education

Department:
Education
REPUBLIC OF SOUTH AFRICA

NATIONAL CERTIFICATES (VOCATIONAL)

SUBJECT GUIDELINES

ELECTRICAL PRINCIPLES AND PRACTICE

NQF LEVEL 2

September 2007

INTRODUCTION

A. What is Electrical Principles and Practice?

This subject covers the basics of electrical principles and practice and introduces the field of learning. At Level 2, it is assumed that students have no previous electrical background. Level 3 and 4 is a continuation of the learning material.

B. Why is Electrical Principles and Practice important in the Electrical Infrastructure Construction programme?

Electrical Principles and Practice transfers trade specific skills, knowledge, values and attitudes so that students can explain how electricity is applied in practice.

C. The link between the Electrical Principles and Practice Learning Outcomes and the Critical and Developmental Outcomes

Electrical Principles and Practice covers the basic electrical theory component of the subject Outcome. The application of this subject is outcomes-based orientated and relates to the Critical and Developmental Outcomes. Students will be able to:

- Identify and solve problems:
  - Recognise principles of electricity and react appropriately.
- Work effectively with others:
  - Solve electricity-related problems.
- Organise and manage their activities and themselves:
  - Apply planned 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 common names for electrical 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 contents.

D. Factors that contribute to achieving the Electrical Principles and Practice Learning Outcomes

- An understanding of technical (electro-mechanical) principles
- Analytical ability
- An ability to do mathematical calculations and manipulations
- Hand skills (practical skills)
- Practical improvisation abilities

ELECTRICAL PRINCIPLES AND PRACTICE – 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 should be able to:

- Demonstrate understanding of the fundamentals of electricity.
- Describe materials and components used in the electrical field.
- Demonstrate understanding of direct current (DC) circuits.
- Demonstrate understanding of alternating current (AC) circuits.
- Gain practical experience.

3 ASSESSMENT REQUIREMENTS

3.1 Internal assessment (50 percent)

All internal assessments must be finalised by an assessor with at least a certificate of competence.

3.1.1 Theoretical component

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

3.1.2 Practical component

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

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

Note: Mathematical calculations that use students' theoretical background can be considered as part of the practical component.

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 (60 percent) and the practical component (40 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: Electrical Principles and Practice* (Level 2).

4 WEIGHTED VALUES OF TOPICS

TOPICS	WEIGHTED VALUE
1. Electric and Magnetic Theory	20
2. DC and AC Circuits	20
3. Protection and Measuring and Testing Instruments	20
4. Circuit Diagrams, Drawings and Cabling	20
5. Materials and Components	20
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 the completion of Electrical Principles and Practice Level 2, the student should have covered the following topics:

Topic 1: Electric and Magnetic Theory
Topic 2: DC and AC Circuits
Topic 3: Protection and Measuring and Testing Instruments
Topic 4: Circuit Diagrams, Drawings and Cabling
Topic 5: Materials and Components

7.1 Topic 1: Electric and Magnetic Theory

Subject Outcome 1: Understand fundamentals of electricity (p.d., e.m.f., current flow [conventional and electron], resistance and power and energy).

Learning Outcomes:

The student should be able to:

- Recall the definitions verbally and in writing.

  Range: Atom, electron, free electron, ionized atom, positive and negative charge, conductors and insulators, potential difference, electromotive force, conventional and electron current flow, resistance and Ohm's law, power and energy
- State the units of measurement of the entities verbally and in writing.

  Range: Potential difference, electromotive force, conventional and electron current flow, resistance and Ohm's law, power and energy
- Understand the relationship between the entities by using a series circuit containing a battery, switch and resistive component and calculate using Ohm's law.

Subject Outcome 2: Do calculations using Ohm's law, the power and energy formulae and Joule's Law.

Learning Outcomes:

The student should be able to:

- State the definitions and formulae for energy and power verbally and in writing.
- Identify the correct formula to be used in practical examples.
- Calculate the answers and insert correct unit of measurement.

Subject Outcome 3: Explain the factors influencing the electrical resistance of materials and do calculations.

Learning Outcomes:

The student should be able to:

- Identify conductor shape, size and length from practical examples.
- State types of material commonly used in manufacturing conductors verbally and in writing.
- State influence of conductor type, length, cross-sectional area and temperature on resistance verbally and in writing.
- Do calculations to determine resistance.

Range: $R = \frac{\rho l}{A}$ and $R_T = R_0(1+\alpha\Delta T)$

Subject Outcome 4: Distinguish between DC, AC, single phase and three-phase AC supply systems, highlighting the advantages and disadvantages of the different systems.

Learning Outcomes:

The student should be able to:

- Sketch sine wave voltage waveforms with different amplitudes and frequencies.
- Show phase angle displacement in three-phase supplies.
- Discuss the supply systems found in South Africa and list the advantages and disadvantages of the systems.
  Range: Direct current (DC) and alternating current (AC) supplies

Subject Outcome 5: Explain the theory of magnetism and electromagnetism (magnetic poles, magnetic fields and field lines, flux, flux density, magnetic field around a currentcarrying conductor and the solenoid, m.m.f., magnetic field strength and force on a currentcarrying conductor).

Learning Outcomes:

The student should be able to:

- Recall definitions verbally and in writing.
- State requirements for sketching magnetic field lines verbally and in writing.
- Sketch magnetic field lines around bar and horseshoe magnets using the rules above.
- Apply the right-hand grip or screw rule and Fleming's left-hand rule to determine the magnetic field around a currentcarrying conductor and the solenoid.

7.2 Topic 2: DC and AC Circuits

Subject Outcome 1: Do calculations for resistors in series, parallel and series-parallel.

Learning Outcomes:

The student should be able to:

- Recall the formulae for combining resistors verbally and in writing.
- Explain principles of operation of a combination of series and parallel resistors by predicting what the distribution of currents in all the branches and volt drops across resistors will be.
- Sketch the circuit from the information supplied by using IEC symbols.
- Calculate total resistance and currents in all the branches and volt drops across resistors.

Subject Outcome 2: Explain continuity and current flow.

Learning Outcomes:

The student should be able to:

- Identify closed and open circuits from examples.
- Predict whether current flow is possible.

Subject Outcome 3: Use look-up tables to select wire and cable sizes.

Learning Outcomes:

The student should be able to:

- List requirements from examples.
- Use look-up tables correctly.

Subject Outcome 4: Do calculations with respect to grouping of cells (series, parallel and series-parallel), taking into account cell resistance.

Learning Outcomes:

The student should be able to:

- Understand internal resistance and reasons for grouping of cells.
- Do calculations using practical examples.

Subject Outcome 5: Do calculations to implement load balancing in a three-phase supplied system.

Learning Outcomes:

The student should be able to:

- List information from a typical scenario.
- Calculate loads per phase using the information given, assuming all appliances are used simultaneously.
- Sketch results to show how the loads must be connected.

Subject Outcome 6: Explain how transformers are constructed and their operating principle and do basic turns-ratio calculations.

Learning Outcomes:

The student should be able to:

- Describe the construction of transformers in terms of windings, core, connections and cooling with the aid of sketches and explanations.
- State the operating principle of transformers verbally and in writing.
- Use the ideal transformer equation to do calculations.

7.3 Topic 3: Protection and Measuring and Testing Instruments

Subject Outcome 1: Discuss the theory behind and the importance of earthing of electrical appliances, installations and distribution systems.

Learning Outcomes:

The student should be able to:

- Explain why earthing is necessary.
- State which devices and systems require earthing according to the SABS Code of Practice (SANS 10142).

Subject Outcome 2: Show how measuring and testing instruments are used in practice.

Range: Ammeters, voltmeters, frequency meters, ohmmeters, Meggers and wattmeters, tong-testers and continuity testers

Learning Outcomes:

The student should be able to:

- State why measuring instruments are important and show how to take proper care of them.
- Sketch and explain the basic design of an insulation resistance tester and the principle of operation.
- Indicate how instrument transformers are used to lower the voltage and current for the instrument.
- Sketch and explain how measuring instruments are inserted in circuits.
- State how the range of a voltmeter and ammeter can be increased.

Subject Outcome 3: Use and care for hand-held electrical test instruments (tong-tester, ammeter, voltmeter, multimeter and Megger).

Learning Outcomes:

The student should be able to:

- Set the instrument for use in a practical scenario.
- Select and read scaled readings off analogue and digital instruments in a practical scenario.
- Insert instruments correctly into circuits in a practical scenario.
- State how to care for the instrument.
- Correctly store the instrument.

7.4 Topic 4: Circuit Diagrams, Drawings and Cabling

Subject Outcome 1: Explain methods to join electric cords, conductors and electric cables.

Range: Low voltage applications only

Learning Outcomes:

The student should be able to:

- Explain the types of joining and soldering of multi-strand insulated conductors.
- State where terminal blocks and screw-its for joining may be used in practice.

- State where joining kits may be used to join cables.
- State advantages and disadvantages of the different joining methods.

Subject Outcome 2: Explain the purpose and design of wire ways.

Learning Outcomes:

The student should be able to:
- State the definition and purpose of wire ways.
- Identify wire ways in buildings and factories.

Subject Outcome 3: Identify common drawing symbols and abbreviations used in electrical drawings.

Range: Wiring diagrams of electrical installations, motors and generators, transformer circuits and relay circuits

Learning Outcomes:

The student should be able to:
- Discuss and explain basic engineering drawing concepts and material lists verbally and in writing.
- Interpret basic engineering drawings verbally and in writing.
- Produce drawing using IEC symbols and standard formats.

Subject Outcome 4: Draw circuit diagrams of electrical sub-circuits

Range: A luminaire circuit supplied from one circuit breaker, two or more luminaires supplied from one circuit breaker, two or more socket outlets supplied from one circuit breaker, a geyser circuit including isolator and ripple relay, a stove circuit including isolator (both single and three-phase connection)

Learning Outcomes:

The student should be able to:
- Understand the requirements of a typical circuit.
- Draw circuit diagrams that conform to standard practice (international standards).
- Compile a parts list from the circuit diagram that includes component ratings.

7.5 Topic 5: Materials and Components

Subject Outcome 1: Identify the most commonly used electrical materials and electrical components.

Range: Materials such as copper, steel, glass, porcelain, mica, plastics, bakelite, carbon, oil-impregnated paper, rubber, lead, aluminium and tin

Components such as insulated cables, stranded conductors, flexible cables, steel-cored cables, armoured cables, conduiting and associated fittings, clamps, cleats and saddles, porcelain, glass and mica insulators, busbars, fuses, heating elements, switches, circuit breakers, protection devices, luminaires, capacitors and transformers

Learning Outcomes:

The student should be able to:
- List types of material and their properties.
- State which materials are conductors of electricity and which are commonly used for insulator material.
- Identify types of material by analysing the application.
- Illustrate with sketches the most commonly used cables, cords, conductors and insulators and where they are commonly used in the electrical field.
- Explain flexible connections.
- Identify meter boxes and distribution boxes and components found inside these boxes.
- Identify electric earthing equipment.

Subject Outcome 2: Describe the operating principles of the most commonly used electrical components.

Learning Outcomes:

The student should be able to:
- Describe the operating principle of circuit breakers, isolators, lightning arrestors and earth leakage relays.
- Sketch and explain the operating principle of geysers, stoves, thermostats, simmerstats, prepaid meters, energy control units (ripple relay and radio controlled), incandescent and fluorescent lamps and light dimmers.

- Identify DC sources (Leclanché dry cell, mercury or silver-oxide cells, rechargeable Ni-Cd or metal hydride cells, lead-acid cells).
- Sketch and explain the operating principle of lead-acid batteries and how to use and maintain them.
- Identify where components are used by giving a practical application of each component.

Subject Outcome 3: Identify materials and components used in the distribution of electricity.

Range: Overhead lines (max. 11000V), poles, struts, ties, pin, strain and suspension insulators, steel-cored conductors, lightning arrestors, transformers, fuses and switchgear (include special erection tools such as the draw-vice)

Learning Outcomes:

The student should be able to:

- List and identify components used in the distribution of electricity.
- State types of material that components in the distribution of electricity are made of.
- Sketch typical erection layouts to illustrate how cable tension is maintained in overhead lines.
- Identify enclosures and mountings for components such as transformers and switchgear.