



education

Department:
Education
REPUBLIC OF SOUTH AFRICA

NATIONAL CERTIFICATES (VOCATIONAL)

SUBJECT GUIDELINES

ELECTRO TECHNOLOGY

NQF Level 2

April 2008

ELECTRO TECHNOLOGY - LEVEL 2

CONTENTS

INTRODUCTION

1. DURATION AND TUITION TIME

2. SUBJECT LEVEL FOCUS

3. ASSESSMENT REQUIREMENTS

3.1. Internal assessment

3.2. External assessment

4. WEIGHTED VALUES OF TOPICS

5. CALCULATION OF FINAL MARK

6. PASS REQUIREMENTS

7. SUBJECT AND LEARNING OUTCOMES

7.1. Explain the fundamental principles of electricity, electronics theory and electro magnetism

7.2. Read, interpret and produce electrical wiring diagrams for installation of electrical equipment, components and circuits according to regulation, in a safe way

7.3. Build and test electronic components and circuits to perform function in a safe way

7.4. Locate and repair fault conditions on electro-technical circuits in accordance with procedure, in a safe way

7.5. Produce and use necessary documentation while working

8. RESOURCE NEEDS FOR THE TEACHING OF ELECTRO TECHNOLOGY - LEVEL 2.

8.1. Physical resources

8.2. Human resources

8.3. Other resources

INTRODUCTION

A. What is Electro Technology about?

This subject covers the basics of practical experience and is designed to be an introduction to the technical field. It will equip the student with electrical and electronic installation skills for the manufacturing industry. Workshop and fieldwork procedures that conform to safety regulations and safe working practices will be learned.

B. Why is Electro Technology important in the Mechatronics programme?

This subject contains trade specific skills, knowledge, attitudes and values so that learners can maintain, repair and install basic mechatronic electrical and electronic sub-systems in practice.

C. The link between Electro Technology and the Critical and Developmental Outcomes

The application of this subject is OBE orientated and relates to the following critical and developmental outcomes:

- Identify and solve problems in which responses display that responsible decisions using critical and creative thinking have been made.
- Work effectively with others as a member of a team, group organization, community.
- Organise and manage oneself and ones activities responsibly and effectively. Collect, analyse, organise and critically evaluate information.
- Communicate effectively using visual, mathematical and/or language skills in the modes of oral and/or written presentation.
- Use science and technology effectively and critically, showing responsibility towards the environment and the health of others.
- Demonstrate an understanding of the world as a set of related systems by recognizing that problem-solving contexts do not exist in isolation.
- Contribute to the full personal development of the learner.

D. Factors that contribute to achieving Electro Technology Learning Outcomes

- An understanding of technical (electrical, electronic, and electro-magnetic) principles.
- An analytical ability.
- An ability to do mathematical calculations and manipulations.
- Hand-skills (specifically assembly work).
- Practical improvisation abilities.

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

- Explain the fundamental principles of electricity, electronics theory and electromagnetism
- Read, interpret and produce electrical wiring diagrams for installation of electrical equipment, components and circuits in accordance with safety regulations
- Build and test electronic components and circuits to perform function in a safe way
- Locate and repair fault conditions on electro-technical circuits in accordance with procedure, in a safe manner
- Produce and use necessary documentation while working.

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 Electro Technology 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 Electro Technology 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:**
 - Presentations (lectures, demonstrations, group discussions and activities, practical work, observation, role-play, independent activity, synthesis and evaluation)
 - Exhibitions by students
 - Visits undertaken by students based on a structured assignment task
 - Research
 - Task performance in a “Structured Environment”
- **Definition of the term “Structured Environment”**

For the purposes of assessment, “Structured Environment” refers to a simulated workplace or workshop environment. Activities in the simulated workplace or environment must be documented in a logbook with a clear listing of the competencies to be assessed.

The following information must be contained in the logbook:

- Nature of department or environment in which practical component was achieved
- Learning Outcomes
- Activities in the environment with which to achieve the Learning Outcomes
- Time spent on activities
- Signature of facilitator or supervisor and student

For the logbook to be regarded as valid evidence, it must be signed by an officially assigned supervisor.

• Evidence in practical assessments

All evidence pertaining to evaluation of practical work must be reflected in the student's Portfolio of Evidence. The assessment instruments used for the purpose of conducting these assessments must be part of the evidence contained in the 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 and the practical component 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: Electro Technology Level 2*.

4 WEIGHTED VALUES OF TOPICS

	TOPICS	WEIGHTED VALUE
1	Explain the fundamental principles of electricity, electronics theory and electromagnetism.	20%
2	Read, interpret and produce electrical wiring diagrams for installation of electrical equipment, components and circuits in accordance with safety regulations.	25%
3	Build and test electronic components and circuits to perform function in a safe way.	25%
4	Locate, identify and repair fault conditions on electro-technical circuits in accordance with procedure in a safe manner.	20%
5	Produce and use necessary documentation while working.	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

A student must obtain at least fifty percent in the internal continuous assessment and fifty percent in the examination.

7 SUBJECT AND LEARNING OUTCOMES

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

- Topic 1: Explain the fundamental principles of electricity, electronics theory and electromagnetism.
- Topic 2: Read, interpret and produce electrical wiring diagrams for installation of electrical equipment, components and circuits in accordance with safety regulations.
- Topic 3: Build and test electronic components and circuits to perform function in a safe way.
- Topic 4: Locate, identify and repair fault conditions on electro-technical circuits in accordance with procedure in a safe manner.
- Topic 5: Produce and use necessary documentation while working.

7.1 Topic 1: Explain the fundamental principles of electricity, electronics theory and electromagnetism.

7.1.1 Subject Outcome 1: Describe and apply the principles of direct current technology.

Learning Outcomes:

The student should be able to:

- Explain
 - what electricity is, with reference to atomic structure, material classification and the control thereof (conductors, semi-conductors and insulators)
 - the basic concept of what makes up a simple electric circuit (function and symbols of on/off control (switches), connecting wires (current path), load resistances (lamps/DC motors), power sources (batteries) and the relationship of the base quantities of electricity to electric circuit (current, resistance, voltage, power and energy, using correct units)
- Demonstrate
 - the use of base quantities of electricity to solve problems graphically and by calculation using Ohm's law and definition thereof
 - an understanding to determine by calculation the resistance of a conductor and the effect that light, temperature and voltage has on resistance
 - an understanding of the following terminology (potential difference, electromotive force, conventional and electron current flow)
 - an understanding of determining an unknown quantity in various resistive configurations (series, parallel and series parallel)
 - an understanding of graphical representation of DC concepts and quantities
 - An understanding of multi-meter connectivity for the purpose of testing and measuring the base quantities of electricity
 - the ability to explain the voltmeter, ammeter and ohm-meter construction and operational principles
 - an understanding of linear resistors, thermistors, varistor and LDR with regard to construction, operation and use.
- Apply fundamental concepts of DC technology for the purpose installing, fault location and repair, commissioning and maintenance of electrotechnical sub-systems.
- Apply concepts of DC technology in a laboratory or workshop area so as to prove relationships and relative definitions.
- Build simple DC technology related circuits for the purpose of embedding fundamental electrical principles.

7.1.2 Subject Outcome 2: Describe and apply the principles of alternating current technology.

Learning Outcomes:

The student should be able to:

- Describe and explain
 - and use the elements that make up the oscilloscope, element function and scope operation
 - various capacitor constructions, markings and types
 - the charging and discharging process of a capacitor, phase shift between voltage and current, capacitive reactance, series and parallel circuiting of capacitors and reactive power of a capacitor
 - construction of various coils in accordance to markings and size
 - switch on/switch off process of a coil, phase shift between current and voltage on a coil, inductive reactance, series/parallel circuiting of coils, reactive power of coils.

- Determine impedance (Z), phase shift, phase angle, active, reactive and apparent power by graph, measurement and calculation in series and parallel RL, RC, RLC circuits.
- Define terms such as reactance, impedance, capacitance, farads, inductance, henries, cycle, frequency, time period, amplitude, peak values, peak-to-peak values, reactive, apparent and real power, impedance, power factor, phase angle and phasor diagram.
- Establish and display
 - characteristics of AC technology on an oscilloscope of sine wave voltage, active power and square wave voltage
 - characteristics of capacitors and inductors to solve problems graphically, visually and by means of calculation.
- Relate the fundamental concepts of AC technology to the workplace.

7.1.3 Subject Outcome 3: Describe and apply electromagnetic principles.

Range: Components relays, coils, contactors transformers, reed switches

Learning Outcomes:

The student should be able to:

- Define and demonstrate an understanding of
 - magnets, magnetic theory and magnetic field characteristics
 - electromagnetism
 - electromagnetic principles applied in the construction of DC and AC components
 - **coupling factors, transformation ratios and resistance transformation in transformers** apparent power by graphical, visual means and by calculation
 - mutual- and self-induction
 - Faraday's and Lenz's laws with respect to magnetism.
- Apply
 - electromagnetic principles in the function of electromagnetic components used in AC and DC applications in the work place
 - electromagnetic principles in the installation of electrotechnical sub-systems.
- Determine safe electrical working quantities for selection and use of electrotechnical components.

7.1.4 Subject Outcome 4: Describe and apply the principles of electronic theory.

Learning Outcomes:

The student should be able to:

- Define and describe
 - atomic theory in relation to atomic structure and material classification (semi-conductors), specifically the release of free electrons
 - ionisation, bonding, intrinsic and extrinsic materials, bonding, N-type and P-type materials and minority and majority carriers
 - PN-junction creation by the process of diffusion and the operating characteristics thereof
 - the use of the PN- diode in rectification applications and diode protection circuits
 - the creation of bi-polar transistors and the operating characteristics thereof
 - the use of a bi-polar transistor in electronic basic switching and amplification circuits
 - zener diodes (on/off characteristics), DC voltage limiting, AC voltage limiting, voltage stabilisation
 - light emitting diodes
 - Silicon Controlled Rectifiers.
- Construct simple electronic circuits so as to prove fundamental working characteristics by graphical representation, measurement or calculation.
- Apply principles of electronic theory in the construction and installation of electrotechnical sub-systems.

7.2 Topic 2: Read, interpret and produce electrical wiring diagrams for installation of electrical equipment, components and circuits in accordance with safety regulations

7.2.1 Subject Outcome 1: Read, interpret and produce electrical wiring diagrams.

Range: Circuits: single-way light circuit (single and multi-lamp), two-way light circuit, three-way light switching, low voltage transformer connection, plug circuit, geyser connection, stove connection, distribution board connection, and protection circuits.

Learning Outcomes:

The student should be able to:

- Distinguish between technical and electrotechnical drawings.
- Read, interpret and produce
 - electrical symbols to standard
 - block diagrams
 - electrical installation diagrams
 - current flow diagrams
 - a wiring sketch.
- Define and describe the terminal and contact wiring of electrical components.
- Determine off load, cable and component ratings (current, power and voltage) by calculation or name plate.
- Demonstrate
 - the operating principles of electrical components as found in basic circuits
 - the purpose of protection circuit types.
- Read and apply
 - partial, group and overall drawings
 - electrical circuit diagrams, block, functions, mounting and connecting plans.
- Draw working sketches.
- Set up parts lists.
- Read and interpret electrotechnical drawings for the purpose of installing, measuring, controlling, testing, fault finding and maintenance.

7.2.2 Subject Outcome 2: Install electrical equipment to standard.

Range: Components: switches, circuit breakers, isolators, thermal switches, relays, timers, counters, earth leakage units, plug tops and sockets, luminaries, incandescent lamps, double pole and neutral isolators, fuses, transformers, lamp holders, connecting plugs

Range: Consumables: solid and stranded wire, ferrules, spade connectors, cable ties and clips, glands, connecting boxes, conduit

Range: Assembling tools: electrical pliers, long nose, side cutter, hole saw, junior hack saw, hammer, steel ruler, tape, scribe, centre punch, various files, screw drivers and spanners

Range: Test equipment: continuity tester, multi meter, megger.

Learning Outcomes:

The student should be able to:

- Define and describe
 - SABS code of practice of installation safety and quality
 - preparation and execution of an installation task
 - Installation of electrical equipment in a safe manner.
 - selecting and using the correct assembly tools and equipment
 - how to test installation wiring for continuity and polarity against an installation/wiring drawing
 - applying fundamental installation techniques.
- Apply and maintain electrical safety while working.
- Identify and select electrical components for a specific purpose.
- Check and test circuit, components for functionality.
- Mount plug-in units, cabinets, and switch boards.
- Determine and install cable ducts in accordance to regulation.
- Control, mount and label components for controlling, measuring and monitoring.

- Select, adjust, install and connect wire by taking into consideration the mechanical and electrical loads, the kind of wiring and purpose.
- Install connecting pieces to wires, such as cable plugs, wire end ferrules, switches and plugs.
- Wire and connect wires by soldering, clamping and plug-in connections.
- Join cables.

7.3 Topic 3: Build and test electronic components & circuits to perform function in a safe way

7.3.1 Subject Outcome 1: Plan to construct a basic electronic circuit.

Learning Outcomes:

The student should be able to:

- Describe
 - the sequence of actions by means of which to construct a basic electronic circuit
 - how to prepare the work area
 - why tools and equipment must be tested for function.
- Identify and select tools, components and equipment in accordance with a plan, diagrams and/or instructions.
- Apply a work area preparation plan.
- Test tools and equipment for function.
- Draw up a work plan and material lists.
- Draw up a circuit diagram and circuit operation.

7.3.2 Subject Outcome 2: Construct a basic electronic circuit.

Learning Outcomes:

The student should be able to:

- Analyse the circuit diagram and describe how the components are related to component layout on a circuit board.
- Describe
 - the factors that must be considered when laying out and preparing a circuit board
 - component handling precautions
 - how to connect wire and external components to an electronic circuit.
- Prepare and lay out electronic components of a circuit board safely.
- Use the correct tools to insert electronic components safely.
- Connect wires and external components to a circuit.
- Insert an electronic circuit into protective housing.

7.3.3 Subject Outcome 3: Test and commission a basic electronic circuit.

Learning Outcomes:

The student should be able to:

- Explain
 - the visual approach to check circuits for faults in accordance to circuit and layout diagrams
 - how to set up and apply circuit supply voltage from a power supply
 - how to check electronic components using a multi-meter and/or scope
 - how to check circuit diagrams in accordance with voltage and current testing using the relevant circuit diagram
 - fault finding techniques in accordance with procedure.
- Visually check circuit boards for errors.
- Set up and connect circuit supply voltage.
- Check components for function.
- Use voltage testing and measurement to determine circuit failure.
- Apply fault finding techniques to locate faults.

7.4 Topic 4: Locate, identify and repair fault conditions on electrotechnical circuits in a safe manner in accordance with procedure.

7.4.1 Subject Outcome 1: Locate, classify and repair types of fault conditions on electrotechnical circuits.

Range: Faults that can occur in electrotechnical components and basic circuits.

Range: Trouble shooting techniques such as visual, history, input/output method, half-cut method, operational methods, continuity testing and resistance testing.

Learning Outcomes:

The student should be able to:

- List fault types (short circuit, open circuit, high and low resistance joints).
- Classify different trouble-shooting techniques.
- Explain the purpose of a structured scientific approach to maintenance and trouble shooting.
- Check input and output signals and test, measure and record results.
- Apply troubleshooting techniques.
- Apply voltage, current and resistance testing in basic circuits and components.
- Order components and repair electrotechnical systems.

7.5 Topic 5: Produce and use necessary documentation while working.

7.5.1 Subject Outcome 1: Produce and use working documentation.

Range: Fault reports, material lists, incident reports, accident reports, maintenance reports, simple budgets (project/task costing) and time management.

Learning Outcomes

The student should be able to:

- Demonstrate an understanding of
 - the importance of work based documentation
 - the function of various work based documents
- Explain the purpose of
 - costing and budgets
 - time management.
- Produce and use
 - accident/ incident reports
 - fault reports (circuit, component, tool and personal safety equipment)
 - Material lists.
- Produce simple budgets.

8 RESOURCE NEEDS FOR THE TEACHING OF INTRODUCTION TO COMPUTERS - LEVEL 2.

8.1 Physical resources

Mechatronics (Vocational Training) Level 2		
1	MECHANICAL FUNDAMENTALS LAB/WORKSHOP	20 learners
1a	Classroom Facilities	
	Workplaces	20
	Teaching	20
	General facilities	20
1b	Hand Tools	
	Workbenches, double	10
	Technical drawing	20
	Basic handtools	20
	Safety and house keeping	20
	Measurement and marking	10
	Sheet metal work	10
1c	Power Tools	
	Work benches, double	10
	Cutting and forming	10
	Drilling and tapping	10
	Welding and joining	10
	Electrical soldering	10
1d	Machining	
	Drilling	1
1c	Materials testing	
	Material testing	1
2	ELECTRICAL INSTALLATION AND MACHINE LAB	
2a	Classroom Facilities	
	Workplace	20
	Teaching	20
	General	1
	Computer hardware	1
2b	Electrical installation	
	Safety and protection	2
	Industrial installation and control	2
	Domestic circuit installation and testing	2
2c	Electrical Machines	
	Transformers	2

3	MOTION AND CONTROL LAB	
3a	Classroom Facilities	
	Workplace	20
	Teaching	20
	General	1
	Computer hardware	10
3b	Pneumatics	
	Basic pneumatics	5
	Workstation pneumatics	2
	Software pneumatics	20
3c	Electro-pneumatics	
	Basic electro-pneumatics	5
	Workstation – electro-pneumatics	2
3d	Hydraulics	
3e	Sensor Technology	
	Proximity sensors	2
	Distance & displacement sensors	2
	Force and pressure sensors	2
	Workstation sensor technology	2
3f	Basic and Advanced PLC	
	Basic PLC	7
4	ELECTRONIC AND SOFTWARE LAB	
4a	Classroom Facilities	
	Workplace	20
	Teaching	20
	Computer hardware	20
4b	Courses	
	Desktop laboratory	20
	Electrical engineering	20
	Electronics	20
	Project work	20
	Communication technology	3
4d	E-learning	
	Electronics	3
	Mechatronics	12

6	COMPUTER LABORATORY	
6a	Classroom facilities	
	Workstations	20
	Computer hardware	20
	Software (Microsoft office)	20
	Internet access	20

8.2 Equipment and machinery

The Mechatronic equipment as indicated above is the suggested minimum and other equipment can be used to obtain the same outcomes. Access by the learner and facilitator to the above listed equipment and machinery is essential. Machinery and laboratory equipment as listed above is essential in the delivery of vocational training for Mechatronics.

8.3 Stationery

Files for Portfolio of Evidence and assessments, notes and learner materials are required.

8.4 Human resources

The lecturer should ideally be an electrician or millwright with knowledge of control engineering, servo, stepper and industrial motors (AC and D driven), registered as an educator on post level 1 or higher at a FET Institution.

8.4 Financial resources

The institution should make provision for workshop practice consumables during practical work, maintenance of physical resources, purchasing of new equipment and finance to hire external providers.