SUBJECT OUTLINE: ME421 INTRODUCTION TO MECHATRONICS

Programs	Mechanical Engineering (NQF Level 8)
Subject Name	Introduction to Mechatronics
Subject Code	ME421
Duration	13 Lecturing 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 interdisciplinary field of mechatronics. The included topics address theoretical and practical aspects encountered in the design, selection, analysis, and control of systems that combine mechanical elements with electronic components, including computers and microcontrollers.

Subject Topics

1. **Analog and Digital Circuits. Microprocessors and Microcontrollers**: Characteristics of analog circuits and components. Operational amplifiers. Semiconductor electronic devices in digital circuits. Digital logic circuits. Basic components in microcontrollers. Data acquisition and microcontroller interfaces. Basic concepts in control software.
2. **Sensors and Actuators**: Sensor performance and selection. Principles of operation of sensors. Actuator performance and selection for mechatronic applications.
3. **Feedback Controllers**: Transfer functions on mechatronic control. P, PI and PID control. Controller simulation in Matlab/Simulink. Effects of non-linearities in mechatronic control.
4. **State Transition Diagrams in Mechatronics**: Transition and steady-state in mechatronic control. PIC interfaces with physical systems.
5. **Software Applications in Mechatronics**: Virtual instrumentation in LabView. Development of computer – microcontroller interfaces for mechatronic applications. Open-source applications on Arduino and Raspberry Pi microcontrollers. Simulation of mechatronic systems responses in Matlab.

6. **Mechatronic System Integration**: Integration of the different components of a mechatronic system such as sensors, actuators, amplifiers, interface circuits, and control software

Subject Learning Outcomes SLOs

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

1. Evaluate analog and digital circuits, logic circuits and microcontroller interfaces. Analyze digital combinational logic circuits and generate logic circuits from a truth table specification. Draw a wiring circuit for digital devices.
2. Analyze and interpret sensor performance and select sensors for specific applications in mechatronics. Model the electro-mechanical behaviour of actuators. Explain drive methods and amplifiers for different actuators.
3. Explain differences between open- and closed-loop control systems. Derive the closed-loop transfer function of a control system. Obtain the steady-state error for first- and second-order systems under P, PI, or PID control. Explain the digital implementation of a PID controller in mechatronics. Use Matlab/Simulink to simulate closed-loop control systems. Implement and analyze the operation of state feedback controllers.
4. Apply state-transition diagrams to the operation and control of different mechatronic systems. Apply circuit design for the construction of circuits to interface PIC microcontrollers with physical systems.
5. Evaluate software for controlling mechatronic systems. Develop software for the interface between a PC and a microcontroller system. Apply modeling techniques to develop a dynamic model of a mechatronic system. Apply Matlab to simulate the response of mechatronic systems.
6. Design and evaluate the integration of the different components in mechatronic systems such as sensors, actuators, amplifiers, interface circuits, and control software
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	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	1, 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	2, 6	2, 3, 4	1.1, 1.2, 2.1, 2.2, 2.4, 3.4
5	Applications, Knowledge and Skills	1, 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, 6,8, 9	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	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	2.1 Application of established engineering methods	3.1 Ethical conduct and professional

physical sciences and the engineering fundamentals applicable to the engineering discipline.	to complex engineering problem solving.	accountability.
1.2 Conceptual understanding of the mathematics, numerical analysis, statistics, and computer and information sciences which underpin the engineering discipline.	2.2 Fluent application of engineering techniques, tools and resources.	3.2 Effective oral and written communicator in 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	Abilities in Articulate	Skills in Delivering high	Ability to communicate and negotiate with

Communicator	Discussions	Quality written essays and oral presentations.	others and to listen to them.
4. Cultural Modernist	Familiarity with international standards, world cultures and human rights.	Tolerance of the religions and cultures of others.	Ability to work in a multicultural setting and comprehension 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

- Jouaneh, M. - *Fundamentals of Mechatronics*, Cengage Learning, Stamford, Connecticut, United States, 2013

References

- Alciatore, D., Histand, M. – *Introduction to Mechatronics and Measurement Systems*, 4th Edition, McGraw Hill, New York, 2012

Readings and Resources

- TecQuipment – CE 110 Servo Trainer, Nottingham, United Kingdom, 2008
- TecQuipment – CE 2000 Software, Nottingham, United Kingdom, 2008

YouTube Clips

1. **https://www.youtube.com/watch?v=6THmFjnmvVY&list=PLbjTnj-t5GklbeqS8OMMJBrTl3DdeNn3t**
2. **https://www.youtube.com/watch?v=qaIDDp5V3ek&list=PL_uaeekrhGzJMZTb5etIdXasVO9-WVPVH**
3. **https://www.youtube.com/watch?v=FTrg8gcB84M&list=PLtuwVtW88fOeTFS_szBWif0Mcc0lfNWaz**

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