MODULE SPECIFICATION PROFORMA

Module Code:	ENG773

Module Title:	Advanced Control Engineering & Systems Analysis

Level:	7	**Credit Value:**	20

Cost Centre(s):	GAME	JACS3 **code**:	H660

School:	Applied Science, Computing & Engineering	**Module Leader:**	Dr Zheng Chen

Scheduled learning and teaching hours	40 hrs
Guided independent study	160 hrs
Placement	0 hrs
Module duration (total hours)	200 hrs

Programme(s) in which to be offered (not including exit awards)	Core	Option
MSc Engineering (Renewable & Sustainable Energy)		✓
MSc Engineering (Electrical & Electronic)	✓	
MSc Engineering (Mechatronics)	✓	
MSc Engineering (Aeronautical)		✓
MSc Engineering (Mechanical Manufacture)		✓
MSc Engineering (Automotive)		✓

Pre-requisites
None

Office use only
Initial approval: 19/06/2018 Version no:1
With effect from: 01/09/2018
Date and details of revision: Version no:

Module Aims

- To develop mastery of dynamic system analysis, the theory of modelling, simulation and control of dynamic systems in the context of practical engineering applications and advanced control theories and approaches;
- To demonstrate a critical understanding of the capabilities of computer-based tools for control systems analysis, design and simulation currently used in industry and to explore the potential for more advanced software tools in this field of applications;
- To conduct critical analysis in applying the theory and computational tools to a variety of industrially relevant problems through case studies, assignments and project work.

Intended Learning Outcomes

Key skills for employability

KS1	Written, oral and media communication skills
KS2	Leadership, team working and networking skills
KS3	Opportunity, creativity and problem solving skills
KS4	Information technology skills and digital literacy
KS5	Information management skills
KS6	Research skills
KS7	Intercultural and sustainability skills
KS8	Career management skills
KS9	Learning to learn (managing personal and professional development, self-management)
KS10	Numeracy

At the end of this module, students will be able to		Key Skills	
1	Select and apply appropriate methods for modelling and analysing engineering dynamic systems;	KS3	KS6
		KS10	
2	Identify and critically evaluate control system types and characteristics;	KS3	KS10
3	Simulate control systems and analyse the outputs of complex applications;	KS1	KS3
		KS4	KS6
		KS10	
4	Systematically develop a control system specification following analysis of system requirements;	KS1	KS3
		KS4	KS6
		KS10	
5	Create new designs in automated control through synthesis of ideas from a wide range of sources.	KS3	KS6
		KS10	

Transferable skills and other attributes

1. Communication
2. ICT Technologies
3. Time management and organisation
4. Interpersonal skills
5. Problem solving
6. Information handling including numeracy

Derogations

Credits shall be awarded by an assessment board for those Level 7 modules in which an overall mark of at least 50% has been achieved with a minimum mark of 40% in each assessment element.

Assessment:

Indicative Assessment Tasks:

Assessment One: An individually prepared report for the critique of the principles, theory, applications and limitations of various advanced control systems. Assessment one contributes 50% of the overall module mark.

Assessment Two: A closed-book written examination. Assessment two contributes 50% of the overall module mark.

Assessment number	Learning Outcomes to be met	Type of assessment	Weighting (%)	Duration (if exam)	Word count (or equivalent if appropriate)
1	3, 4	Coursework	50%		2000
2	1, 2, 5	Examination	50%	2 hours	

Learning and Teaching Strategies:

The module will be delivered through detailed presentations combined with interactive sessions to enhance students' learning. A significant amount of the content is to be achieved through individual study. Principles are covered in formal lectures and computer based exercises develop knowledge and understanding of control system characteristics, specification and design. The learning experience will be further supported by various case studies of advanced control systems.

Syllabus outline:

- Modelling, system identification and simulation of engineering dynamic systems: Mechanistically analysis-based modelling and empirical data-based modelling; Autoregressive moving average model; Model structure selection; Model parameter identification/estimation; Simulation and model validation.
- Classical control system analysis and design: Laplace transform and transfer function; Inverse Laplace transformation and time domain response; System stability, stability criteria; Frequency response analysis and design; Root locus.

- State space methods, multivariable control and state estimation: State space representation of a dynamic system; Controllability and observability; State transition matrix; State feedback control design; Full-order and reduced-order state estimators.
- Digital control systems: Sampling theory and determination of sampling frequency; Z transform and Z-transfer function; Stability criteria; Digital implementation of analogue controllers; Performance criteria and discrete domain control system design.
- Model uncertainties and robust control: Effects of model uncertainties; Modelling model uncertainties; linear parameter varying model; Robustness in stability and performance; Small gain theorem.

Indicative Bibliography:

Essential reading

Dorf, R.C.; Bishop, R.H.; (2013) *Modern Control Systems (12th Edition)*; Pearson Prentice Hall.

Other indicative reading

Chin, C.S.; (2014) *Computer-Aided Control Systems Design: Practical Applications Using MATLAB and Simulink*; CRC Press

Ioannou, P.; (2013) Robust *Adaptive Control*; Dover Publications Inc.

Kwon, W.H.; and Han, S.; (2005) *Receding Horizon Control: model predictive control for state models* (Advanced Textbooks in Control & Signal Processing); Springer-Verlag.

Camacho, E.F.; Bordons, C.; (2004) Model predictive control; Springer-Verlag.

Albertos, P.; Sala, A.; (2001) *Multivariable Control Systems: An Engineering Approach* (Advanced Textbooks in Control & Signal Processing); Springer-Verlag.

Gu, D.W.; Petkov, P.H.; (2013) *Robust control design with MATLAB* (Advanced Textbooks in Control & Signal Processing), 2nd edition; Springer-Verlag.

Roffel, B.; Betlem, B.; (2003) *Advanced Practical Process Control*; Springer-Verlag.

Shaw, I.S.; (2010) *Fuzzy Control of Industrial Systems: Theory and Applications* (The Springer International Series in Engineering and Computer Science); Springer-Verlag.

IET Computing & Control Engineering Journal, monthly journal

IEEE Control Systems Magazine, monthly journal

International Journal of Control, monthly journal