Wrexham glyndŵr UNIVERSITY

MODULE SPECIFICATION

Module Title:	**Avionics, Flight Dynamics and Control**	**Level :**	5	**Credit Value:**	20

Module code:	ENG547	**Is this a new module?**	No	**Code of module being replaced**:	

Cost Centre(s):	GAME	**JACS3 code**:	H430

Trimester(s) in which to be offered:	1, 2	**With effect from:**	September 17

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

Scheduled learning and teaching hours	60 hrs
Guided independent study	140 hrs
Placement	0 hrs
Module duration (total hours)	200 hrs

Programme(s) in which to be offered	Core	Option
BEng (Hons) Aeronautical and Mechanical Engineering	✓	☐

Pre-requisites
None

Office use only
Initial approval: February 17
APSC approval of modification: Version: 1
Have any derogations received Academic Board approval? Yes √ No ☐ N/A ☐
If new module, remove previous module spec from directory? Yes ☐ No ☐

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Module Aims
1. To develop an understanding of the principles of flight dynamics, aircraft motion measurement and control and sensors and actuator for aircraft control and guidance; 2. 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 system design implementation, particularly to aircraft control.

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	Understand flight dynamics and select the appropriate avionics sensor to measure the corresponding motion variable	KS5	
2	Analyse the functional structure of avionics systems within a modern aircraft and to define the performance of a component sub-system	KS5	KS6
3	Understand and use correct mathematical techniques to analyse control systems and their application to aircraft systems	KS3	KS6
4	Design and/or modify a control system to meet a specified performance in the time domain using analytic, graphical, empirical and computer methods	KS3	KS6
5	Design and/or modify a control system to meet a specified performance in the frequency domain using analytic, graphical, empirical and computer methods	KS3	KS6

Transferable skills and other attributes

1. Apply technology;
2. Relate theory to applications;
3. Problem solving;
4. Mathematical applications

Derogations

A derogation from regulations has been approved for this programme 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%.

Assessment:

Assessment One: is by means of a report of research, design and problem solving tasks covering outcomes 1 and 2.

Assessment Two: is by means of an examination covering outcomes 3 to 5. It is an unseen time-constrained examination.

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

Learning and Teaching Strategies:

The module will be delivered by a set of structured lectures backed up by tutorials, practical and computer-based Laboratory work and assignments, including use of videos. Approximately 30% of module time will be spent on practical investigations and will include the use of computer simulation software.

Syllabus outline:

Principles of Flight Instruments: altimeter, VSI, air speed indicator, Mach number, Compressibility, density errors, IAS, TAS. Attitude Indicator, Direction Indicator, Radio Magnetic Indicator (RMI), Magnetic variation and deviation, Turn Coordinator.

Sensors and Actuator: static pressure, pitot pressure, pitot tube, air data computer, gyroscopes, accelerometers, electrical actuators, hydraulic actuator

Flight Dynamics Principles: Aerodynamic forces, lift and drag, control surfaces, aircraft handling and flying qualities, aircraft stability; Aircraft modelling for control, Longitudinal Dynamics, Lateral Dynamics.

Elements of Flight Control Systems: sensors, actuators and control laws; stability augmentation, attitude control and navigation and guidance.

Navigation and Guidance: Inertial Navigation, terrestrial radio navigation (NDB, VOR,

DME, ILS, LORAN), satellite radio navigation (GPS), multisensor navigation (Doppler/INS, GPS/INS).

Modelling and Analytical Techniques: System models of Aero/Mech systems; open and closed loop systems; similarities of models from different physical 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, quarter decrement and continuous cycling approaches; variations in system response for controller settings.

Frequency Domain Analysis: Bode 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 the above.

Bibliography:

Essential reading

Collinson R.P.G. (2013) Introduction to Avionics Systems, 3rd edition, Springer.

Dorf, R.C. and Bishop, R.D. (2013) Modern Control Systems, 12th edition, Pearson.

Other indicative reading

Spitzer, C.R. (2006) Digital Avionics Handbook, 2nd Edn., CRC Press.

Ogata, K. (2008) Modern Control Engineering, 5th Edn., London: Prentice-Hall.

Attaway, S. (2011) Matlab: A Practical Introduction to Programming and Problem Solving, 2nd Edn., Butterworth-Heinemann.