BEng (Hons) Mechatronics - E441

1. Objectives

The Mechatronics course combines mechanical, electrical/electronic and computer modules in an attempt to demonstrate the close integration of these disciplines in product design. The Programme offers both theory and laboratory work designed to enable the students to understand the principles underlying the application of intelligent controllers in the control of machine components. The knowledge and skills gained will be useful to deal with a broad range of engineering products such as robotics, automated production systems, consumer goods and so on. The scheme of study also offers adequate background for further studies/research at graduate level and beyond both locally and abroad.

2. General Entry Requirements

As per General Entry Requirements for admission to the University for Undergraduate Degrees.

3. Programme Requirements

2 GCE ‘A’ Level Passes in Mathematics and one of the following subjects: Physics, Physical Science, Engineering Science, Physics with Chemistry, Design & Technology (Technology).

4. (i) Minimum Requirements for Degree Award – 133 Credits

- For the degree award all core modules prescribed by the Department must be completed.
- Vacation Training & Industrial training must be completed satisfactorily for the award of the degree.

(ii) Minimum Requirements for Diploma Award

A student may opt for a Diploma in Mechatronics provided s/he satisfies the following minimum requirements.

<table>
<thead>
<tr>
<th>MODULES</th>
<th>CREDITS</th>
</tr>
</thead>
<tbody>
<tr>
<td>Modules from Levels 1 &amp; 2</td>
<td>54</td>
</tr>
<tr>
<td>Diploma Project</td>
<td>6</td>
</tr>
<tr>
<td><strong>TOTAL</strong></td>
<td><strong>60</strong></td>
</tr>
</tbody>
</table>

The Diploma project would normally be of 8 weeks duration for an input of at least 90 hours.

5. Programme Duration:

<table>
<thead>
<tr>
<th></th>
<th>Normal</th>
<th>Maximum</th>
</tr>
</thead>
<tbody>
<tr>
<td>Degree</td>
<td>4 years</td>
<td>7 years</td>
</tr>
</tbody>
</table>

6. Credits per Year: Minimum 18, Maximum 48 subject to Regulation 5 above.

7. Assessment

Assessment will be based on a written examination of 2 to 3-hour duration (normally a paper of 2 hour duration for modules carrying less or equal to 3.5 credits and 3 hour paper for modules carrying four-six credits) and on continuous assessment done during the semester or year.

Written examinations for all modules, whether taught in semester 1 or in semester 2 or both, will be carried out at the end of the academic year (unless otherwise stated).
The continuous assessment will count for 10-40% of the overall percentage mark of the module(s), except for a Programme where the structure makes for other specific provision(s). Continuous assessment may be based on laboratory work, seminars and/or assignments and should include at least 1 class test.

There will be a compulsory class test for all modules taught in semester 1 at the end of semester 1 of the given academic year unless stated otherwise in the Programme Structure.

A minimum of at least 30% should be attained in each of continuous assessment and written examination, with an overall total of 40% for a candidate to pass a module.

Special examinations (e.g. class tests) will be arranged at the end of semester 1 or semester 2 for exchange students who have registered only for one semester. In case of yearly modules, credits will be assigned on a pro-rata basis.

8. Programme Plan – BEng (Hons) Mechatronics

<table>
<thead>
<tr>
<th>YEAR/LEVEL 1</th>
<th>Code</th>
<th>Module Name</th>
<th>Hrs/Wk</th>
<th>Credits</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>CORE</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>MECH 1001Y(1)</td>
<td>Mechanics of Materials &amp; Machines I</td>
<td>2+1</td>
<td>5</td>
</tr>
<tr>
<td></td>
<td>MECH 1003Y(1)</td>
<td>Engineering Graphics</td>
<td>2+2</td>
<td>6</td>
</tr>
<tr>
<td></td>
<td>CSE 1010e(1)</td>
<td>Introduction to Information Technology</td>
<td>O.E.</td>
<td>3</td>
</tr>
<tr>
<td></td>
<td>COMS 1010(1)</td>
<td>Communication Skills</td>
<td>D.E.</td>
<td>3</td>
</tr>
<tr>
<td></td>
<td>MATHS 1111(1)</td>
<td>Mathematics 1</td>
<td>D.E.</td>
<td>3</td>
</tr>
<tr>
<td></td>
<td>MATHS 1211(1)</td>
<td>Mathematics 2</td>
<td>D.E.</td>
<td>3</td>
</tr>
<tr>
<td></td>
<td>ELEC 1033Y(1)</td>
<td>Electrical Technology</td>
<td>3+1</td>
<td>7</td>
</tr>
<tr>
<td></td>
<td>ELEC 1031Y(1)</td>
<td>Electronics</td>
<td>2+1</td>
<td>5</td>
</tr>
<tr>
<td></td>
<td>ELEC 1032Y(1)</td>
<td>Basics of Computer Programming</td>
<td>1+2</td>
<td>4</td>
</tr>
<tr>
<td></td>
<td>MECH 1000</td>
<td>Vacation Training*</td>
<td>-</td>
<td>0 (I or S)</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>YEAR/LEVEL 2</th>
<th>Code</th>
<th>Module Name</th>
<th>Hrs/Wk</th>
<th>Credits</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>CORE</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>MECH 2002Y(3)</td>
<td>Mechanics of Materials &amp; Machines II</td>
<td>2+1</td>
<td>5</td>
</tr>
<tr>
<td></td>
<td>MECH 2005Y(1)</td>
<td>Thermofluids</td>
<td>2+1</td>
<td>5</td>
</tr>
<tr>
<td></td>
<td>MECH 2006Y(3)</td>
<td>Mechanical Processing of Materials</td>
<td>3+1</td>
<td>7</td>
</tr>
<tr>
<td></td>
<td>ELEC 2001Y(3)</td>
<td>Analytical Techniques</td>
<td>3+0</td>
<td>6</td>
</tr>
<tr>
<td></td>
<td>ELEC 3001Y(5)</td>
<td>Microprocessors</td>
<td>2+2</td>
<td>6</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>SEMESTER CORE MODULES</th>
</tr>
</thead>
<tbody>
<tr>
<td>MECH 2019(3)</td>
</tr>
<tr>
<td>ELEC 2034(3)</td>
</tr>
<tr>
<td>ELEC 2032(3)</td>
</tr>
<tr>
<td>ELEC 2033(3)</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>YEAR/LEVEL 3</th>
<th>Code</th>
<th>Module Name</th>
<th>Hrs/Wk</th>
<th>Credits</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>MECH 3003Y(5)</td>
<td>Drives and Controls</td>
<td>3+1</td>
<td>7</td>
</tr>
</tbody>
</table>
### SEMESTER 1 CORE MODULES

<table>
<thead>
<tr>
<th>Code</th>
<th>Module Name</th>
<th>Hrs/Wk</th>
<th>Credits</th>
</tr>
</thead>
<tbody>
<tr>
<td>MECH 3062(5)</td>
<td>Engineering Management 1</td>
<td>3+0</td>
<td>3</td>
</tr>
<tr>
<td>MECH 3060(5)</td>
<td>Factory Automation</td>
<td>3+0</td>
<td>3</td>
</tr>
<tr>
<td>MECH 3064(5)</td>
<td>Engineering Design*</td>
<td>1+2</td>
<td>2</td>
</tr>
<tr>
<td>ELEC 3031(5)</td>
<td>Power Electronic Devices &amp; Converters</td>
<td>3+1</td>
<td>3.5</td>
</tr>
<tr>
<td>ELEC 3032(5)</td>
<td>Control Engineering 1</td>
<td>3+0</td>
<td>3</td>
</tr>
</tbody>
</table>

#### SEMESTER 2

MECH 3000 Industrial Training will be done in Semester 2 of Level 3

* To be assessed by continuous assessment only

### YEAR/LEVEL 4

<table>
<thead>
<tr>
<th>Code</th>
<th>Module Name</th>
<th>Hrs/Wk</th>
<th>Credits</th>
</tr>
</thead>
<tbody>
<tr>
<td>MECH 4000Y(5)</td>
<td>Project</td>
<td>-</td>
<td>12</td>
</tr>
<tr>
<td>MECH 4007Y(5)</td>
<td>Robotics &amp; Machine Intelligence</td>
<td>2+0</td>
<td>4</td>
</tr>
<tr>
<td>ELEC 4031Y(5)</td>
<td>Measurement &amp; Control</td>
<td>2+0</td>
<td>4</td>
</tr>
<tr>
<td>ELEC 4012Y(5)</td>
<td>Digital Signal Processing</td>
<td>2+0</td>
<td>4</td>
</tr>
</tbody>
</table>

### SEMESTER 2 CORE MODULE

MECH 4205(5) | Engineering Management II 3+0 3

### ELECTIVES

**CHOOSE TWO, ONE FROM EACH DEPT**

#### Mechanical

<table>
<thead>
<tr>
<th>Code</th>
<th>Module Name</th>
<th>Hrs/Wk</th>
<th>Credits</th>
</tr>
</thead>
<tbody>
<tr>
<td>MECH 4003(5)</td>
<td>Reliability &amp; Safety Engineering</td>
<td>3+0</td>
<td>3</td>
</tr>
<tr>
<td>MECH 4008(5)</td>
<td>Automotive Electronics Systems</td>
<td>3+0</td>
<td>3</td>
</tr>
</tbody>
</table>

#### Electrical

<table>
<thead>
<tr>
<th>Code</th>
<th>Module Name</th>
<th>Hrs/Wk</th>
<th>Credits</th>
</tr>
</thead>
<tbody>
<tr>
<td>ELEC 4002Y(5)</td>
<td>Power Electronic Drives</td>
<td>2+0</td>
<td>4</td>
</tr>
<tr>
<td>ELEC 4238(5)</td>
<td>Power Systems</td>
<td>3+0</td>
<td>3</td>
</tr>
<tr>
<td>ELEC 4239(5)</td>
<td>Control Engineering 2</td>
<td>3+0</td>
<td>3</td>
</tr>
</tbody>
</table>

### 9. Outline Syllabus

This outline syllabus is not prescriptive and is intended to serve as a guide only.

Note: Pre-requirement (PQ), Pre-requisite (PR).

**CSE 1010e(1) - INTRODUCTION TO INFORMATION TECHNOLOGY**

IT and Computers; Stepping in the Computer; Input and Output Devices; Secondary Storage; Programming; Systems Software; Applications Software; Systems Development; Computer Networks; The internet; Computer Security; Software Utilities; Issues and Trends in IT.

**COMS 1010(1) - COMMUNICATION SKILLS**

Writing skills, non-verbal communication, modes of speech delivery and presentation aids, speeches, perception and listening skills, business and technical writing.

**ELEC 1031Y(1) - ELECTRONICS**

Semiconductors, PN Junctions, Diode Circuits, Operational Amplifiers, BJT Physics and Electrical Characteristics, BJT Large Signal Model and Analysis, BJT Amplifier, BJT Switch, JFET, MOSFET, Boolean Variables, Logic Gates, Logic Functions, Boolean Algebra, Implementation of Combinatorial Logic
Circuits, Minimization of Boolean Expressions, Sequential Logic Circuits, Flip-Flops, Digital Arithmetic, Counters, Decoders, Encoders, Multiplexers, Demultiplexers.

**ELEC 1032Y(1) - BASICS OF COMPUTER PROGRAMMING**
Introductory concepts, C fundamentals, Operators and Expressions, Data Input and Output, Flowcharts and Pseudocodes, Control Statements, Functions, Arrays, Pointers, Data files, Structures.

**ELEC 1033Y(1) - ELECTRICAL TECHNOLOGY**

**ELEC 2001Y(3) - ANALYTICAL TECHNIQUES (PQ: MATHS 1211(1))**
Laplace Transforms: Introduction to transforms and operators, Laplace transforms of basic functions, unit step function, transforms of 1st and 2nd derivatives, application to electrical circuits, transfer functions, inverse Laplace transforms, derivation using partial fractions, Direct (s-domain) analysis of electrical circuits, interpolation of s-domain functions, system poles and their effect on system response, initial and final value theorems, transforms of piecewise continuous functions; Fourier Transforms; Fourier Series; Matrix solution of simultaneous linear equations, row reduction methods, Gaussian and Gauss Jordan elimination, consistency of simultaneous linear equations, transpose and inverse of a matrix, use of inverse to solve simultaneous linear equations, determinants, properties of eigenvectors, diagonalisation, couples linear systems; Generating functions: Recurrence relations, Proof using mathematical induction; Probability and statistics: Permutations and combinations, random events and assignment of probability, axioms of probability, Venn diagrams, independence, conditional probability and Baye’s rule, Bernoulli trials, discrete and continuous random variables, Probability density (PDF) and cumulative distribution (CDF) functions, mean and variance, uniform, Gaussian and Poisson PDFs, The Central Limit Theorem, Estimation and Hypothesis testing, Linear regression and correlation, Examples: SNR of a PCM signal, bit error rate for binary data with Gaussian noise.

**ELEC 2034(3) - SIGNALS AND SYSTEMS**

**ELEC 2032(3) - ELECTROMECHANICAL SYSTEMS I (PQ: ELEC 1033Y(1))**

**ELEC 2033(3) - ELECTRICAL ENERGY SYSTEMS**

**ELEC 3001Y(5) - MICROPROCESSORS**

ELEC 3031(5) - POWER ELECTRONIC DEVICES AND CONVERTERS
Characteristics of Power Semiconductor devices, Losses and Thermal flow models in switching devices, thermal design, switching aid and snubber circuits, Switch Mode De-de Converters: Buck, Boost, Buck-boost and bridge topologies, Continuous and Discontinuous Modes of Operation, Closed loop control of dc-de converters. Introduction to controlled rectification. Gate drive circuit design: Transformer and opto-isolated drive circuits, Single phase dc to ac inverters. Dc motor drive operating modes; Control of dc drives using switch mode power converters.

ELEC 3032(5) - CONTROL ENGINEERING 1 (PQ: ELEC 2034(3))

ELEC 4002Y(5) - POWER ELECTRONIC DRIVES (PQ: ELEC 3031(5))
3-phase dc to ac inverter configurations, Single phase and three-phase switch mode ac to dc converter topologies; continuous and discontinuous modes of operation. Motor drive applications and selection criteria, Mechanical system requirements and torque speed characteristics, Synthesis of low frequency ac voltages for motor drives, Inverter based Induction motor adjustable speed drives, Speed control using 3-phase ac voltage controllers, Single phase thyristor-based ac voltage controllers, Power Quality issues and Uninterruptible Power Supply Systems.

ELEC 4012Y(5) - DIGITAL SIGNAL PROCESSING (PQ: ELEC 2034 (3))
Continuous-time to discrete-time conversion and back, discrete-time systems and definition of DSP, DTFT, filter specifications, sampling rate conversions, DFS, DFT, FFT, filter structures, IIR filter design, FIR filter design, autocorrelation and power spectral density of random signals, applications.

ELEC 4031Y(5) - MEASUREMENT AND CONTROL (PQ: ELEC 3032(5))

ELEC 4238(5) - POWER SYSTEMS (PQ: ELEC 2033(3))

ELEC 4239(5) - CONTROL ENGINEERING 2 (PQ: ELEC 3032(5))
State-Space Representation of Transfer Functions, Control Systems Analysis and Design by State-Space Methods, Multiple-Input Multiple-Output (MIMO) systems. Controllability, Observability, Design via Pole-Placement, Ackermann's Formula., Z-transform, Numerical Integration, Linear Difference Equations, Discrete Transfer Function, Sampled Data System, Analysis of Sample and Hold, Design of Sampled-Data

MATHS 1111(1) - MATHEMATICS 1

MATHS 1211(1) - MATHEMATICS 2

MECH 1001Y(1) - MECHANICS OF MATERIALS AND MACHINES 1

MECH 1003Y(1) - ENGINEERING GRAPHICS
Introduction to Drawing Office Practice, BS 308, etc; Geometrical constructions; Blending of curves; Linkages, Locus, Ellipse, cycloid, epicycloid, etc; Introduction to development (Prisms, cylinders, etc); Orthographic Projection (systems of projection); Dimensioning and Tolerancing; Sections and sectional views. Introduction to isometric projection; Standard Parts (Threading, Fasteners, etc); Assembly Drawing. Further Isometric projection, True lengths & True Shapes, Further Development & Interpenetration, Development of Truncated Parts & Transition pieces, Assembly & Working Drawings, Drawing analysis, Cams, Gearing & Gears, Piping Drawing, Welding representation, Limits, Fits and Tolerances - BS 4500, Geometrical Tolerancing, Freehand sketching & Perspective Drawing.

MECH 2002Y(3) - MECHANICS OF MATERIALS AND MACHINES 2 (PQ: MECH 1001Y(1))
Strain Energy, Complex Stress and Strain, Theories of Elastic Failure, Thick Cylinders, Torsion of Non-Circular Sections, Cams, Clutches, Gear Trains, Gyroscopes.

MECH 2005Y(1) - THERMOFLUIDS

MECH 2006Y(3) - MECHANICAL PROCESSING OF MATERIALS

MECH 2019(3) - PROJECT APPRAISAL TECHNIQUES
economics. Welfare Economics: Indifference curves, Choices for the development of society. Accounting for
decision-making: concepts, Elements of Costing methods and Techniques, Accounting ratios, applications
to engineering.

MECH 3003Y(5) - DRIVES AND CONTROL
Pneumatics & Hydraulics Systems; Standards; Generation of Pneumatic & Hydraulic Power; Design and
Implementation of Pneumatics and Hydraulics Circuits; Pneumatics and Hydraulics Components – Valves,
Actuators, etc; Design of cascade circuits and troubleshooting; Electrohydraulic & Electropneumatic
Systems and Components; Proportional Control; Systems Integration and Interfacing to PLC’s and
Microprocessors; Safety Aspects; Applications and Comparisons between Different Systems.
Demonstration. Fluidics - Wall attachment principle; Fluidic elements- applications. Programmable Logic
Controllers; Microcontrollers; PC based systems; Mini-project.

MECH 3000 - INDUSTRIAL TRAINING
The industrial attachment is for a minimum period of 20 weeks to be undertaken within a company. The
industrial training report will be assessed.

MECH 3062(5) - ENGINEERING MANAGEMENT I
Introduction to the Production and Operations Management; Decision Analysis; Capacity Planning; Process
Selection and Facility Layout; Location Planning and Analysis; Introduction to Quality; Introduction to
Inventory Management: Requirements of an effective Inventory Management System; EOQ & EBQ models,
Reorder levels, Quantity Discounts; Materials Requirement Planning; Project Management.

MECH 3064(5) - ENGINEERING DESIGN
Course Introduction, Design for Quality and Manufacturability, Manufacturing Considerations for
Material Selection, Design Problem Formulation and evaluation, Mechanical Component Design,
Communicating Engineering Design, Patents, Liability and Ethics, Design Project Presentation.

MECH 3060 (5) - FACTORY AUTOMATION
Fundamentals of Manufacturing and Automation; Type of Automation Systems and Strategies; Design for
Automation; Line Balancing; Automated Assembly Lines; Automated Materials Handling and Storage;
Automated Inspection; Numerical Control, NC Part Programming; Introduction to CAD/CAM; Introduction
to CIM; Group Technology; Flexible Manufacturing Systems.

MECH 4000Y(5) - PROJECT
Project in Mechatronics and Related Areas.

MECH 4003Y(5) - RELIABILITY & SAFETY ENGINEERING
Reliability: Definition of reliability, failure determination and measures; Failure frequency distributions;
Graphical analysis of item failure data, Trend analysis, Reliability and Availability Assessment of systems;
Failure Mode Effect & Criticality Analysis (FMECA); Fault Tree Analysis (FTA); Implications for
Maintenance; Industrial Case Studies.
Definition of critical maintenance terms, the basic model of the maintenance system, Maintenance
approaches, relationship between reliability and failure, common types of failure in components, safe system
of work for maintenance, Principles of preventive maintenance: definition of a plant item, maintainability
diagrams, Models for optimising the balance of preventive and corrective work, Selection of the best
maintenance procedure in the light of cost and safety factors, The Top-down Bottom-up (TDBU) approach to
the formulation of maintenance strategy, Introduction to Reliability-Centred Maintenance, its uses and
limitations, Total Productive Maintenance, Integrated Condition Based Maintenance, Machine Life cycles,
Trend Monitoring, Parameter Symptom limits, Thermal monitoring, Lubricant monitoring, Vibration
monitoring, Machine faults and frequency range of symptoms.


Relevant legislation for occupational health and safety in Mauritius.

MECH 4007Y(5) - ROBOTICS & MACHINE INTELLIGENCE
Course Overview, Importance of a knowledge of Robotics Systems for engineers; Fundamentals of Robotics & Automation; Robot characteristics; Control Systems and Components; Robot Motion Analysis and Control; Robot End Effectors; Sensors in Robotics: Internal & External sensors; Introduction to Machine Vision & Edge detection techniques; Robot Programming and Languages; Robot Cell Design and Control; Economics of Robotic Systems; Robot Applications in Manufacturing; Robot Implementation and safety requirements; Mini-project + Hands on sessions. Representation of knowledge; Knowledge based systems; Introduction to fuzzy systems and inexact reasoning; Artificial neural networks; Pattern matching; Control techniques; Expert systems design.

MECH 4008Y(5) - AUTOMOTIVE ELECTRONICS SYSTEMS
Semiconductors, Transistors, Digital circuit principles, Sensors, Actuators, Electronics Control Unit (ECU); Combustion and Ignition; Engine Fuelling; Engine and Exhaust Management; Instrumentation and Auxiliaries; Comfort, Safety and Security; Road wheel control; other electronic fault diagnosis applications.

MECH 4205(5) - ENGINEERING MANAGEMENT II (PQ: MECH 3062(5))