Prifysgol Wrecsam
Wrexham University

Module specification

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Module Code	ENG5AQ
Module Title	Instrumentation and Control
Level	5
Credit value	20
Faculty	FAST
HECoS Code	100166
Cost Code	GAME
Pre-requisite module	None

Programmes in which module to be offered

Programme title	Core/Optional/Standalone
BEng (Hons) Mechatronics Engineering	Core

Breakdown of module hours

Learning and teaching hours	60 hrs
Placement tutor support hours	0 hrs
Supervised learning hours e.g. practical classes, workshops	0 hrs
Project supervision hours	0 hrs
Active learning and teaching hours total	**0** hrs
Placement hours	0 hrs
Guided independent study hours	140 hrs
Module duration (Total hours)	200 hrs

Module aims

To develop methods of obtaining measurements of system variables in an industrial environment and to compare the operation of differing transducers by analysing response time, accuracy, stability and cost. To understand the transduction process and analyse various transducer types.

To develop concepts of mathematical modelling in the area of control engineering and to extend established mathematical skills and thus to apply analytical methods to control analysis, system design, implementation and modification.

To develop knowledge and skills to plan, manage and conduct control system design with consideration of social, economic and commercial constraints, to conduct the simulation, tuning and testing to evaluate and optimise a continuous control system.

Module Learning Outcomes

At the end of this module, students will be able to:

1	To critically analyse the measurements of an industrial process in terms of the physical quantities which constitute the measured variables, and define the principles of operation of common transducers and match these to the requirements of the measured variables.
2	To critically analyse the parameters of a range of transducers for a given task (eg the measurement of flow) and hence select an appropriate device, and define and apply the criteria for evaluating the validity of measurements.
3	To plan, manage and conduct control system design with consideration of social, economic and commercial constraints.
4	To develop in-depth knowledge and skills of using correct mathematical techniques to model and simulate system/process dynamics; conduct detailed practical analyses of continuous control systems.
5	To design and/or modify a control system to meet a specified performance in the time domain and through root locus analysis using analytic, graphical, empirical and computer methods.
6	To design and/or modify a control system to meet a specified performance frequency domain using analytic, graphical, empirical and computer methods and understand the impact of uncertainties to control system design.

Assessment

Indicative Assessment Tasks:
This section outlines the type of assessment task the student will be expected to complete as part of the module. More details will be made available in the relevant academic year module handbook.

Assessment 1: A portfolio of work covering learning outcomes 1, 2, and 3, made up of theoretical aspects, research elements and practical results.

Assessment 2: A 2-hour examination covering outcomes 4, 5 and 6. It is an unseen time-constrained examination.

Assessment number	Learning Outcomes to be met	Type of assessment	Duration/Word Count	Weighting (%)	Alternative assessment, if applicable
1	1, 2, 3	Portfolio	2500	50%	
2	4, 5, 6	Examination	2 hrs	50%	

Derogations

None

Learning and Teaching Strategies

The module will be presented to students through lectures, tutorials and practically-based exercises. Approximately one-third of the time will be devoted to practical investigations and will include the use of computer simulation software.

The ‘Instrumentation’ part will be delivered through lectures supported by pre-written notes, tutorials and laboratory exercises. Practical work will take up approximately 30% of the time allocated to this component. Where possible, industrial visits to observe different process applications will be included.

In ‘Continuous Control’ the emphasis will be on dynamic system modelling and simulation, and the use of different traditional control system analysis and synthesis approaches for control system design.

Welsh Elements

Programme is delivered in English and Chinese, however students can submit assessments in Welsh.

Indicative Syllabus Outline

Physical Variables: linear and angular displacement, velocity, strain, flow, level, etc.. Selection of appropriate transducers for above with signal conditioners where required.

Errors in measurement systems: Accuracy, precision, hysteresis, zero shift,resolution, linearity, sensitivity. Maximum possible and probable errors. Response and dead time.

Transducers: potentiometers, optical encoders, variable reactance transducers, piezoelectric devices, dc and ac tachogenerators, synchro resolvers.

Comparison of the Measurement Techniques: force, pressure and strain; strain gauges, diaphragm, piezo-electric, Hall effect transducers; analysis of performance parameters of the measurement techniques - for each of the physical variables listed above - in terms of accuracy, resolution, sensitivity and repeatability. Selection of appropriate components for a given measurement system.

Measurement: flow, temperature; optical intensity measurement; proximity detectors.

Control Systems Configuration: Sensors, transducers and actuators; specifications of constituent elements in a control system; electrical, pneumatic and hydraulic actuators; Comparison of pneumatic, electrical and hydraulic systems for various control tasks; Plan, manage and conduct control system design with consideration of social, economic and commercial constraints.

Modelling and Analytical Techniques: System models of physical/electrical systems; open and closed loop systems; similarities of models from different physical systems; differences between servo systems, regulators and process control systems; steady state and transient response; Laplace transform solutions for step, ramp and sinusoidal inputs; final value theorem; transfer functions and characteristic equations; block diagram algebra; poles and zeros; stability; Routh Hurwitz stability criterion; use of computer software for correlation of open and closed loop transient responses.

Time Domain Analysis: Performance criteria – damping ratio, natural frequency, rise time, overshoot, settling time, logarithmic decrement; system lags and time constants; system class and steady state errors for standard input functions; proportional, integral and derivative control empirical methods for determining controller parameters – Zeigler and Nicholls tuning; variations in system response for controller settings.

Frequency Domain Analysis: Bode and Nyquist diagrams; stability criteria; relative stability; gain and phase margins; correlation between frequency response and transient response parameters; derivation of transfer function from Bode diagram; compensation techniques – lag and/or lead networks; design for a specified performance; use of computer software for control system analyses, syntheses and simulations; Uncertainties in control systems design.

Root Locus Analysis: Closed loop system root loci; Analysis of root locus diagrams; Stability analysis; Compensation design.

Case studies of industrial applications and subject-relevant systems. Selection of appropriate components for a given measurement system.

Indicative Bibliography

Please note the essential reads and other indicative reading are subject to annual review and update.

Essential Reads:

Bolton W. (2015) Instrumentation and Control Systems, Newnes.

Other indicative reading:

Bishop, R.D. and Dorf, R.C. (2013) Modern Control Systems, 13th Edn., London: Prentice-Hall.

Dunn, W.C. (2005) Fundamentals of Industrial Instrumentation and Process Control, McGraw Hill.

Morris, A.S. (2006) Measurement and Instrumentation Principles, Butterworth-Heinemann.

Administrative Information

For office use only	
Initial approval date	24/09/2020
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Date and details of revision	22/07/2025 revalidated, module LO’s reworded not changed, updated template, derogation removed
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