



education

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Education
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NATIONAL CERTIFICATE (VOCATIONAL)

SUBJECT GUIDELINES

ELECTRICAL PRINCIPLES AND PRACTICE

NQF Level 3

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ELECTRICAL PRINCIPLES AND PRACTICE – LEVEL 3

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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 is 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, organize 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

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

3 ASSESSMENT REQUIREMENTS

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

An assessor with at least a certificate of competence must finalize all internal assessments.

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.

4 WEIGHTED VALUES OF TOPICS

TOPICS	WEIGHTED VALUE
1. Materials, components and interpret electrical drawings	20%
2. Electric and magnetic theory	20%
3. D.C. and A.C. circuits	20%
4. Protection and measuring instruments	20%
5. Circuit diagrams and electric machines	20%
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 (50) percent in the examination.

7 SUBJECT AND LEARNING OUTCOMES

On completion of Electrical Principles and Practice Level 3 the student should have covered the following topics:

Topic 1:	Materials, components and interpret electrical drawings
Topic 2:	Electric and magnetic theory
Topic 3:	D.C. and A.C. Circuits
Topic 5:	Protection and measuring instruments
Topic 4:	Circuit diagrams and electric machines

7.1 Topic 1: Materials, components and interpret electrical drawings

7.5.1 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

Range: Machine components include but are not limited to:(D.C. motors (separately excited, shunt, series and compound), A.C. motors (squirrel cage, wound rotor and universal)), and their associated internal circuitry and starting methods (face plate, star-delta, starting windings and direct-on-line)

Learning Outcomes

- List types of materials and their properties
- State which materials are conductors of electricity and which are commonly used for insulator material.
- Illustrate with sketches the most commonly used cables, cords, conductors and insulators and where they are commonly used in the electrical field.
- Know of flexible connections and where they are used.
- Identify meter boxes and distribution boxes and components found inside these boxes.
- Identify electric earthing equipment.
- Identify transformers and switchgear.
- Identify electric motors

7.5.2 Subject Outcome 2: Identify and maintain batteries.

Learning Outcomes

- Sketch and explain the operating principle of lead-acid batteries and how to use and maintain them.

7.5.3 Subject Outcome 3: Explain the operating principle of electrical components.

Learning Outcomes

- Explain the operating principle of circuit breakers, isolators/disconnectors, lightning arrestors, earth leakage relays, no-volt and overload protection devices.
- Sketch and explain the operating principle of geysers, stoves, thermostats, simmerstats, prepaid meters, energy control units (ripple relay and radio controlled), the incandescent and fluorescent lamp and light dimmers.

7.5.4 Subject Outcome 4: Identify materials and components used in the distribution of electricity.

Range: Includes overhead lines (max. 1000V), poles, struts, ties, pin-, strain- and suspension-insulators, steel cored conductors, lightning arrestors, transformers, fuses, switchgear. Include special erection tools such as the draw-vice.

Learning Outcomes

- List and identify components.
- State type of material that components are made of.
- Sketch typical erection layouts to illustrate how cable tension is maintained.
- Identify enclosures and mountings for components such as transformers and switchgear.

7.5.5 Subject Outcome 5: Identify common drawing symbols and abbreviations used in electrical drawings and know how components are cross-referenced (e.g. relay contacts appearing in another circuit diagram).

Learning Outcomes

- Discuss and explain basic engineering drawing concepts and material lists.
- Interpret basic engineering drawings.
- Produce drawing according to accepted international standards.

7.2 Topic 2: Electric and magnetic theory

7.2.1 Subject Outcome 1: Understand fundamentals of electricity.

Range: p.d., e.m.f, current flow (conventional and electron), resistance, power (true, reactive and apparent), power factor and energy. Use R.M.S, D.C. and instantaneous values where applicable.

Learning outcome

- Recall the definitions and units of measurement.
- State the relationships between entities, if any
- Manipulate formulae
- Understand the concepts
- Understand case studies and calculate values.
- Interpret the results.

7.2.2 Subject Outcome 2: Do calculations using Ohm's Law, the power and energy formulas, Joule's Law and the cost of electricity.

Range: Use typical values found in domestic houses.

Learning Outcomes

- Recall the definitions and units of measurement.
- Understand case studies and calculate values.
- Interpret the results.

7.2.3 Subject Outcome 3: Explain the theory of magnetism and electromagnetism (magnetic poles, magnetic fields and field lines, flux, flux density, magnetic field around a current carrying conductor and the solenoid, m.m.f (magneto motive force) magnetic field strength and force on a current carrying conductor).

Learning Outcomes

- Recall magnetic theory.
- Explain and state the relation between flux and flux density.
- Use the formula to calculate the force on a current carrying conductor in a magnetic field and apply Fleming's left hand rule.
- Calculate the force of attraction or repulsion between two parallel current carrying conductors.

7.2.4 Subject Outcome 4: Explain motor/generator theory (electromagnetic induction, Faraday and Lenz's Law).

Learning Outcomes

- Recall definitions and theory of magnetism.
- Apply Fleming's left hand rule.
- Sketch a simple generator to illustrate the generation of electricity.

7.3 Topic 2: D.C. and A.C. Circuits

7.3.1 Subject Outcome 1: Explain the generation and distribution of D.C., A.C., single phase and 3-phase A.C supply systems, highlighting the advantages and disadvantages of the different systems.

Range: Calculations include $P=VI\cos\phi$ and the relationship between phase and line voltages. Includes an introduction to power factor.

Learning Outcomes

- Understand how electricity is generated in D.C. supply systems and A.C. supply systems.
- Understand the waveforms and values of line and phase voltages.
- Understand star and delta configurations and transformer connections in A.C. supply systems.
- Understand the advantages of using high voltages for distribution networks and state the relative merits of A.C. and D.C. supply systems.

7.3.2 Subject Outcome 2: Do calculations for resistors in series, parallel and series-parallel.

Range: Does not include a nested series circuit within a series-parallel circuit. Does not include a nested parallel circuit within a series-parallel circuit.

Learning Outcomes

- Recall the formulas for total resistance, voltage, current and power.
- Draw a circuit diagram from the given data, do the calculations and verify that the answers make sense by interpreting the results.

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

Range: Include two different materials connected in series or in parallel.

Learning Outcomes

- Explain the formulae.
- Do the calculations after interpreting the information supplied.

7.3.4 Subject Outcome 4: Calculate current flow and use look-up tables to select wire and cable sizes.

Learning Outcomes

- Understand the case studies.
- Do the calculations and select the correct wire and cable sizes.

7.3.5 Subject Outcome 5: Do calculations for capacitors in series, parallel and series-parallel.

Range: Does not include a nested series circuit within a series-parallel circuit, does not include a nested parallel circuit within a series-parallel circuit.

Learning Outcomes

- Understand the concept 'capacitance' and the theory of connecting capacitors together.
- Do the calculations.

7.3.6 Subject Outcome 6: Do calculations for inductors in series, parallel and series-parallel.

Range: Does not include a nested series circuit within a series-parallel circuit. Does not include a nested parallel circuit within a series-parallel circuit.

Learning Outcomes

- Understand the concept 'inductance' and the theory of connecting capacitors together.
- Do the calculations.

7.3.7 Subject Outcome 7: Do calculations with respect to grouping of cells (series, parallel and series-parallel), taking into account the cell resistance.

Learning Outcomes

- Understand the limitations and the theory of connecting cells together.
- State the formulas to calculate terminal voltage and short circuit current.
- Do typical calculations.
- Interpret the results.

7.3.8 Subject Outcome 8: Do calculations to implement load balancing in a three-phase supplied system.

Learning Outcomes

- Understand case studies.
- Do calculations to split the loads.
- Sketch end-result according to electrical drawing standards.

7.3.9 Subject Outcome 9: Explain how transformers are constructed, their operating principle and do basic turns-ratio calculations.

Range: Includes 3-phase star-delta transformers.

Learning Outcomes

- Recall construction and operating principle theory.
- Use the ideal transformer equation, phase and line voltage and current relations and total power formulae to do calculations.

7.4 Topic 4: Protection and measuring instruments

7.4.1 Subject Outcome 1: Sketch and explain the fundamentals of measuring instrument design (analog meters) and how measuring instruments are inserted into circuits

Range: 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.

Learning Outcomes

- Illustrate with the aid of sketches how instruments work.
- Illustrate with the aid of sketches how instruments are adapted to read a wide range of values.
- Illustrate with the aid of sketches how 3-phase measurements are made.

7.4.2 Subject Outcome 2: Use and care for hand-held electrical test instruments

Range: tong-tester, ammeter, voltmeter, multimeter and megger

Learning Outcomes

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

7.5 Topic 5: Circuit diagrams and Electric Machines

7.5.1 Subject Outcome 1: Draw circuit diagrams of star/delta connected transformers and how the windings are connected to form a star or delta system.

Learning Outcomes

- Understand the case study.
- Sketch the connection diagram.

7.5.2 Subject Outcome 2: Draw circuit diagrams of electrical sub-circuits.

Range: A luminair 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 3-phase connection).

Learning Outcomes

- Understand the requirements.
- Circuit diagrams must conform to standard practice (international standards).
- Draw up a parts list from the circuit diagram that includes component ratings

7.5.3 Subject Outcome 3: Discuss how to identify, electrically connect and disconnect, and carry out detailed inspection on electric machines.

Range: D.C motor and generator, universal motor, squirrel cage motor, single and 3-phase machines, does not include installation.

Learning Outcomes

- Machines smaller than 10kW are identified correctly.
- Typical connection diagrams are reproduced.
- List inspection points.
- Electrically connect the machine.

1 RESOURCE NEEDS FOR THE TEACHING OF ELECTRICAL PRINCIPLES & PRACTICE – LEVEL 3

8.1 Physical resources

Well equipped classrooms and workshops are essential for this practical 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 resources and
- purchasing of new equipment.