education

Department:
Education
REPUBLIC OF SOUTH AFRICA

NATIONAL CERTIFICATE (VOCATIONAL)

SUBJECT GUIDELINES

ELECTRICAL PRINCIPLES AND PRACTICE

NQF Level 4

September 2007

ELECTRICAL PRINCIPLES AND PRACTICE – LEVEL 4

CONTENTS

INTRODUCTION

A. What is Electrical Principles and Practice?

This subject covers the basics of electrical principles and practice and is designed to be an introduction to the field of learning. For level 2 the assumption is made that the student has no previous electrical background. Level 3 and 4 are a continuation of the learning material.

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

This subject contains enough trade specific skills, knowledge, attitudes and values for the students to understand how electricity is applied in practice.

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

This subject covers a substantial portion of the theoretical knowledge component of the exit level outcomes. The application of this subject is OBE orientated and relates to the critical and developmental outcomes. Students will be taught to:

- Identify and solve problems:
  - Recognize principles of electricity and react appropriately
- Work effectively with others
  - When solving problems
- Organize 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 content

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

- An understanding of technical (electro-mechanical) principles
- An analytical ability
- An ability to do mathematical calculations and manipulations
- Hand-skills (practical skills)
- 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 all of the assessment requirements set out hereunder are adhered to.

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

2 SUBJECT LEVEL FOCUS

- Explain and apply principles of electricity
- Analyse electrical equipment in terms of their operating principles
- Understand typical electrical circuits and calculations
- Understand typical electrical installations

3 ASSESSMENT REQUIREMENTS

3.1 Internal assessment (constitutes 50 percent of the final mark)

3.1.1 Theoretical Component

The theoretical component will form 60 percent of the internal assessment.

3.1.2 Practical Component

All practical components must be indicated in a Portfolio of Evidence (PoE).

The practical component will form 40 percent of the internal assessment.

Please note that a mathematical calculation that makes use of the theoretical background of the student can be considered to be 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 and the practical component of the internal continuous assessment.

3.1.4 Moderation of internal assessment mark

Internal assessment is subject to internal and external moderation procedures as set out in the *National Examinations Policy for Further Education and Training College Programmes.*

3.2 External assessment (constitutes 50 percent of the final mark)

A national examination is conducted annually in October or November each year by means of a paper set externally and marked and moderated internally.

External assessment details are set out in the *Assessment Guidelines: Electrical Principles and Practice* (Level 4).

4 WEIGHTED VALUES OF TOPICS

TOPICS	WEIGHTED VALUE
1. Fundamentals of electricity	20%
2. Generation and supply of electricity	20%
3. Earthing and load balancing	15%
4. Transformers	15%
5. Motor/generator/alternator principles	15%
6. Illumination	15%
TOTAL	**100**

5 CALCULATION OF FINAL MARK

Continuous assessment:	Student's mark/100 x 50/1 = a mark out of 50	(a)
Theoretical 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, amongst others, purposes of moderation and verification.

6 PASS REQUIREMENTS

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

7 SUBJECT AND LEARNING OUTCOMES

On completion of Electrical Principles and Practice Level 4 the student should have covered the following topics:

Topic 1: Fundamentals of electricity
Topic 2: Generation and supply of electricity
Topic 3: Earthing and load balancing
Topic 4: Transformers
Topic 5: Motor/generator/alternator principles
Topic 6: Illumination

7.1 Topic 1: Fundamentals of electricity

7.1.1 Subject Outcome 1: State and use essential electrically related knowledge.

Range: All work done for NQF level 2 and 3. Additional work mentioned here. Include series RLC circuits and all the associated calculations but exclude resonance. Exclude parallel RLC circuits and all the associated calculations. Include calculations involving power in a balanced 3-phase system. Instrument connections such as ammeter and voltmeter (with/without shunt and multiplier resistors and current and potential transformers), wattmeter (single and 3-phase connections), frequency meter, megger and tong tester. . Electrical Components such as geysers, stoves, thermostats, simmerstats, prepaid meters, energy control units (ripple relay and radio controlled. Exclude parallel RLC circuits and all the associated calculations.

Learning Outcomes:

- Identify, rate and use fuses and circuit breakers by selecting the most appropriate one for the application.
- Explain, with the aid of sketches, the operating principle of isolators/disconnectors, lightning arrestors, no-volt and overload protection devices.
- Explain the operating principle of the thermal magnetic, magnetic, oil dashpot and bi-metal type circuit breakers.
- Sketch and explain the operating principle of geysers, stoves, thermostats, simmerstats, prepaid meters, energy control units (ripple relay and radio controlled).
- Draw circuit diagrams of electrical sub-circuits (a laminar circuit, a socket outlets circuit, a geyser circuit, a stove circuit (both single and 3-phase connection)).
- Interpret electrical drawings by identifying common drawing symbols and abbreviations used in electrical and electronic drawings and know how components are cross-referenced (e.g. relay contacts appearing in another circuit diagram).
- Explain methods to join electric cords, conductors and electric cables.
- Know the purpose and design of wireways.
- Explain analog measuring instrument design (moving coil, moving iron, dynamometer type).
- Sketch and explain how measuring instruments are inserted into circuits (ammeter and voltmeter (with/without shunt and multiplier resistors and current and potential transformers), wattmeter (single and 3-phase connections), frequency meter, megger and tong tester).
- Understand fundamentals of electricity (p.d., e.m.f., current flow (conventional and electron), resistance, inductive and capacitive reactance, impedance, power (true, reactive and apparent), power factor and energy. Use R.M.S, D.C and instantaneous values where applicable.
- Do calculations using Ohms Law, the power and energy formulae, Joule's Law and the cost of electricity.

- Do calculations for impedances in series, parallel and series-parallel.

7.2 Topic 2: Generation and supply of electricity

7.2.1 Subject Outcome 1: Understand the principles behind the generation and supply of electricity.

Learning Outcomes:

- Explain how a single phase and 3-phase A.C supply is generated, highlighting the advantages and disadvantages of the different systems.
- Understand electric power distribution practices.
- State disadvantages of single phase distribution.
- State advantages of 3-phase distribution.
- Explain the layout and different sections comprising electric distribution networks (from the generating plant (supplier) to the end user (client)).
- Sketch and explain the design of materials and components used in overhead lines (max. 11000V) (poles, struts, ties, pin-, strain- and suspension-insulators, steel cored conductors, lightning arrestors, transformers, fuses, switchgear and the draw-vice).

7.3 Topic 3: Earthing and load balancing

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

Learning Outcomes:

- Define nomenclature such as earth continuity conductors, earth bar, earthing lead, earth electrode and earth fault.
- Understand earthing practices.
- State regulations regarding protection.
- Draw a circuit to electrically earth an installation.
- Perform tests on installations to ensure that the installation conforms to earthing regulations.
- Explain, with the aid of sketches, the operation of a core balance earth leakage relay.

7.3.2 Subject Outcome 2: Do calculations to implement load balancing in a three-phase supplied system.

Learning Outcomes:

- Understand and interpret load-balancing case studies.
- Calculate and sketch possible solutions.

7.4 Topic 4: Transformers

7.4.1 Subject Outcome 1: Understand transformers.

Range: Include power factor and transformer efficiency in calculations (single and 3-phase).

Learning Outcomes:

- Understand the following: Why and where transformers are used, transformer turns ratio, rating, core, laminated plates, secondary isolated from primary, eddy currents, electromagnetic interference.
- Explain how transformers are constructed, their operating principle and do basic turns ratio calculations.
- Draw circuit diagrams of star/delta connected transformers and calculate phase and line values and turns ratios.
- Draw a typical switchyard circuit (transformers, switchgear and protection).

7.5 Topic 5: Motor/generator/alternator principles

7.5.1 Subject Outcome 1: Explain motor/generator/alternator principles and the different characteristics of the different types of motors/generators/alternators (A.C and D.C).

Range: Include but not limited to separately excited, shunt excited, series, and compound machines. Include the effect of a load on the machine. Include speed control of dc motors and the reversal of direction of motors. Include the induction, the split-phase, and the universal motor. Include direct on line starting. Include reduced voltage starting (manual and automatic star-delta, manual auto-transformer and resistance starting).

Learning Outcomes:

- Understand the following: Nomenclature such as rotor, stator, armature, yoke, poles and pole shoes, commutator, slip rings, brushes and brush holders, field coils, back emf, induction, squirrel cage, speed and slip, synchronous speed, split-phase, armature reaction, brush shifting, interpoles and compensating windings, rotating magnetic field.
- Understand the operating principles.
- Understand the basic construction.
- Understand the connection diagrams and identify the type of machine.
- Draw and explain their characteristic curves (load characteristic).
- Draw a circuit diagram and explain the operating principle of the face-plate starter and associated protection devices.
- Draw circuit diagrams and explain the operating principles of starter circuits for ac motors.
- Explain tests that can be conducted to test electric machines.
- Draw circuit diagrams of electric machinery circuits (D.C motor and generator, universal motor, squirrel cage motor, single and 3-phase machines) (include starter and protection circuitry and direction reversal).

7.6 Topic 6: Illumination

7.6.1 Subject Outcome 1: Understand illumination and lamp circuits.

Learning Outcomes:

- Understand nomenclature such as light intensity, lux or lumens, stroboscopic effect, incandescence.
- Explain the operating principle of light dimmers.
- Sketch and explain the design and principle of operation of lamps (incandescent, tungsten halogen, Hg- and Na-vapour, and fluorescent).
- Sketch and explain the circuitry needed to start and operate lamps (incandescent, tungsten halogen, Hg- and Na-vapour, and fluorescent).
- Discuss the cost, colour emitted, efficiencies and life expectancy of different lamp types and chose the best lamp for the application.
- Understand earthing practices.
- Understand electric power distribution practices.
- Draw a circuit to electrically earth an installation.
- Draw circuit diagrams of electrical sub-circuits (a luminair circuit, a socket outlets circuit, a geyser circuit, a stove circuit (both single and 3-phase connection)).
- Draw a typical switchyard circuit (transformers, switchgear and protection).
- Draw circuit diagrams of electric machinery circuits (D.C motor and generator, universal motor, squirrel cage motor, single and 3-phase machines) (include starter and protection circuitry and direction reversal).

8 RESOURCE NEEDS FOR THE TEACHING OF ELECTRICAL PRINCIPLES & PRACTICE – LEVEL 4

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

Registered post level 1 or higher educators at FET institutions.

8.3 Financial resources

The institution should make provision for

- consumables during practicals,
- maintenance of physical resourses and
- purchasing of new equipment. `