlinear systems, 3rd ed. Upper Saddle River, N.J.: Prentice Hall.
[8] M. Krstic and P. V. Kokotovic, Nonlinear and adaptive control design. New York : Wiley-Interscience, 1995.
[9] B. Brogliato and O. Egeland, Dissipative systems analysis and control : theory and applications, Second edition. London : Springer, 2007.
[10] J.-J. E. Slotine and W. Li, Applied nonlinear control. Englewood Cliffs : Prentice-Hall, 1991.
[11] E. D. Sontag, Input to state stability: basic concepts and results. pp. 163–220.

Quality assurance

Date of first approval	February 2022
Date of last revision	July 2025
Date of this approval	
Module leader	David Angeli
Notes/ comments	

Office use only

QA Lead	
Department staff	
Date of collection	
Date exported	
Date imported	

Template version #####

Assessment details

		Pass mark
Grading method	Numerical	50%

Assessments

Assessment type	Assessment description	Weighting	Pass mark	Must pass?
Examination	3 hour open book written examination	75%	50%	N
Coursework	Simulation and analysis of robotic arm	25%	50%	N
0	0	0%	0%	0.00
0	0	0%	0%	0.00
0	0	0%	0%	0.00
0	0	0%	0%	0.00
0	0	0%	0%	0.00
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		100%		