Taylor's University

School of Engineering
Scheme of Work

SOW/SoE/03/18

Module	Control Systems	**Module Code**	EEE61203
Module Status	Core	**Prerequisite**	EEE60303 Signal and Systems
Semester/year	Semester 5,6 / Year 3	**Date Prepared**	19 March 2018
Lecturer	Dr. Phang Swee King B.Eng (Hons 1) Ph.D.	**Credit Hours**	Three (3)
Period	Fourteen (14) weeks	**Date(s) of Revision**	N/A
Module Synopsis	This subject deals with the open loop, closed loop control systems, mathematical models of different physical systems with concept of state space analysis. Time domain and frequency domain analysis are applied to determine the stability of systems.		
Contact hours	Lectures: 2 hours/week Tutorials: 1.5 hours/week (Average) Lab: 0.6 hours/week (Average)		
Evaluation	25% Continuous Assessment 15% Test (Moderated) 60% Final Examination (Moderated)		
Learning Outcomes	On completion of this module, students will be able to: LO 1 Describe the time domain and frequency domain analysis of control systems. LO 2 Evaluate the concept of stability in control systems. LO 3 Solve electrical, mechanical and electromechanical systems. LO 4 Use block diagram reduction and signal flow graph methods to simplify complex systems. LO 5 Organise system equations into state-space format and derive the time-domain solution. LO 6 Design lead, lag and lead-lag compensated control systems.		

Assessment Methods

Distribution	(%)	LO1	LO2	LO3	LO4	LO5	LO6
Final Examination	60	✓	✓	✓	✓	✓	✓
Test	15	✓		✓	✓		
Laboratory Assessment	25	✓	✓				
Total	100						

Note: All internal assessments with feedback will be made available within 7 days after each assessment submission except Final Exam.

Learning References

1. Norman S. Nise. "Control Systems Engineering" Wiley, 6th Ed, 2011.
2. Katsuhiko Ogata. "Modern Control Engineering" Prentice-Hall, 2001.

Additional References

3. B.C. Kuo. "Automatic Control Systems" Prentice-Hall, 2002.
4. Richard C. Dorf. "Modern Control Systems" Prentice-Hall, 2000.

Program Outcomes (Electrical and Electronic Engineering)

PO1	Apply the knowledge of mathematics, science, engineering practices, innovation techniques, entrepreneurship and human factors to provide value-adding solutions to complex Electrical and Electronic Engineering challenges.
PO2	Identify, formulate, analyse and document complex engineering challenges to arrive at viable solutions and substantiated conclusions.
PO3	Conceive, Design, Implement and Operate solutions for complex engineering challenges that meet specified requirements with appropriate consideration for public health and safety, cultural, societal, environmental and economical considerations.
PO4	Conduct research and investigation into complex challenges using methods which include experiment design, analysis of data and synthesis of information to provide valid conclusions.
PO5	Create, select and apply appropriate techniques, resources, and modern engineering and IT tools, including prediction and modelling, to complex engineering activities, with an awareness of the accompanying assumptions and limitations.
PO6	Apply reasoning informed by contextual knowledge to assess societal, health, safety, legal, economical and cultural issues and the consequent responsibilities relevant to professional engineering practice.
PO7	Explain the global impact of professional engineering solutions in societal, economical and environmental contexts and demonstrate knowledge of and need for sustainable development.
PO8	Apply professional and ethical responsibilities of engineering practice.
PO9	Effectively communicate complex engineering activities, both orally and in a written form, in both technical & non-technical contexts.
PO10	Function effectively as an individual and in multidisciplinary settings with the capacity to be a leader.
PO11	Recognise the importance of lifelong learning and engaging in continuous professional development activities in accordance with technological change.
PO12	Effectively manage projects in multidisciplinary environments and apply project management tools and techniques to one's own work, as a member and leader in a team to satisfy stakeholders requirements.

Chapter	Topic	Week	Topic Outcomes (TO)	PO	LO	Delivery Methods
1	Introduction to control system terminology	Week 1	Briefing on LO POs Examples of simple control systems, open loop and closed loop control systems, effect of feedback on overall gain, stability, sensitivity, external noise, types of feedback control systems, linear time invariant and time varying, nonlinear, discrete systems.	PO1	LO1	Lecture, Tutorial
2	Mathematical models of physical systems in frequency and time domain	Week 2	Review of signal and systems, system model, system properties	PO1	LO1	Lecture, Tutorial
		Week 3	Laplace Transform review, formulation of differential equations for electrical, mechanical and electromechanical systems in frequency domain.	PO2	LO3	Lecture, Tutorial
3	Time domain analysis	Week 4	Poles, zeros, and system response, impulse response, step response, first and second-order system specifications	PO2	LO3	Lecture, Tutorial
		Week 5	Steady state response, steady state error, stability, steady state performance, transient performance	PO2	LO3	Lecture, Tutorial
4	Reduction of multiple subsystems	Week 6	Block diagrams, analysis of feedback systems, block diagram reduction, signal-flow graphs, single-flow graphs of state equations	PO1	LO4	Lecture, Tutorial
Lab 1: Application of MATLAB and Simulink in Analysis of Control System (Week 7)						
Test (Week 7)						
5	Stability	Week 8	Open loop system, closed loop system, feedback control, Routh-Hurwitz criterion, stability in controlled system	PO2	LO2	Lecture, Tutorial
Lab 2: Design and Simulation of Feedback Control Systems (Week 9)						
6	State-space analysis	Week 9	Concepts of state, state variables, state vector, input vector, output vector, development of state models for simple systems *TES briefing (15 min) – week 9	PO2	LO5	Lecture, Tutorial, Lab

7	Root locus analysis	Week 10	The root locus concept, basic properties, magnitude and angle conditions, properties and construction of the complex root loci, root sensitivity, effects of adding poles and zeros. * Fill up TES student evaluation (15 min). Students are required to bring their own devices to complete the evaluation. – week 10	PO2	LO2	Lecture, Tutorial
Lab 3: Root Locus Analysis on Systems (Week 11)						
8	Frequency domain analysis	Week 11	Frequency domain specification, correlation between time and frequency response, Bode plot, polar plot	PO1	LO1	Lecture, Tutorial, Lab
		Week 12	Nyquist plot, phase margin and gain margin, stability analysis * e-learning week	PO2	LO2	Lecture, Tutorial
Lab 4: Assessment on Control Systems Analysis (Week 13)						
9	Design & compensation technique	Week 13	Preliminary design considerations – lead, lag compensation techniques based on the frequency response approach	PO5	LO6	Lecture, Tutorial, Lab
		Week 14	Design lead - lag compensation techniques based on the frequency response approach. Review of coursework	PO5	LO6	Lecture, Tutorial

Assessment Details:

Assessment Details			
Type	Details	Learning Domain	Mark
Final Examination	Individual	Cognitive	60%
Test	Individual	Cognitive	15%
Laboratory Assessment 1,2,3	Group	Psychomotor	15%
Laboratory Assessment 4	Individual	Psychomotor	10%
Total			100%

Assessment Schedule:

		Week Nº.													
		1	2	3	4	5	6	7	8	9	10	11	12	13	14
Assessment Methods	Test							✓							
	Laboratory Assessment							✓		✓		✓		✓	
	Final Examination	During Examination period													

For all assessment, Turnitin similarity limit: 30%
Student is not allowed to transcribe directly (cut and paste) any material from another source into their submission.

PO-LO (TGC) mapping:

		Programme Outcomes (POs) and Taylor's Graduate Capabilities (TGC)											
		PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 10	PO 11	PO 12
Learning Outcomes, LOs	LO 1	✓											
	LO 2		✓										
	LO 3		✓										
	LO 4	✓											
	LO 5		✓										
	LO 6					✓							

Prepared By:

…….
Dr. Phang Swee King
Date: 19 March 2018
Email:
sweeking.phang@taylors.edu.my
Office No: 56295396
Office Location: C5A.45

Checked By:

……
Officer: Norhabibah Mohamad
Date:

Approved by:

……
Dr. Chockalingam Aravind Vaithilingam
Programme Director
Date:

Remarks:

1. The Scheme of Work is to be distributed to the students in the first week of the semester.
2. Any changes to the Scheme of Work shall be communicated (in writing) to the Program Director and the approved revised version must be communicated to the students.
3. Module coordinators may set a more stringent similarity percentage (minimum 20%) for their respective modules pertaining to student's submissions. However, it must be communicated in writing to the respective Programme Director (PD) and the approved revised version must be communicated to the students.