NATIONAL CERTIFICATE (VOCATIONAL)

SUBJECT GUIDELINES

ELECTRONIC CONTROL AND DIGITAL ELECTRONICS

NQF LEVEL 3

IMPLEMENTATION: JANUARY 2014
INTRODUCTION

A. What is Electronic Control and Digital Electronics about?

Electronic Control and Digital Electronics at Levels 2 and 3 cover the basics of electronics and are designed to introduce the field of learning. As this subject becomes increasingly embedded in electrical systems, students need to learn how Electronic Control and Digital Electronics modules receive inputs, how inputs are processed and produce outputs, the form of the output and how it affects the operation of the electrical system. It is assumed that students will have no previous electronic background.

In Levels 3 and 4, students continue with theoretical and practical implementation of the learning material. Some of the Level 2 theoretical knowledge is repeated in greater detail to further develop basic knowledge. In Level 3 students will begin to see the connections between electronic system components and the functions of the module. By Level 4 students should be able to integrate modules into a system that is operational.

B. Why is Electronic Control and Digital Electronics important in the Electrical Infrastructure Construction programme?

This subject provides an introduction to the basic theoretical and practical knowledge component of Electronic Control and Digital Electronics. The purpose of including this subject is not to produce students who are electronics or digital experts but to familiarise them with basic circuitry so that they understand electrical systems better. Electronic Control and Digital Electronics addresses the necessary trade-specific skills, knowledge, values and attitudes enabling students to understand, maintain, repair and construct basic electronic systems in practice.

C. The link between the Electronic Control and Digital Electronics Learning Outcomes and the Critical and Developmental Outcomes

This subject is outcomes-based and relates to the Critical and Developmental Outcomes. With particular reference to Electronic Control and Digital Electronics procedures, students should be able to:

- Identify and solve problems:
  Recognise situations that require action and react appropriately.

- Work effectively with others:
  Construct and test projects in groups or teams.

- Organise and manage themselves and their activities:
  Apply the correct procedures for using, storing and looking after equipment, tools, test equipment, drawings and parts.

- Collect, organise and evaluate information and take appropriate action:
  Use media centres to collect information.

- Communicate effectively:
  Use proper terms for equipment, tools, test equipment, drawings and parts.

- Use science and technology:
  Use and apply science and technology principles in both theory and practice.
• Demonstrate understanding of subject content through the application of acquired knowledge:
  Solve problems by using subject content.

D. Factors that contribute to achieving the Electronic Control and Digital Electronics Learning Outcomes

• An understanding of technical (electro-mechanical) principles
• Analytical ability
• Ability to do mathematical calculations and manipulations
• Hand skills (practical skills)
• Practical improvisation abilities.
ELECTRONIC CONTROL AND DIGITAL ELECTRONICS – LEVEL 3

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1. DURATION AND TUITION TIME

This is a one year instructional programme comprising 200 teaching and learning hours. The subject may be offered on a part-time basis provided the student meets all the assessment requirements.

2. SUBJECT LEVEL OUTCOMES AND FOCUS

SAQA QUALIFICATION ID: 50442

Exit level outcome: Explain the fundamentals of electronics and construct electronic circuits.

Associated Assessment Criteria:

- Measuring instruments are used in a structured scenario
- Elementary electronic circuits on breadboards or viro boards are constructed according to given specifications
- The binary system is used in a structured scenario
- A computer is assembled and booted according to given specifications
- The operation of simple ladder diagram logic is applied using theoretical knowledge
- Electronic circuit construction and programmable logic controllers are described using examples
- Demonstrate the practical usage of measuring instruments
- Identify, rate and explain the functioning of electronic components
- Demonstrate an ability to work within the binary system
- Demonstrate an ability to assemble and boot a computer and to troubleshoot hardware faults
- Explain how controllers sense and react to physical conditions
- Demonstrate a basic knowledge of PLCs.

3. ASSESSMENT

Information on internal and external assessment provided in this document aims to inform, assist and guide lecturers to plan the effective teaching of the subject. The Assessment Guidelines accompanying this document provide detailed information for planning and conducting internal and external assessments.

3.1 Internal assessment (50 percent)

Detailed information regarding internal assessment and moderation is outlined in the current Internal Continuous Assessment (ICASS) Guideline document provided by the Department of Higher Education and Training (DHET).

3.2 External assessment (50 percent)

A national examination is conducted annually in October or November by means of a paper(s) set and moderated externally. A practical component, the Integrated Summative Assessment Task (ISAT), will be included in the external assessment.

Detailed information regarding external assessment and moderation is outlined in the ‘National Policy on the Conduct, Administration and Management of the Assessment of the
Assessment of the National Certificate Vocational, Gazette Number 30287, dated 12 September 2007.

4. WEIGHTED VALUES OF TOPICS

<table>
<thead>
<tr>
<th>TOPICS</th>
<th>WEIGHTED VALUE</th>
<th>*TEACHING HOURS</th>
</tr>
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<tbody>
<tr>
<td>1. Fundamentals of electronics</td>
<td>40</td>
<td>44</td>
</tr>
<tr>
<td>2. Digital electronics</td>
<td>25</td>
<td>27</td>
</tr>
<tr>
<td>3. Assembling a personal computer</td>
<td>15</td>
<td>17</td>
</tr>
<tr>
<td>4. Transducers</td>
<td>10</td>
<td>11</td>
</tr>
<tr>
<td>5. Ladder logic as used in programmable logic controllers (PLCs)</td>
<td>10</td>
<td>11</td>
</tr>
<tr>
<td>TOTAL</td>
<td>100</td>
<td>110</td>
</tr>
</tbody>
</table>

*Teaching Hours refers to the minimum hours required for face to face instruction and teaching. This excludes time spent on revision, tests and internal and external examinations and assessment. The number of allocated teaching hours is influenced by the topic weighting, complexity of the subject content and the duration of the academic year.

5. CALCULATION OF FINAL MARK

Continuous assessment: Student's mark/100 x 50/1 = a mark out of 50 (a)
Examination mark: Student's mark/100 x 50/1 = a mark out of 50 (b)
Final mark: (a) + (b) = a mark out of 100

All marks are systematically processed and accurately recorded to be available as hard copy evidence for, among others, moderation, verification and reporting purposes.

6. PASS REQUIREMENTS

A student must obtain at least fifty (50) percent in ICASS and fifty (50) percent in the examination to achieve a pass in this subject.

7. SUBJECT AND LEARNING OUTCOMES

On completion of Electronic Control and Digital Electronics Level 3, the student should have covered the following topics:

- Topic 1: Fundamentals of electronics
- Topic 2: Digital electronics
- Topic 3: Assembling a personal computer
- Topic 4: Transducers
- Topic 5: Ladder logic as used in programmable logic controllers (PLCs)
Topic 1: Fundamentals of Electronics

Subject Outcome 1.1: Use electronic measuring instruments

*Range: Multimeter (digital and analogue), oscilloscope, signal and function generator.*

**Learning Outcomes:**

The student should be able to:

- Explain how to take care of the measuring instruments in the range.
- Explain how to use the measuring instruments in the range.

Subject Outcome 1.2: Explain the concept of atomic theory

**Learning Outcomes:**

The student should be able to:

- Show the distribution of electrons in different orbits or shells of an atom
  *Range but not limited to: Silicon, Germanium, Gallium and Arsenic*
- Describe the following terms with respect to atomic theory: *Valence electrons, ionize atoms, free electrons and hole.*
- Explain energy levels and energy bands
  *Range: Insulator, Semiconductor and Conductor*
- Identify the types of bonds in solids
  *Range: Ionic, Covalent and Metallic bond*
- Distinguish between donor and acceptor doping
- Explain the effect of heat on a conductor and semiconductor

Subject Outcome 1.3: Explain the characteristics and operation of semiconductor diodes

**Learning Outcomes:**

The student should be able to:

- Explain the effect of temperature on diode characteristics
- Compare the characteristic curve of various semiconductor diode materials
- Explain the operation of diodes and their applications
  *Range: Zener, varactor (varicap), tunnel diodes, Light emitting diode (LED), Liquid crystal display (LCD), seven-segment display and photo diodes.*
- Use diode specification sheets

Subject Outcome 1.4: Describe the concept of Bipolar Junction Transistors (BJT)

**Learning Outcomes:**

The student should be able to:

- Describe the biasing of bipolar junction transistors.
  *Range: Forward, saturation and cut-off*
- Calculate current gain of bipolar junction transistors in common-base, common-emitter and common-collector configuration.
- Use bipolar junction transistor specification sheets.
• Explain how a bipolar junction transistor can be used as an amplifier.
  \textit{Range: Common-base (CB), common-emitter (CE) and common-collector (CC).}

\textbf{Subject Outcome 1.5: Explain and build power supplies}

\textbf{Learning Outcomes:}

The student should be able to:

• Explain the operation of rectifier circuits.
  \textit{Range: half-wave, full-wave, centre-tap and full-wave bridge rectifier.}
• List the advantages and disadvantages of centre-tap and bridge rectifier circuits.
• Explain how filters are used in power supply circuits.
  \textit{Range: Capacitor, Inductor, Inductor-Capacitor and \pi\ filter.}
• Explain how voltage regulators are used in power supply circuits.
  \textit{Range: Zener diode shunt regulator, Transistor shunt regulator, Transistor series regulator, constant current regulator and IC voltage regulators (fixed positive and negative linear voltage regulators).}
• Build a complete DC power supply.

\textbf{Subject Outcome 1.6: Explain the characteristics, functions and use of junction fieldeffect transistors (JFETs) and metal-oxide semi-conductor field-effect transistors (MOSFETs)}

\textbf{Learning Outcomes:}

The student should be able to:

• Describe the operation and construction of junction field-effect transistors (JFETs)
• Sketch and name the electronic symbols of JFETs
• Describe the characteristics of JFETs
  \textit{Range: Drain and transfer}
• Use JFET specification sheets
• Explain the difference between field-effect transistors and bipolar junction transistors (BJT)
• Describe the construction and operation of MOSFETs
  \textit{Range: Depletion and enhancement type}
• Sketch and name the electronic symbols of MOSFETs
• Use MOSFET specification sheets
• Describe the characteristics of MOSFETs
  \textit{Range: Drain and transfer}
• List the precautions for handling MOSFETs

\textbf{Subject Outcome 1.7: Explain the characteristics and application of operational amplifiers (Op-Amps)}

\textbf{Learning Outcomes:}

The student should be able to:

• Sketch the circuit symbol of an Op-amp.
• Identify the different types of Op-amp packages.
• List the important parameters of an Op-amp.
  Range: gain, input resistance, output resistance, common mode rejection ratio, slew rate and bandwidth
• List and explain the applications of Op-amps.
  Range: Inverting amplifier, non-inverting amplifier, voltage follower, voltage summer or adder, integrators, differentiators and as an audio amplifier.

Topic 2: Digital electronics

Subject Outcome 2.1: Explain binary number systems
Learning Outcomes:
The student should be able to:
• Demonstrate ability to convert between the binary, octal, hexadecimal and decimal systems.
• Solve arithmetic operations using the binary system.
  Range: Calculations include addition, subtraction, multiplication and division.

Subject Outcome 2.2: Explain digital counters
Learning Outcomes:
The student should be able to:
• Describe the difference between an asynchronous and a synchronous counter.
• Describe the operation of a 4-bit asynchronous binary up and down counter.
• Describe the operation of an asynchronous decade counter.
• Describe the operation of a 4-bit synchronous binary up and down counter.
• Describe the operation of a synchronous decade counter.

Topic 3: Assembling a personal computer

Subject Outcome 3.1: Assemble and boot a computer
Learning Outcomes:
The student should be able to:
• Identify the components of a personal computer.
• Troubleshoot hardware faults on a computer.
• Assemble a personal computer by connecting components to the motherboard to the point that the computer is bootable.

Topic 4: Transducers

Subject Outcome 4.1: Explain how controllers sense and react to physical conditions
Learning Outcomes:
The student should be able to:
• List the requirements when selecting a transducer
• Identify and explain how instruments can be modified to act as sensors for an electronic controller.
  *Range: Resistive, capacitive, inductive, photosensitive, crystal transducers*

**Topic 5: Ladder logic as used in programmable logic controllers (PLCs)**

**Subject Outcome 5.1: Demonstrate a basic knowledge of programmable logic controllers PLCs.**

**Learning Outcomes:**

The student should be able to:

• Compare PLCs and relay systems
• Sketch the block diagram of a PLC
• Explain the function of the processor in a PLC
• Name the schematic symbols used in ladder logic diagrams
• Sketch the schematic symbols used in ladder logic diagrams
• Explain how a given simple ladder logic diagram would function
• Predict the end result of a given simple ladder logic diagram.

**8 RESOURCE NEEDS FOR THE TEACHING OF ELECTRONIC CONTROL AND DIGITAL ELECTRONICS – LEVEL 3**

**8.1 Physical resources**

Well equipped classrooms and workshops are essential for this practically orientated subject. If possible using the facilities of employers in the electrical field, for training, is preferred.

**8.2 Human resources**

• Lecturing staff must have appropriate electrical qualifications and must possess the necessary knowledge, skills and reflexive approach to ensure that students' learning is kept up to date with the latest technologies and changing trends in their specialist field.

• Continuous staff development with exposure to an industrial environment is necessary for lecturers to acquire new skills and update their existing skills where new technologies have been introduced. Lecturers are required to spend a structured and routine period annually in an industrial environment for these purposes.

• Staff development in terms of updating teaching, learning and assessment skills is required on an ongoing basis, particularly for staff coming from industry into the educational environment of an FET college.

**8.3 Other resources**

The institution should have funding available to provide the following:

• consumables required to perform practical assignments and examinations
• maintenance of physical resources
• Purchasing of new equipment.