



higher education
& training

Department:
Higher Education and Training
REPUBLIC OF SOUTH AFRICA

NATIONAL CERTIFICATE (VOCATIONAL)

SUBJECT GUIDELINES

ELECTRONIC CONTROL AND DIGITAL ELECTRONICS

NQF LEVEL 4

IMPLEMENTATION: JANUARY 2015

INTRODUCTION

A. What is *Electronic Control and Digital Electronics*?

Electronic Control and Digital Electronics Level 2 covers the basics of electronics and is designed to introduce the field of learning. The assumption is made that the student has no previous electronics background.

In Levels 3 and 4, students continue with the theoretical and practical implementation of the learning material. Repetition of some of the work will be noticed, since the foundation of knowledge is important.

B. Why is *Electronic Control and Digital Electronics* important in the Electrical Infrastructure Construction programme?

Electronic Control and Digital Electronics transfers the necessary trade-specific skills, knowledge, values and attitudes for students to understand, maintain, repair and construct basic electronic systems in practice.

C. The link between the Learning Outcomes for *Electronic Control and Digital Electronics* and the Critical and Developmental Outcomes

This subject covers a substantial portion of the practical knowledge component of the exit level outcomes. The application of this subject is outcomes based education (OBE) orientated and relates to the Critical and Developmental Outcomes. Students will be taught to:

- **Identify and solve problems:**

Recognise situations that require action and react appropriately.

- **Work effectively with others:**

Construct and test projects in groups or teams.

- **Organise and manage themselves and their activities:**

Apply the correct 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 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 *Electronic Control and Digital Electronics* 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.

ELECTRONIC CONTROL AND DIGITAL ELECTRONICS – LEVEL 4

CONTENTS

INTRODUCTION

1 DURATION AND TUITION TIME

2 SUBJECT LEVEL OUTCOMES AND FOCUS

3 ASSESSMENT

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

Topic 1: Alternating current theory

Topic 2: Fundamentals of electronics

Topic 3: Basic design procedures

Topic 4: Binary decoding and loading software on a computer

Topic 5: Operating PLCs

8 RESOURCE NEEDS FOR THE TEACHING OF ELECTRONIC CONTROL AND

DIGITAL ELECTRONICS – LEVEL 4

8.1 Physical resources

8.2 Human resources

8.3 Financial resources

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 that 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 OUTCOMES AND FOCUS

SAQA Qualification ID: 50442

Exit Level Outcome: Apply Electronic Practices and Procedures

On completion of this subject the student should be able to:

- Apply the principles of alternating theory to analyse and explain RC, RL and RLC circuits and resonance.
- Design, construct, test, fault-find and repair basic electronic circuits using technical manuals.

Range: Timing and oscillator circuits, circuits using SCR and triac, amplifiers and power supplies

- Use binary code to encode and decode shift registers and load software onto a computer in order to design, operate and fault-find PLC circuits.

Associated Assessment Criteria:

- RC, RL and RLC circuits and resonance are analysed and explained using alternating theory principles.
- Basic electronic circuits are designed, constructed, tested for faults and repaired using technical manuals.

Range: Timing and oscillator circuits, circuits using SCR and triac, amplifiers and power supplies

- Encode and decode shift registers and use software to design, operate and fault-find PLC circuits.

3 ASSESSMENT

Information provided in this document on internal and external assessment aims to inform, assist and guide lecturers to plan the effective teaching of the subject.

The *Assessment Guidelines* accompanying this document provide detailed information for planning and conducting internal and external assessments.

3.1 Internal assessment (50 percent)

Detailed information regarding internal assessment and moderation is outlined in the current Internal Continuous Assessment (ICASS) Guideline document provided by the Department of Higher Education and Training (DHET).

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, the Integrated Summative Assessment Task (ISAT), will be included in the external assessment.

Detailed information regarding external assessment and moderation is outlined in the *National Policy on the Conduct, Administration and Management of the Assessment of the National Certificate Vocational Gazette Number 30287*, dated 12 September 2007.

4 WEIGHTED VALUES OF TOPICS (Topic weighting and time allocation)

TOPICS	WEIGHTED VALUE	*TEACHING HOURS
1. Alternating current theory	20%	22
2. Fundamentals of electronics	30%	33
3. Basic design procedures	20%	22
4. Binary decoding and loading software onto a computer	15%	16.5
5. Operating PLCs	15%	16.5
TOTAL	100	110

**Teaching Hours* refers to the minimum hours required for face to face instruction and teaching. This excludes time spent on revision, tests and internal and external examination/assessment. The number of allocated teaching hours is influenced by the topic weighting, complexity of the subject content and the duration of the academic year.

5 CALCULATION OF FINAL MARK

Continuous assessment: Student's mark/100 x 50/1 = a mark out of 50 (a)

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, among others, reporting, moderation and verification purposes.

6 PASS REQUIREMENTS

A student must obtain at least fifty (50) percent in ICASS and fifty percent (50) in the examination to achieve a pass in this subject.

7 SUBJECT AND LEARNING OUTCOMES

On completion of *Electronic Control and Digital Electronics Level 4* the student should have covered the following topics:

Topic 1: Alternating current theory

Topic 2: Fundamentals of electronics

Topic 3: Basic design procedures

Topic 4: Binary decoding and loading software onto a computer

Topic 5: Operating PLCs

Topic 1: Alternating current theory

Subject Outcome 1.1: Explain RC circuits

Learning Outcomes:

The student is able to:

- Describe the relationship between current and voltage in an RC circuit
- Determine the impedance and phase angle (ϕ) in an RC circuit
- Explain the frequency selectivity characteristic of RC series circuit (low and high pass circuit)
- Explain the effect of faulty components in RC circuits

Subject Outcome 1.2: Explain RL circuits

Learning Outcomes:

The student is able to:

- Describe the relationship between current and voltage in an RL circuit
- Determine the impedance and phase angle in an RL circuit
- Explain the frequency selectivity characteristic of RL series circuit (low and high pass circuit)
- Explain the effect of faulty components in RL circuits

Subject Outcome 1.3: Explain RLC circuits and resonance

Learning Outcomes:

The student is able to:

- Analyse RLC circuits
- Determine the impedance and phase angle in an RLC circuit – series / parallel
- Analyse the circuit for resonance
- Analyse the operation of resonant filters
- List practical applications for resonant circuits

Topic 2: Fundamentals of electronics

Subject Outcome 2.1: Explain sinusoidal oscillators

Learning Outcomes:

The student is able to:

- Compare an amplifier to an oscillator
- Explain the difference between damped and undamped oscillations
- Explain how oscillations are produced in an LC circuit and calculate oscillation frequency
- List the factors that affect the oscillation frequency
- Describe the operation of oscillator circuits and calculate frequency of oscillation
Range: Phase shift, Colpitts, Hartley and Wein bridge oscillator
- Sketch and describe the operation of a crystal oscillator circuit.

Subject Outcome 2.2: Explain non-sinusoidal oscillators

Learning Outcomes:

The student is able to:

- Explain the difference between sinusoidal and non-sinusoidal oscillators

- Describe the operation of transistor multivibrators
Range: astable, bistable and monostable multivibrator
- List applications of multivibrators
- Explain the circuit operation of a 555 timer in astable and monostable mode

Subject Outcome 2.3: Explain power supplies

Learning Outcomes:

The student is able to:

- Describe the uses, applications and functioning of an inverting power supply with the aid of a block diagram
- Describe the uses, applications and functioning of a switch mode power supply with the aid of a block diagram

Subject Outcome 2.4: Explain bipolar junction transistor (BJT) biasing and amplifiers

Learning Outcomes:

The student is able to:

- Explain the various operating points within the limits of operation of a transistor
- Analyse the DC load line of a common emitter amplifier
- List the factors that affect the stability of the Q point
- Explain the different coupling methods used in amplifiers.

Range: Resistance-capacitance, transformer and direct coupling

- List the advantages, disadvantages and applications of the different coupling methods used in amplifiers
- Describe the operation and characteristics of class A, B and C amplifiers
- Explain the operation and list the advantages of a class B push-pull amplifier
- Distinguish between positive and negative feedback amplifiers
- Explain and compare the different types of feedback connections

Range: Voltage-series, voltage-shunt, current-series and current-shunt feedback connection

Subject Outcome 2.5: Explain silicon control rectifier (SCR)

Learning Outcomes:

The student is able to:

- Explain the operation of the silicon controlled rectifier (SCR)
- Explain how SCRs are triggered ON and OFF
- Explain the characteristic curve of a SCR and its ratings
- List the applications of the SCR
- Explain with the aid of a circuit diagram, input and output waveforms the operation of a phase control circuit
- Explain how a Triac operates
- List the applications of Triac
- List the difference between the SCR and Triac

Topic 3: Basic design procedures

Subject Outcome 3.1: Demonstrate the ability to read and interpret semi-conductor manuals

Learning Outcomes:

The student is able to:

- Show how to find any semi-conductor's operational limits by using technical manuals
- Interpret the data found in technical manuals
- Show how to look up replacement parts in technical manuals

Subject Outcome 3.2: Demonstrate an understanding of the design, construction, testing, fault-finding and repair of basic electronic circuits

Range: Includes but not limited to components such as resistors, capacitors, inductors, diodes, transistors, switches, batteries, ICs, 555 timers, LEDs, relays, transformers, opto-couplers, LDRs, SCR, Triac and analogue op-amps.

Learning Outcomes:

The student is able to:

- Design basic electronic circuits.

Range: Timing, circuits, oscillator circuits, circuits using SCR and triac, amplifiers and power supplies

- Construct basic electronic circuits.
- Test basic electronic circuits.
- Fault-find basic electronic circuits.
- Repair basic electronic circuits.

Topic 4: Binary decoding and loading software onto a computer

Subject Outcome 4.1: Explain Boolean algebra

Learning Outcomes:

The student is able to:

- State and apply Boolean expressions

Range: AND, OR, NOT, NAND, NOR, XOR and XNOR

- State and apply Boolean laws

Range: Commutative, associative and distributive laws

- State and apply the twelve basic rules of Boolean algebra
- State and apply De-Morgan theorems

Subject Outcome 4.2: Demonstrate an understanding of binary code

Learning Outcomes:

The student is able to:

- Convert decimal numbers to binary coded decimal (BCD) and vice versa.

Range: 8421 and 2421 code

- Convert from decimal to excess 3 code
- Use alphanumeric codes
- Convert decimal numbers to floating point numbers
- Convert binary numbers to floating point numbers

Subject Outcome 4.3: Demonstrate an understanding of encoders, decoders and shift registers

Learning Outcomes:

The student is able to:

- Explain with the aid of sketches the operation and functioning of encoders and decoders
- List uses of encoders and decoders
- Explain the two basic functions of a register

Range: Data storage and data movement

- Explain with the aid of sketches the operation and function of shift registers

Range: Serial in – serial out, serial in-parallel out, parallel in – serial out and bidirectional shift registers

- List uses of shift registers

Subject Outcome 4.4: Demonstrate an ability to load software onto a computer

Learning Outcomes:

The student is able to:

- Demonstrate an ability to load a variety of software onto a functioning computer
- Explain the types of problems that can affect the proper running of computer software
- Explain the possible origins, cures and prevention of computer software problems

Topic 5: Operating PLCs

Subject Outcome 5.1: Design and fault-find PLC circuits

Learning Outcomes:

The student is able to:

- Interpret the working of simple ladder logic diagrams
- Solve simple problems using ladder logic diagrams
- Design and build simple solutions to repetitive mechanical actions using ladder logic diagrams
- Analyse simple faults occurring in a PLC circuit
- Diagnose faults occurring in transducers to PLC connections

Range: Input and output devices: Limit switches, proximity switches, photo electric sensors and switches, encoders, temperature sensors, displacement sensors, strain gauges, pressure sensors, keypads, contactors, motors, lamps sinking and sourcing connections

- Repair faults on a transducer-PLC control circuit including wiring connections

8 RESOURCE NEEDS FOR THE TEACHING OF ELECTRONIC CONTROL AND DIGITAL ELECTRONICS – LEVEL 3

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

- Lecturing staff must have appropriate electrical qualifications and must possess the necessary knowledge, skills and reflexive approach to ensure that students' learning is kept up to date with the latest technologies and changing trends in their specialist field.
- Continuous staff development with exposure to an industrial environment is necessary for lecturers to acquire new skills and update their existing skills where new technologies have been introduced. Lecturers are required to spend a structured and routine period annually in an industrial environment for these purposes.
- Staff development in terms of updating teaching, learning and assessment skills is required on an ongoing basis, particularly for staff coming from industry into the educational environment of an FET college.

8.3 Other resources

The institution should have funding available to provide the following:

- consumables required to perform practical assignments and examinations
- maintenance of physical resources
- purchasing of new equipment.