SUBJECT OUTLINE: ME412 CONTROL ENGINEERING

Programs	Mechanical Engineering (NQF Level 8)
Subject Name	Control Engineering
Subject Code	ME412
Duration	13 Teaching Weeks, 1 Examination Week, 1 Mid-Semester Week
Contact Hours	6 Hours/Week (4 Lec./1 Tut./1 Lab)
Credit Points	20
Delivery Mode	On campus
Prerequisites	EN212 – Engineering Mathematics III
Corequisites	Nil
Subject Coordinator	TBA

Synopsis

The subject introduces students to the field of automatic control, of major importance in robotics and space exploration. The included topics address theoretical and practical aspects in control engineering, like modeling and optimization of dynamic systems in Laplace mathematics, sensors and actuators, control strategies, or transient and steady-state response analysis. Of significant importance are topics related to the experimental implementation and optimization of dynamic processes.

Subject Topics

1. **Introduction, Definitions and Examples**: Mathematical challenges in control engineering. Control variable, plant, disturbance and process definitions. Speed and temperature-controlled systems. Closed loop and feedback in automatic control. Experimental capabilities in process control.

2. **Laplace Mathematics in Control Engineering**: Operational methods for linear differential equations. Complex functions, Euler's theorem, direct and inverse Laplace transforms and related theorems. Partial fraction expansion, zeros and poles in automatic control. Direct and inverse Laplace transforms for common functions.

3. **Matlab Implementation in Control Engineering**: Analytical methods for partial-fraction expansion and numerical implementations in Matlab. Numerical applications involving distinct and multiple poles. Numerical solutions for linear time-invariant differential equations.

4. **System Dynamics and Modeling in Process Control**: Control parameters. Mass and energy balance differential equations. Feedback, feedforward, cascade, interactive and ratio controls. Transfer and weighting system functions.

5. **Block Diagrams, Control Actions and Engineering Applications**: Closed loop and open loop block diagrams and transfer functions. Simple and combined control actions. Proportional-Integral-Derivative controls. Block diagram reduction. Automatic control implementation in electrical, electronic and thermo-fluidic systems.

6. **Sensors and Actuators. Transient and Steady-State System Responses. Root Locus Analysis**: Servosystems and sensors employed in control engineering. Test signals and signal analog to digital and digital to analog conversion, filtering and amplification. Transient and steady-state system responses. System stability and steady-state errors. First, second order and higher order systems. Matlab implementation for second and higher order systems. Routh's stability criterion. Root locus analysis.

Subject Learning Outcomes SLOs

On completion of this subject, students will be able to:

1. Define the characteristics of dynamic systems and evaluate experimental capabilities in control engineering.
2. Analytically evaluate governing differential equations encountered in control engineering by direct and inverse Laplace transforms. Perform partial fraction expansions, establish the position of poles and zeros in complex space and explain their significance in control engineering.
3. Employ Matlab for numerical evaluation of solutions for linear time-invariant differential equations encountered in automatic control.
4. Design and model system dynamics using mass and energy balance differential equations. Establish transfer and weighting functions for various systems involved in control engineering.
5. Built and reduce block diagrams for common systems encountered in automatic control. Evaluate typical automatic control systems encountered in electric, electronic and thermo-fluidics applications.
6. Evaluate sensors and actuators and implement them into automatic systems. Analyze transient and steady-state system responses and evaluate their stability.
7. Undertake team laboratories and communicate team-based laboratory outcomes via well structured reports.

Assessment Tasks and Weightings

To obtain a pass grade in this Subject at least 50% overall must be achieved, and at least 40% achieved in the final examination.

Students must also refer to the Subject Assessment Details.

Assessment 1–Lab/Project Concept Report: A team based or individual component report outlining individual or team formation. Team based report outlining formation and member roles, project selection, team and member action plan and a schedule of future activities to achieve the outcome. The report contributes 20% towards the final grade for the subject.

Assessment 2 – Assignments: The assignments are intended to support students achieving the learning outcomes for the Subject and will contribute 20% towards the final grade for the subject.

Assessment 3 – Class Test: The Test contributes 20% towards the final grade for the subject and evaluates progress towards achievement of learning outcomes.

Assessment 4- Final Examination (E): The individual components of final examination enable final evaluation of achievement of learning outcomes and contribute 40% towards the final grade for the subject

It is important that all students familiarise themselves with the University of Technology Assessment Guidelines including those on plagiarism in the Academic Integrity Policy at:

http://asix.unitech.ac.pg/apps/pnguot/?q=unitech/policies

Subject Mapping

Subject Learning Outcomes (SLO) are mapped to each of the PNG National Qualifications Framework (NQF), Course Learning Outcomes (CLO), Unitech Graduate Attributes (GA), Assessment Tasks (AT) and Engineers Australia (EA) Stage 1 Competencies.

SLO	SLO to NQF	SLO to CLO	SLO to GA	SLO to AT	SLO to EA Stage 1 Competencies
1	Applications, Knowledge and Skills	1, 2, 3	2, 6	2, 3, 4	1.1, 1.2, 2.1, 2.2, 2.3
2	Applications, Knowledge and Skills	2, 3	2, 6	2, 3, 4	1.1, 1.2, 2.1, 2.2, 2.3
3	Applications, Knowledge and Skills	2, 3	2, 6	2, 3, 4	1.1, 1.2, 2.1, 2.2, 2.3, 3.4
4	Applications, Knowledge and Skills	2, 3, 5,6	2, 6	2, 3, 4	1.1, 1.2, 2.1, 2.2, 2.3,2.4, 3.4
5	Applications, Knowledge and Skills	2, 3, 5	2, 6	2, 3, 4	1.1, 1.2, 2.1, 2.2, 2.4, 3.4
6	Applications, Knowledge and Skills	2, 3, 5, 7	2, 6	2, 3, 4	1.2, 1.4, 2.1, 2.2, 2.3, 3.4
7	Applications, Knowledge and Skills	2,3,4,6,7, 8.9	2, 6	1	1.2, 1.4, 2.1, 2.2, 2.3, 3.4, 3.5, 3.6

Engineers Australia Stage 1 Competencies

1. Knowledge and Skills Base	2.Engineering Application Ability	3. Professional and Personal Attributes
1.1 Comprehensive, theory based understanding of the underpinning natural and physical sciences and the engineering fundamentals applicable to the engineering discipline.	2.1 Application of established engineering methods to complex engineering problem solving.	3.1 Ethical conduct and professional accountability.
1.2 Conceptual understanding of the mathematics, numerical analysis, statistics, and computer	2.2 Fluent application of engineering techniques, tools and	3.2 Effective oral and written communicator in

and information sciences which underpin the engineering discipline.	resources.	professional and lay domains.
1.3 In-depth understanding of specialist bodies of knowledge within the engineering discipline.	2.3 Application of systematic engineering synthesis and design processes.	3.3 Creative, innovative and pro-active demeanour.
1.4 Discernment of knowledge development and research directions within the engineering discipline.	2.4 Application of systematic approaches to the conduct and management of engineering projects.	3.4 Professional use and management of information.
1.5 Knowledge of engineering design practice and contextual factors impacting the engineering discipline.		3.5 Orderly management of self and professional conduct.
1.6 Understanding of the scope, principles, norms, accountabilities and bounds of sustainable engineering practice in the specific discipline		3.6 Effective team membership and team leadership.

Unitech Graduate Attributes

Attribute	Academic Dimension	Personal Dimension	Transferable Dimension
1. Lifelong Learner	Sustained Intellectual Curiosity and Use of Feedback Reflected in Work	Sets Aspiration Goals for Personal Improvement and Career Growth	Takes responsibility for one's learning and development.
2. Critical Thinker	Use of Inference Rules in Analysing and Finding Solutions for Complex Problems	Non-Emotional, Logic and Critical Thinking Abilities in all Situations.	Ability to find solutions to problems by using logical and imaginative thinking.
3. Effective Communicator	Abilities in Articulate Discussions	Skills in Delivering high Quality written essays and oral presentations.	Ability to communicate and negotiate with others and to listen to them.
4. Cultural Modernist	Familiarity with international standards, world	Tolerance of the religions and cultures of	Ability to work in a multicultural setting and comprehension

	cultures and human rights.	others.	and tolerance of religious and cultural differences.
5. Moral Uprightness	Understand and act upon the ethical responsibilities of their actions.	Character of acting in a morally upright way in all situations.	Professional behaviour at all times.
6. Technologically Savvy	Familiarity and use of technologies appropriately.	Keeping up to date with innovations.	Character of accepting new technology and quickly adapting to it.

Graduate Statement

The mechanical engineering graduate will have the skills and ability to systematically apply the engineering knowledge in an ethical and morally responsible manner in providing practical and sustainable solutions to engineering problems while upholding a level of sensitivity to social, cultural, legal and environmental issues in society.

Mechanical Engineering Course Learning Outcome CLO

Course Learning Outcomes	Engineers Australia Stage 1 Competencies
1. Possession of a deep understanding of the sciences, math, information systems and engineering fundamentals that underpin the mechanical engineering discipline.	1.1, 1.2
2. An in-depth understanding of the body of knowledge that forms the mechanical engineering discipline.	1.2, 1.3
3. Collection, synthesis and application of information within the mechanical and related engineering disciplines.	1.4, 1.5, 2.1, 2.3, 2.4, 3.4
4. Undertaking research, analysis & evaluation of ideas and concepts within mechanical engineering.	1.3, 1.4, 1.6, 2.1, 2.3, 2.4, 3.2, 3.4
5. Applying problem solving skills to complex mechanical engineering systems and processes.	1.1, 1.2, 1.3, 1.4, 1.5, 2.1, 2.2, 2.3

6. Undertake mechanical engineering design and manage engineering projects.	1.6, 2.2, 2.4, 3.1, 3.2,3.3, 3.4, 3.5, 3.6
7. Communication via multiple media to diverse audiences, undertaking team roles, teamwork and providing team leadership.	2.4, 3.2, 3.3, 3.4, 3.5, 3.6
8. Behaving in an ethical and professional manner and respecting others.	1.6, 2.4, 3.1, 3.4, 3.5, 3.6
9. Being cognisant of the importance of sustainability and the environmental impact of engineering.	1.5, 1.6, 3.1, 3.3, 3.4

Student Workload

The total subject workload for the average student is a nominal 150 hours, based on a 15 week semester with 13 weeks of lecturing and laboratories, one mid-semester week and one examination week as per PNG National Qualification Framework.

Subject Textbook

- Ogata, K. – *Modern Control Engineering*, 4th Edition, Prentice Hall, New Jersey, 2002

References

- Bishop, R. – *Modern Control Systems Analysis and Design Using Matlab and Simulink*, Addison Wesley Publishing, New York, United States, 2004

Readings and Resources

- TecQuipment – CE 117 Process Trainer, Nottingham, United Kingdom, 2008
- TecQuipment – CE 2000 Software, Nottingham, United Kingdom, 2008

YouTube Clips

1. https://www.youtube.com/watch?v=7LZSjgZz-Qw&list=PLxn52v8fxX5l5tGzU1NAxRDkgqxK0k5UZ
2. https://www.youtube.com/watch?v=g53tqrBjIgc&list=PL5105727DD6E8DE98
3. https://www.youtube.com/watch?v=vVFDm__CdQw&list=PLA74601484F6994D8

Relevant Unitech Policies

- It is important that all students familiarise themselves with the PNGUOT Assessment Guidelines including those on plagiarism and other relevant policies. These policies are available at the PNGUOT

  website: http://asix.unitech.ac.pg/apps/pnguot/?q=unitech/policies