Unit Title	Control Engineering
Level	6
Reference No. ***(showing level)***	ENG_6_423
Credit Value	15 CAT points (1 unit = 15 points)
Student Study Hours	Contact hours: 52 Student-managed learning hours: 98
Pre-requisite learning	Principles of Control 2 Engineering Mathematical Methods 2
Co-requisites	None
Excluded combinations	None
Unit co-ordinator	Shuwo Chen
Faculty/Department	ESBE / Engineering Design
Short Description	The unit will build on the unit *Principles of Control* where the student will have studied methods to model and analyse the dynamics of continuous-time systems and to modify these dynamics via simple feedback control. This unit will introduce a range of Analogue and Digital Control methods to estimate system dynamics and to improve system stability, servo tracking and regulation of system outputs against unknown disturbances. Implementation of these methods in a laboratory will closely support the theory. The application oriented parts of the unit will involve members of the teaching team from all the three degrees and use case studies and labwork relating specifically to the individual disciplines.
Aims	This unit's aims are as follows - to develop the student's knowledge and understanding of the theory and practise of engineering control systems - to introduce the student to some advanced analytical techniques used in the design of control systems
Learning Outcomes	**Knowledge and Understanding** On successful completion of the unit, students should be able to: 1. Model and analyse the stability, frequency and time behaviour of continuous-time and discrete-time dynamical systems and know how to experimentally identify their transfer functions and difference equations. 2. Map continuous-time descriptions to discrete-time equivalents and apply corresponding analysis techniques to discrete-time dynamical systems. 3. Design feedback control systems for both regulation and tracking requirements using transfer function, state-space and difference equation descriptions of the underlying system. 4. Deal with problems caused by modelling errors due to plant uncertainty, parameter variation, stochastic disturbances and hardware implementation issues. 5. Perform case studies of the analysis and design methods with the CAD packages MATLAB and CODAS and implement real-time PC-based control of servomechanisms and pilot process plant. **Transferable Skills** the following general and engineering skills are exercised to varying extents in the unit: - ability to use a variety of techniques for finding solutions to problems - effective management of self-study time with respect to maintaining log books of data gained from practical laboratory measurements, and writing reports to meet deadlines.
Teaching and learning pattern	Teaching is by 24 hours of lectures (2 hours/week for 12 weeks); 20 hours of laboratory work (2 hours/week for 10 weeks); and 8 hours of tutorials (2 hours/week in weeks 11, 12 and 13). The use of MATLAB and CODAS toolboxes is integrated with the laboratory investigations to analyse system behaviour and to design and simulate control systems. The workstations include analogue servomechanisms on which PD

	control and system identification is performed, digital servomechanisms on which PC based PID control, pole-placement control, and parameter estimation is performed. Level control, temperature control, and PL control workstations. New process rigs will be added to these. Demonstration of industry standard PL and PID controllers will be given.
Indicative content	*Continuous-time Control* : - PID control of second order systems. Ziegler-Nichols Tuning rules for PID controllers. - Performance of tracking systems to step, ramp and parabolic inputs. - Analysis and design of feedback systems using the root locus method. - Frequency response methods for the analysis of systems. Experimental identification of system Transfer Function from Bode diagrams. Determination of system stability from Bode plots. Gain and phase margins. Design of control systems using frequency response methods. - Representation and analysis of systems using state-space methods. Some useful continuous-time canonical state space descriptions (Controller and Observer canonical forms). State controllability and observability. - State feedback pole placement controller. - State Observer and the combined pole-placement/state observer system. *Digital Control* : Sampling and mapping of the s plane to the z-plane, z transforms and the transformation of underlying continuous-time dynamical systems to discrete time equivalents. Transfer functions, difference equations and state variable descriptions of discrete-time systems. - Digital PID control and Pole-Assignment Control. *Process Control*: Extension of difference equations to include transportation delays, stochastic disturbances and offsets. Minimum Variance and Pole-placement regulators. System identification (Parameter estimation with recursive Least Squares).
Assessment ***Elements & weightings***	One three hour written examination at the end of the unit carrying 80% of the mark One formal report based on design work done in the laboratory carrying 20% of the mark.
Indicative Sources ***(Reading lists)***	Main text for continuous-time control: - Stefani R.T., Shahian B., Savant C.J., Hostetter G.H., *Design of Feedback Control Systems*, 4th Edition, Oxford University Press, 2002. Other supporting texts: - Gene H. Hostetter, Clement J. Savant, JR, and Raymond T. Stefani, *Design of Feedback Control Systems*, Holt, Rinehart and Winston, Inc. - Gajic, Z., *Modern Control Systems Engineering*, Prentice-Hall, 2002. - Phillips C.L., Harbor R.D., *Feedback Control Systems*, Prentice-Hall. - Warwick, W., *An Introduction to Control Systems*, World Scientific. - Gene F. Franklin, Powell David J., Emami-Naeini Abbas, *Feedback Control of Dynamic Systems* 3rd Ed, Addison Wesley. Main text for digital control: - - Phillips, C.L. & Nagle, H.T. *Digital Control System Analysis and Design*, 2nd Ed, Prentice-Hall Other supporting texts: - Franklin, G.F. & Powell, J.D., *Digital Control of Dynamic Systems*, 3rd Ed, Addison-Wesley, 1998. - Kuo, B.C., *Digital Control Systems*, 2nd Ed, Holt Saunders - Golten, J & Verwer, A, *Control System Design and Simulation*, McGraw-Hill Also available: - CAD resources: MATLAB, Simulink. - BlackBoard and Links to Control Systems resource sites.