Module specification

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Module Code	ENG5AA
Module Title	Analytical Control Techniques
Level	5
Credit value	20
Faculty	FAST
HECoS Code	100403
Cost Code	GAME

Programmes in which module to be offered

Programme title	Is the module core or option for this programme
BEng (Hons) Production Engineering	Core
BEng (Hons) Industrial Engineering Design (Mechanical)	Core
BEng(Hons) Industrial Engineering Design (Electrical & Electronic)	Core
BEng (Hons) Low Carbon Energy, Efficiency and Sustainability	Core
FdEng Industrial Engineering (Mechanical) FdEng Industrial Engineering (Electrical and Automation) FdEng Industrial Engineering (Manufacturing and Production)	Core

Pre-requisites

None

Breakdown of module hours

Learning and teaching hours	30 hrs
Placement tutor support	0 hrs
Supervised learning e.g. practical classes, workshops	0 hrs
Project supervision (level 6 projects and dissertation modules only)	0 hrs
Total active learning and teaching hours	**30** hrs
Placement / work based learning	0 hrs
Guided independent study	170 hrs
Module duration (total hours)	200 hrs

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Initial approval date	11/09/19
With effect from date	11/09/19
Date and details of revision	30/01/20 Admin update of derogation 12/8/20 Temporary change to assessment for 2020/21 post Covid, and addition to FdEng programme as option Oct 22 minor modification to LO wording through the revalidation and template update Sept 22 addition of FdEng programmes
Version number	5

Module aims

This module is intended to develop concepts of mathematical modelling in the area of control engineering. It will build on previously established mathematical and computer modelling skills and apply analytical methods to the design and implementation of control system solutions

Module Learning Outcomes - at the end of this module, students will be able to:

1	Solve second- order differential equation. Understand and apply methods for treating coupled sets ordinary differential equations;
2	Develop solutions for partial differential equations. Use Laplace transform tables to solve initial value problems for ordinary differential equations;
3	Determine Fourier series for some basic periodic functions and demonstrate the ability to interpret solutions and draw conclusions from them;
4	Apply IT software which supports engineering applications (such as spreadsheets, MATLAB etc.).

In addition to the module learning outcomes, students will also cover the following accreditation of higher education programme (AHEP) fourth edition learning outcomes: C1, C2 & C3 for BEng degree apprenticeship programmes and F1, F2 & F3 for FdEng programmes.

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 one - a 2-hour examination relating to the theoretical and mathematical content contained within the specified outcomes.

Assessment two - a series of tasks, involving computer simulations relating to control engineering problems. Examples of assessments are:

- Sketch the graph of a given function and determine the Fourier series up to and including the certain harmonics by using maths, use MATLAB to confirm the solution;
- define a PID controller in MATLAB using a transfer function, for given transfer function design the step response of the system;

Assessment number	Learning Outcomes to be met	Type of assessment	Weighting (%)
1	1,2,3	Examination	50
2	4	Coursework	50

Derogations

A derogation from regulations has been approved for this module which means that whilst the pass mark is 40% overall, each element of assessment (where there is more than one assessment) requires a minimum mark of 30%.

Learning and Teaching Strategies

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

The tutorials will be used for students to practice problem solving to reinforce the lecture material and to provide individual attention where needed.

Indicative Syllabus Outline

Define and Apply Fourier Series: Full-range and half-range series. Even and odd functions. Coefficients in exponential form of complex numbers. Elementary properties. Numerical harmonic analysis. Apply Complex Numbers to Engineering Applications: Cauchy-Riemann equations. Conformal mappings, bilinear mappings. Impedance and admittance loci. Joukowski transformation. Contour integration, residues.

Laplace Transforms: The (one-sided) Laplace transform and its existence, standard functions and use of look-up tables. Use of Laplace transforms in solving simple ODEs with constant coefficients and given boundary conditions. The solution of slightly more complicated ordinary differential equations with given initial or boundary conditions - constant coefficient equations, simultaneous equations, some equations with non-constant coefficients, equations with discontinuous forcing terms.

Solve Partial Differential Equations: Method of separation of variables. Laplace, wave, heat conduction and Schrodinger equations. Initial and boundary value problems. Application of Fourier series to the solution of PDEs.

Linear Algebra: Matrices and their properties, manipulation and applications, involving determinants, inverses, Gaussian elimination, eigenvalues and eigenvectors. Applications to systems of first order differential equations (control theory). Vector Analysis. Scalar and vector fields. Line integrals and gradient. Double integrals, repeated integrals, surface integrals. Grad, div, curl. Stoke's and Gauss's theorems.

Software: mathematical modelling software to support other elements of this module, emphasising potential as an analytical tool.

Indicative Bibliography:

Please note the essential reads and other indicative reading are subject to annual review and update. Please *ensure correct referencing format is being followed as per University Harvard Referencing Guidance.*

Essential Reads

D. Jordan and P. Smith, *Mathematical Techniques: An Introduction for the Engineering, Physical, and Mathematical Sciences*, 4th ed. Oxford: Oxford University Press, 2008.

Other indicative reading

D.M. Etter, *Engineering problem solving with MATLAB*, 3rd ed. London: Printice Hall, 2007.

S. Attaway, *Matlab: A Practical Introduction to Programming and Problem Solving,* 4th ed. Oxford: Butterworth-Heinemann, 2017.

R. D. Bishop and R.C. Dorf, *Modern Control Systems*, 13th Global ed. Harlow: Pearson Education Ltd., 2017.

G. James, *Modern Engineering Mathematics*. 5th ed. Harlow: Pearson, 2015.

Employability skills – the Glyndŵr Graduate

Each module and programme is designed to cover core Glyndŵr Graduate Attributes with the aim that each Graduate will leave Glyndŵr having achieved key employability skills as part of their study. The following attributes will be covered within this module either through the content or as part of the assessment. The programme is designed to cover all attributes and each module may cover different areas.

Core Attributes

Engaged
Enterprising
Creative
Ethical

Key Attitudes

Commitment
Curiosity
Resilience
Confidence
Adaptability

Practical Skillsets

Digital Fluency
Organisation
Leadership and Team working
Critical Thinking
Emotional Intelligence
Communication