Subject Description Form

Subject Code	ME41001
Subject Title	Automatic Control Systems
Credit Value	3
Level	4
Pre-requisite/ Co-requisite/ Exclusion	Pre-requisite: ME31002 Linear Systems and Control
Objectives	To provide students with the fundamental knowledge of controller design for automatic control systems.
Intended Learning Outcomes	Upon completion of the subject, students will be able to: a. Formulate and solve problems relating to modeling of linear mechanical systems, analysis of system relative stabilities; determining specifications for open- or closed-loop control systems and designing controllers or compensators for mechanical systems. b. Complete a given task such as a project in system modeling or controller design by applying knowledge acquired in the subject and information obtained through literature search. c. Analyze and interpret data obtained from experiments in system modeling, stability analysis or frequency-domain analysis of mechanical systems. d. Present effectively in completing written reports of laboratory work and the given task.
Subject Synopsis/ Indicative Syllabus	***Time Domain Controller Design*** - Multi-mode controllers; Optimum controller settings; Ratio, cascade and feedforward control. ***Frequency Domain Compensator Design*** - Nyquist criterion; Phase and gain margins; Multiple design constraints; Characteristics of lead, lag and lag-lead elements; Compensator design via Bode plots. ***State-Space Representation of Dynamic Systems*** - State variables of a dynamic system; State differential equations; State-space form equations from transfer functions; Canonical forms and decoupled systems; Relationship between eigenvalues and system poles. ***Control System Analysis Using State Variable Method*** - Direct numerical solution of state equation; Solution using state transition matrix; System stability; Controllability and observability. ***Control System Design Using State Variable Method*** - State variable feedback; Direct calculation of gains by comparison with characteristic equation; Pole placement via control canonical form of state equations; Pole placement via Ackermann's formula. **Laboratory Experiment**

	There are two 2-hour laboratory sessions. Typical Experiments: 1. Twin-rotor control 2. Inverted pendulum control 3. DC servo control
Teaching/Learning Methodology	Lectures aim at providing students with an integrated knowledge required for understanding controller or compensator design, analyzing and designing state-space control systems (Outcomes a and b). Tutorials aim at enhancing the analytical skills of the students. Examples on time-domain controller design, frequency domain compensator design, state-space system representation, analysis and controller design are used to illustrate the application of integrated knowledge to solve real-world problems (Outcomes a and b). Experiments will provide the students with experience on the use of simulation tools for the computer-aided analysis and controller design of typical state-space dynamic systems. It also trains students in the measurement and instrumentation, the analysis and presentation of experimental data (Outcomes c and d).

Teaching/Learning Methodology	Outcomes			
	a	b	c	d
Lecture	√	√		
Tutorial	√	√		
Experiment			√	√

Assessment Methods in Alignment with Intended Learning Outcomes

Specific assessment methods/tasks	% weighting	Intended subject learning outcomes to be assessed (Please tick as appropriate)			
		a	b	c	d
1. Examination	50%	√	√		
2. Test	25%	√	√		
3. Assignment	15%	√	√		
4. Laboratory report	10%			√	√
Total	100%				

Explanation of the appropriateness of the assessment methods in assessing the intended learning outcomes:

Overall Assessment:

$0.50 \times$ End of Subject Examination + $0.50 \times$ Continuous Assessment

Examination is adopted to assess students on the overall understanding and the ability of applying the concepts. It is supplemented by the tests, assignments and laboratory reports which provide timely feedbacks to both lecturers and students on various topics of the syllabus.

Student Study Effort Expected	Class contact:	
	▪ Lecture	31 Hrs.
	▪ Tutorial/Laboratory	8 Hrs.
	Other student study effort:	
	▪ Course work	26 Hrs.
	▪ Self-study	45 Hrs.
	Total student study effort	110 Hrs.
Reading List and References	1. M. Gopal, Control Systems, Principles and Design, McGraw-Hill, latest edition. 2. N.S. Nise, Control Systems Engineering, Wiley, latest edition. 3. K. Ogata, Modern Control Engineering, Prentice Hall, latest edition.	

Revised July 2014