School of Professional Education and Executive Development

Subject Description Form

Subject Code	SEHS4653
Subject Title	Control System Analysis
Credit Value	3
Level	4
Medium of Instruction	English
Pre-requisite/ Co-requisite/ Exclusion	Nil
Prior Knowledge	Calculus at engineering degree level *(The above is not a pre-requisite for taking the subject but is for students' reference of the scope of basic knowledge required. It is the responsibility of students to ensure their fulfilment of the prior-knowledge required for the subject.)*
Objectives	This subject aims to introduce the principles and techniques used in the analysis and design of feedback control systems. It also provides the foundation for the later subjects in the areas of power systems, drives and control.
Intended Learning Outcomes	Upon completion of the subject, students will be able to: (a) analyse the stability, transient response and steady-state response of continuous time systems; (b) design compensators and controllers for control systems with suitable parameters; (c) create control system models by using block diagram and signal flow graph; (d) interpret experimental findings through written report.
Subject Synopsis/ Indicative Syllabus	**Introduction to Control System Analysis** Open-loop control systems; Closed-loop control systems; Effects of feedback; Examples of control systems in engineering. **Mathematical Modelling of Dynamic Systems** Electrical and electro-mechanical system components; Transducers and actuators; Laplace transform; Inverse Laplace transform; Transfer functions. **System Diagrams and Simulations**

<table>
<tr><td></td><td>Block diagram; Signal flow graphs; Mason’s formula; Simulation of continuous systems using MATLAB.

Time Domain Analysis of Linear Systems
First-order systems; Second-order systems; Transient response; Steady-state response; Routh-Hurwitz stability criterion and related analysis on system stability.

Frequency Domain Analysis of Linear Systems
Frequency response; Bode Diagrams; Gain margin and phase margin; Polar plots; Nyquist stability criterion; Nichols plots.

Compensators and PID Controllers
Compensators; PID controllers; Controller tuning.

State-space Analysis
State-space models; Transfer matrix; State transition matrix.</td></tr>
<tr><td>Teaching/ Learning Methodology</td><td>Lectures are the primary means of conveying the basic concepts and theories.

Tutorials are used to practice the related exercises and illustrate the necessary steps on formulating and solving the control system.

Laboratory sessions are designed to supplement the lecturing materials. The students are encouraged to take extra readings and to look for relevant information.</td></tr>
<tr><td>Assessment Methods in Alignment with Intended Learning Outcomes</td><td>A variety of assessment tools will be used to develop and assess students’ achievement of the subject intended learning outcomes.

<table>
<tr><th rowspan="2">Specific assessment methods/ tasks</th><th rowspan="2">% weighting</th><th colspan="4">Intended subject learning outcomes to be assessed</th></tr>
<tr><th>a</th><th>b</th><th>c</th><th>d</th></tr>
<tr><td>Continuous Assessment</td><td>40</td><td></td><td></td><td></td><td></td></tr>
<tr><td>▪ Individual Assignment</td><td>10</td><td>✓</td><td>✓</td><td>✓</td><td></td></tr>
<tr><td>▪ Group Project</td><td>10</td><td>✓</td><td>✓</td><td></td><td>✓</td></tr>
<tr><td>▪ Test</td><td>20</td><td>✓</td><td>✓</td><td>✓</td><td></td></tr>
<tr><td>Examination</td><td>60</td><td>✓</td><td>✓</td><td>✓</td><td></td></tr>
<tr><td>Total</td><td>100</td><td></td><td></td><td></td><td></td></tr>
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To pass this subject, students are required to obtain Grade D or above in <u>both</u> the Continuous Assessment and Examination.

Individual assignment requires students to apply basic principles for solving controller design and analysis problems in control systems.</td></tr>
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<tr><td></td><td colspan="2">Group project is to validly assess students' ability to interpret the results of study and experimental findings by applying theories learnt in lectures and tutorials.

Test is used to examine students' understanding of the fundamentals of the control systems, the ability to reduce and analyze block diagram and design controller to achieve stable control systems.

Examination is used to assess students' deeper understanding of system analysis of different control systems and ability to apply appropriate control theories for controller design.</td></tr>
<tr><td rowspan="6">Student Study Effort Expected</td><td>Class contact</td><td>Hours</td></tr>
<tr><td>▪ Lecture</td><td>29</td></tr>
<tr><td>▪ Tutorial</td><td>4</td></tr>
<tr><td>▪ Laboratory</td><td>6</td></tr>
<tr><td>Other student study effort</td><td></td></tr>
<tr><td>▪ Self-study</td><td>91</td></tr>
<tr><td>Total student study effort</td><td>130</td></tr>
<tr><td>Reading List and References</td><td colspan="2">Recommended Textbook

There is no prescribed textbook for this subject. Readings can include materials from the Internet and/or other materials from libraries.

References

Bakshi, U. A., & Bakshi, V. U. (2020). Control system engineering. Technical Publications.

Dorf, R. C., & Bishop, R. H. (2022). Modern control systems (14th ed.). Pearson.

Golnaraghi, F., & Kuo, B. C. (2017). Automatic control systems (10th ed.). Mc-Graw Hill Education.

Lim, D. J. (2021). Control systems engineering: Design and implementation using Arm Cortex-M microcontrollers. Independently published.

Ogata, K. (2010). Modern control engineering (5th ed.).Pearson.

Journals

Automatica, Elservier Ltd.

Foundations and Trends in Systems and Control, Now Publishers Inc.</td></tr>
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	IEEE Transactions on Automatic Control, The Institute of Electrical and Electronics Engineers *The Reading List and References are indicative. Relevant reading materials will be suggested and assigned from time-to-time when they are deemed appropriate.*