education

Department:
Education
REPUBLIC OF SOUTH AFRICA

NATIONAL CERTIFICATES (VOCATIONAL)

SUBJECT GUIDELINES

ELECTRONICS

NQF LEVEL 2

September 2007

INTRODUCTION

A. What is Electronics?

Electronics is a field of engineering and applied physics dealing with the design and application of devices, usually electronic circuits, the operation of which depends on the flow of electrons for the generation, transmission, reception and storage of information. The information can consist of voice or music (audio signals) in a radio receiver, a picture on a television screen or numbers and other data in a computer.

Students are introduced to different electronic parts and their functions and how to care for, handle and assemble the parts to form electronic systems. Students build actual circuits and see and measure the effects that the different components have on the electrical circuits. As many electronic systems use decision-making, students are introduced to basic programmable logic controllers.

Electronics empowers students to learn about the sophistication of advance technology in telecommunications and information technology.

B. Why is Electronics important in the Information Technology and Computer Science programme?

Electronic circuits provide different functions to process information, including amplifying weak signals to a usable level; generating radio waves; extracting information, such as an audio signal from a radio wave (demodulation); controlling, for example superimposing an audio signal onto radio waves (modulation) and performing logic operations, such as the electronic processes that take place in computers.

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

Students will be able to identify and solve problems and collect, analyse, organise and critically evaluate information related to Electronics. Students will also demonstrate an understanding of the world as a set of interrelated systems by recognising problem-solving contexts do not exist in isolation.

D. Factors that contribute to achieving the Electronics Learning Outcomes

- Analytical and logical ability
- Keen powers of observation
- Ability to transfer skills from familiar to unfamiliar situations
- Meticulous nature
- Interest in computers and related topics

ELECTRONICS – LEVEL 2

CONTENTS

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.

Students with special education needs (LSEN) must be catered for in a way that eliminates barriers to learning.

2 SUBJECT LEVEL FOCUS

The student is able to explain the principles of electricity and electronics.

3 ASSESSMENT REQUIREMENTS

3.1 Internal assessment (50 percent)

3.1.1 Theoretical component

The theoretical component forms 40 percent of the internal assessment mark.

Internal assessment of the theoretical component in Electronics Level 2 takes the form of observation, class questions, group work, informal group competitions with rewards, individual discussions with students, class, topic and semester tests and internal examinations. Lecturers can observe students when marking exercises from the previous day and asking class questions.

Assignments, case studies and tests can be completed at the end of a topic. Tests and internal examinations must form part of the internal assessment.

3.1.2 Practical component

The practical component forms 60 percent of the internal assessment mark.

Practical components include applications and exercises. All practical components must be indicated in a Portfolio of Evidence (PoE).

Internal assessment of the practical component in Electronics Level 2 takes the form of assignments, practical exercises, case studies and practical examinations in a simulated business environment.

Students may complete practical exercises daily. Assignments and case studies can be completed at the end of a topic. Practical examinations can form part of internal practical assessment.

- **Some examples of practical assessments include, but are not limited to:**

  A. Presentations (lectures, demonstrations, group discussions and activities, practical work, observation, role-play, independent activity, synthesis and evaluation)

  B. Exhibitions by students

  C. Visits undertaken by students based on a structured assignment task

  D. Research

  E. Task performance in a “Structured Environment”

- **Definition of “Structured Environment”**

For the purposes of assessment, “Structured Environment” refers to a simulated workplace or workshop environment. It is advised that a practicum room is available on each campus for practical assessment.

- **Evidence in practical assessments**

All evidence pertaining to evaluation of practical work must be reflected in the students' Portfolio of Evidence (PoE). The tools and instruments constructed and used to conduct these assessments must be clear from the evidence contained in the Portfolio of Evidence (PoE).

3.1.3 Processing of internal assessment mark for the year

A year mark out of 100 is calculated by adding the marks of the theoretical component (40 percent) and the practical component (60 percent) of the internal continuous assessment (ICASS).

3.1.4 Moderation of internal assessment mark

Internal assessment is subjected to internal and external moderation procedures as set out in the *National Examinations Policy for FET College Programmes*.

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 will also be assessed.

External assessment details and procedures are set out in the *Assessment Guidelines: Electronics* (Level 2).

4 WEIGHTED VALUES OF TOPICS

TOPICS	WEIGHTED VALUE
1. Fundamentals of Electricity	15
2. Basic Electronic Theory and Concepts	10
3. Electrical Safety Standards	10
4. Use and Care of Hand-held Electrical Test Instruments	10
5. Soldering Techniques	10
6. Basic Electronic Circuits	15
7. Principles of Digital Logic	5
8. Basic Programmable Logic Controllers (PLC)	15
9. Basic Concepts of Telecommunications	10
TOTAL	**100**

5 CALCULATION OF FINAL MARK

Internal assessment mark: Student's mark/100 x 50 = a mark out of 50 (a)

Examination mark: Student's mark/100 x 50 = 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, amongst others, reporting, moderation and verification purposes.

6 PASS REQUIREMENTS

The student must obtain at least fifty (50) percent in ICASS and fifty (50) percent in the examination.

7 SUBJECT AND LEARNING OUTCOMES

On completion of Electronics Level 2, the student should have covered the following topics:

Topic 1: Fundamentals of Electricity

Topic 2: Basic Electronic Theory and Concepts

Topic 3: Electrical Safety Standards
Topic 4: Use and Care of Hand-held Electrical Test Instruments
Topic 5: Soldering Techniques
Topic 6: Basic Electronic Circuits
Topic 7: Principles of Digital Logic
Topic 8: Basic Programmable Logic Controllers (PLC)
Topic 9: Basic Concepts of Telecommunications

7.1 Topic 1: Fundamentals of Electricity

Subject Outcome 1: Explain electron theory.

Learning Outcomes:

The student should be able to:

- Explain atomic theory in terms of electrical materials.
- Explain electron flow in a conductor with reference to electron theory.
- Explain the effect of an external power source on electrons in a conductor with reference to electron theory.
- Explain the principles of basic electrical circuits in terms of a power source and load.
- Explain the basic principles of voltage and current flow in an electrical circuit in terms of electron theory.

Subject Outcome 2: Explain magnetic theory.

Learning Outcomes:

The student should be able to:

- Explain the concept of permanent magnet in terms of the molecular structure of materials.
- Explain five characteristics of magnet lines of flux in terms of magnetic theory.
- Explain the concept of an electromagnet in terms of magnetic lines of flux around a current-carrying conductor and core.
- Explain and calculate the relationship between magnetic field and current flow in terms of movement, field strength and conductor length in the magnetic field.

Subject Outcome 3: Explain the fundamentals of power generation and distribution.

Learning Outcomes:

The student should be able to:

- Explain the production of electricity with reference to pressure, heat, light, friction, magnetism and chemicals.
- Explain conversion of resources into usable energy with reference to coal, gas, nuclear, water, wind and solar energy.
- Explain the generation of direct current (DC) in terms of a single loop in a magnetic field.
- Explain and calculate the generation of single phase alternating current (AC) in terms of a single loop in a magnetic field.

Subject Outcome 4: Apply and explain electrical units and symbols.

Learning Outcomes:

The student should be able to:

- Identify and apply the electrical units and symbols in accordance with SI units.
- Explain the relationship between voltage, current and resistance in terms of Ohm's law.
- Explain the factors influencing resistance in terms of material type, length, diameter and temperature.
- Calculate the power consumed by a simple resistive electrical circuit in terms of DC theory.

Subject Outcome 5: Draw and interpret series, parallel and series-parallel DC resistive circuits and calculate variables.

Learning Outcomes:

The student should be able to:

- Draw and interpret series, parallel and series-parallel circuits according to instructions.
- Calculate and interpret resistance, voltage, current and power variances in series circuits according to instructions.
- Calculate and interpret resistance, voltage, current and power variances in parallel circuits according to instructions.
- Calculate and interpret resistance, voltage, current and power variances in series-parallel circuits according to instructions.

7.2 Topic 2: Basic Electronic Theory and Concepts

Subject Outcome 1: Draw and explain atomic and electron theory in terms of current flow.

Learning Outcomes:

The student should be able to:

- Draw and explain the structure of an atom in the context of basic electron theory.
- Explain the free electron in the context of electron theory principles.
- Explain the conduction of different types of material in the context of electron theory principles.
- Explain the bonding process between different molecule types and draw the lattice structure in the context of valence electron principles.
- Explain the process of doping intrinsic materials in terms of p-type and n-type semiconductor principles.
- Explain the effect of heat on semiconductor materials in relation to their conductivity characteristics.

Subject Outcome 2: Understand and explain the operation of basic electronic components.

Learning Outcomes:

The student should be able to:

- Explain the different types of values and symbols of resistors in relation to basic electron theory and applications.
- List and explain the different types of values and symbols of capacitors in relation to basic electron theory and applications.
- List and explain the different types of values and symbols of inductors in relation to basic electron theory and applications.
- Explain and illustrate graphically the combination effect of different basic electronic components on one circuit in relation to basic electronic theory and applications.

Subject Outcome 3: Understand the operation of a P-N diode.

Learning Outcomes:

The student should be able to:

- Describe and illustrate graphically the creation and biasing of a P-N junction in the context of semiconductor theory.
- Describe the effect of temperature on a P-N junction in the context of semiconductor theory.
- Draw and describe forward bias and reverse bias in the context of semiconductor theory.
- Identify and describe different types of specialised diodes in the context of semiconductor theory.
- Explain basic calculations carried out in the context of semiconductor theory.

Subject Outcome 4: Understand the operation and function of power supplies.

Learning Outcomes:

The student should be able to:

- Explain the operation of various rectifier techniques with the aid of graphical representations.
- Explain the operation of various half wave and full wave rectifiers with the aid of graphics.
- Explain DC power supply consisting of transformer and rectifier with the aid of graphical representations.

7.3 Topic 3: Electrical Safety Standards

Subject Outcome 1: Understand the nature of electrical safety.

Learning Outcomes:

The student should be able to:

- Discuss the dangers of electricity.
- Define electrical safety using applicable terminology.

  Range: Dead, live, restricted and/or prohibited and dangerous areas
- Explain the characteristics of electrical flow.
- Explain earthing concepts and safety practices.
- Explain electrical apparatus isolation requirements.

  Range: Isolator locked in an open position and connecting to earth

Subject Outcome 2: Understand the governance of electrical safety.

Learning Outcomes:

The student should be able to:

- Explain the statutory requirements related to electrical safety.

  Range: Occupational Health and Safety Act
- Explain workplace procedures related to electrical safety.

Subject Outcome 3: Understand first aid related to electrical incidents.

Learning Outcomes:

The student should be able to:

- Explain causes of electrical shock.
- Explain the effects of electrical shock on the body.
- Explain and demonstrate how to free the victim of an electrical shock.
- Explain and demonstrate how the treatment is given after an electrical shock.

7.4 Topic 4: Use and Care of Hand-Held Electrical Test Instruments

Subject Outcome 1: Explain theoretical knowledge of principles related to use of hand-held electrical test instruments.

Learning Outcomes:

The student should be able to:

- Explain the purpose of using and caring for hand-held electrical test instruments according to specified requirements.
- Explain Ohm's law based on the appropriate electrical units.
- Explain electrical units that pertain to the use of hand-held electrical test instruments.
- Explain and demonstrate the methods of connecting instruments to measure voltage and current in AC and DC circuits with reference to specified requirements.

Subject Outcome 2: Care for hand-held electrical test instruments.

Learning Outcomes:

The student should be able to:

- Explain and demonstrate how personal protective equipment is examined and used according to specified requirements to protect the individual.
- Explain and demonstrate how test instruments are cleaned.
- Explain and demonstrate how test instruments are examined and stored according to requirements.
- Explain and demonstrate how batteries are removed from a test instrument when stored for an extended period according to specified requirements.

- Explain and demonstrate the consequences of not caring for hand-held electrical test instruments according to specific requirements, with reference to personal and safety, impact on environment, production cost and lost time.

Subject Outcome 3: Use hand-held electrical test instruments.

Learning Outcomes:

The student should be able to:
- Select and demonstrate correct test instruments according to specified requirements.
- Explain and demonstrate how a pre-use inspection and test is carried out according to specified requirements.
- Explain and demonstrate how the test instrument is set and used to measure the required electrical unit.
- Identify and explain how to address hazards and risks when using hand-held electrical test instruments according to specified requirements.
- Explain and demonstrate how test instruments, which are unsafe or defective, are dealt with according to specified requirements.
- Explain how positive interpersonal interaction, consistent with specified requirements, promotes effective teamwork and avoids dysfunctional conflict.

7.5 Topic 5: Soldering Techniques

Subject Outcome 1: Plan the work task.

Learning Outcomes:

The student should be able to:
- Identify and select appropriate hand tools to meet the requirements of the job.

  Range: Side cutters, long nose pliers, set of jeweller's screwdrivers, wire stripper and small files
- Use appropriate hand tools safely to meet the requirements of the job according to worksite procedures.
- Identify and mark unsafe and faulty tools for repair or replacement according to set procedures.
- Select and test applicable test instrument for functionality.

Subject Outcome 2: Prepare for soldering.

Learning Outcomes:

The student should be able to:
- Inspect the work area for safe working conditions.
- Take corrective action where necessary.
- Select applicable soldering equipment as required by task.

  Range: Soldering iron (gas, electrical, battery), soldering stations and solder sucker
- Identify and use personal protective equipment as per Occupational Health and Safety Act and worksite regulations.
- Select correct soldering material as required by task.

Subject Outcome 3: Perform soldering and de-soldering.

Range: Straight wire to wire connection, solder connection to solder tag, screened cable to a connector (audio jack) and multi-core cable to a multi-pin connector

Learning Outcomes:

The student should be able to:
- Use applicable tools and equipment safely to meet the requirements of the job.
- Explain and demonstrate how connections are cleaned of dirt or oxidation using appropriate cleaning materials.
- Explain and demonstrate tinning of connections according to the manufacturer's specifications.
- Explain and demonstrate soldering connections according to set specifications or techniques.

Subject Outcome 4: Inspect the solder joint.

Learning Outcomes:

The student should be able to:

- Explain and demonstrate how to ensure that the solder joints are not dull in colour or do not have excess resin.
- Explain and demonstrate how to ensure that soldered joints do not contain solder globules or insufficient solder that will cause a poor electrical or mechanical connection.
- Explain and demonstrate how to ensure that the components or soldering substrate are not scorched by excessive heat.

Subject Outcome 5: Complete the work task.

Learning Outcomes:

The student should be able to:

- Explain and demonstrate how the work area is cleaned after completion of the task according to housekeeping standards.
- Explain and demonstrate how waste materials are disposed of according to site-specific standards and procedures.
- Provide reasons for the application of the disposal method in terms of human safety and environmental management.
- Explain and demonstrate how to take care of, maintain and store hand tools according to worksite procedures.

7.6 Topic 6: Basic Electronic Circuits

Subject Outcome 1: Plan to construct basic electronic circuits.

Learning Outcomes:

The student should be able to:

- Explain and demonstrate how a sequence of events is planned and instructions are interpreted.
- Identify and select tools and components according to the diagrams and instructions.
- Select and test applicable test equipment for functionality and safety prior to conducting the test.
- Explain and demonstrate how to prepare a work area according to worksite procedures.

Subject Outcome 2: Construct basic electronic circuits.

Learning Outcomes:

The student should be able to:

- Analyse the circuit diagram to ensure correct component layout on the board.
- Explain and demonstrate how to lay out components on the circuit board according to the circuit diagram.
- Explain and demonstrate how to solder components using the correct soldering technique.
- Explain and demonstrate how component layout conforms to the circuit diagram.

Subject Outcome 3: Test and commission the circuit.

Learning Outcomes:

The student should be able to:

- Explain and demonstrate how to visually check the circuit for faults according to circuit and layout diagrams.
- Explain and demonstrate how to correctly connect the circuit according to operating procedures.
- Select the correct supply voltage and demonstrate how it is applied.
- Explain and demonstrate how to visually confirm circuit operation with the aid of relevant test equipment.
- Identify and repair faults according to worksite procedures.

Subject Outcome 4: Complete the work task.

Learning Outcomes:

The student should be able to:

- Explain and demonstrate how to clean the work area after completion of the task according to housekeeping standards.
- Explain and demonstrate how to dispose of waste materials according to specific standards, procedures and environmental policies.
- Explain and demonstrate how to clean and store tools and equipment according to worksite procedures.
- Explain and demonstrate how job cards are completed and reported according to worksite procedures.

7.7 Topic 7: Principles of Digital Logic

Subject Outcome 1: Describe the binary number systems.

Learning Outcomes:

The student should be able to:

- Explain the difference between analogue and binary number systems.
- Calculate using the decimal systems.
- Convert from the decimal to the binary number system.
- Convert from the binary to the decimal number system.
- Add and subtract binary numbers.

Subject Outcome 2: Explain basic logic gates.

Learning Outcomes:

The student should be able to:

- Explain the AND gate by using simple switches, a truth table and a symbol.
- Explain the OR gate by using simple switches, a truth table and a symbol.
- Explain the NOT gate by using simple switches, a truth table and a symbol.
- Explain NAND gate by using simple switches, a truth table and a symbol.
- Explain the NOR gate by using simple switches, a truth table and a symbol.

7.8 Topic 8: Basic Programmable Logic Controllers (PLC)

Subject Outcome 1: Demonstrate an understanding of input/output peripherals.

Learning Outcomes:

The student should be able to:

- Identify the correct peripheral (input/output, discrete, digital, analogue and intelligent).
- Select manuals or specifications and drawings according to the peripheral.
- Explain how to recognise hazards and necessary precautions associated with worksite procedures.
- Demonstrate the correct operation of the peripheral device.
- Explain and demonstrate how to correctly remove and replace peripherals according to the manufacturer's specifications.

Subject Outcome 2: Demonstrate an understanding of field devices interfaced to programmable logic controllers.

Learning Outcomes:

The student should be able to:

- Identify the correct field device for a PLC.
- Verify the operation of the field device.
- Explain how to correctly connect the field device to the appropriate peripheral.
- Select personal safety equipment according to activity requirements.

Subject Outcome 3: Demonstrate an understanding of the processor in a programmable logic controller.

Learning Outcomes:

The student should be able to:

- Explain the functions of the indicator lights of the processor.
- Explain and demonstrate how the battery of the processor is correctly identified, removed and replaced according to manufacturer specifications.
- Explain and demonstrate how to correctly diagnose faults using the indicator lights.
- Explain and demonstrate how the processor mode switch is correctly identified and used according to the task instruction.
- Explain and demonstrate how to correctly identify communication status indicators.

Subject Outcome 4: Demonstrate an understanding of the back plane and power supply of a programmable logic controller.

Learning Outcomes:

The student should be able to:

- Explain and demonstrate how to correctly place programmable logic peripherals and processor on the back plane according to the address structure of the back plane.
- Select the correct addressing modes on the back plane for the peripheral modules.
- Explain and demonstrate how to insert the power supply correctly according to the manufacturer's specifications.
- Explain and demonstrate how to correct connections for redundant power supply.

Subject Outcome 5: Demonstrate an understanding of the programming terminal.

Learning Outcomes:

The student should be able to:

- Explain and demonstrate how to correctly connect a hand-held or programming terminal to the processor.
- Explain and demonstrate how to establish communication between the programmer and the processor.
- Explain and demonstrate the correct sequence to monitor an online programme that resides in the processor.
- Explain instruction mnemonics with reference to field devices.

7.9 Topic 9: Basic Concepts of Telecommunications

Subject Outcome 1: Demonstrate knowledge of the underlying concepts of telecommunications.

Learning Outcome:

The student should be able to:

- Explain underlying concepts in simple non-mathematical terms with reference to their relevance to telecommunications.

  Range: Sound, frequency, wavelength, bandwidth, modulation, attenuation and bits

Subject Outcome 2: Demonstrate knowledge of the operation of a simple telephone and basic fax machine.

Learning Outcomes:

The student should be able to:

- Explain the use of a simple telephone with the aid of a diagram and with reference to components, signalling and transmission of speech.

  Range: Microphone, receiver, tone signalling, ringing and anti-sidetone control

- Explain the use of a simple facsimile machine with the aid of a diagram and with reference to components, signalling and transmission of pictures.

  Range: Signalling, tone detection, paper path, scanning, modulation, receiving and printing

Subject Outcome 3: Demonstrate knowledge of the underlying technologies used in telecommunications.

Learning Outcomes:

The student should be able to:

- Explain types of modulation and the principle of multiplexing as used in telecommunication systems.
  Range: Process, input and output waveforms, advantages and applications
- Explain concepts of impedance, termination, reflection, crosstalk, noise and signal level in non-mathematical terms and in relation to transmission media.
- Explain the transmission media employed in telecommunications.
  Range: Untwisted shielded pair from audio through to category 5, coaxial, fibre optic, analogue and digital microwave relay systems, cellular radio and microcell networks
- Compare digital transmission of data to analogue transmission.
  Range: Signal waveforms, bandwidth requirements, errors, tolerance to noise and line coding
- Explain the basic components and concepts of a data network with reference to the operation of the network.
  Range: Compute, file server, modem, channel access, collision avoidance, bus, star and ring

Subject Outcome 4: Demonstrate knowledge of the operation and use of networks and systems in telecommunications.

Learning Outcomes:

The student should be able to:

- Describe a Public Switched Telephone Network (PSTN) in terms of its operation and the service provided.
  Range: Switching plan and topology, PABX and bandwidth limitations
- Describe data network services in terms of their operation, the services provided and the key features of each.
  Range: Leased data services, packet switch network, ISDN and frame relay
- Describe computer networks in terms of their operation and the services provided.
  Range: LANs, WANs and the Internet

8 RESOURCE NEEDS FOR THE TEACHING OF ELECTRONICS - LEVEL 2

8.1 Physical resources

The following teaching aids should be made available, if possible:

- Lecture room
- Electronics laboratory
- Soldering iron
- Testing instruments
- Pliers, side cutters, screwdrivers – flat and star and hammers
- Drilling machine and drill bits

8.2 Human resources

- The lecturer should have a qualification at NQF level 4 and have completed Electronics as a major subject. The lecturer should also be trained in outcomes-based education.
- It would be an advantage if the lecturer has already been declared competent as an assessor and/or moderator.

8.3 Other resources

- One file per student for the Portfolio of Evidence (PoE)
- Toolkit
- 1,5 m solder per student

- 2 circuit boards per student
- Components (e.g. resistors, capacitors, transistors, diodes, transformers, permanent magnets, coils and batteries)
- First aid kit