education

Department:
Education
REPUBLIC OF SOUTH AFRICA

NATIONAL CERTIFICATES (VOCATIONAL)

SUBJECT GUIDELINES

ELECTRO TECHNOLOGY

NQF Level 4

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ELECTRO TECHNOLOGY LEVEL 4

CONTENTS

INTRODUCTION

A. What is Electro Technology about?

This subject covers application of practical analytical and design experience and is intended to develop the student to design, assemble and commission mechatronic systems in the manufacturing application technical field. It will equip students with skills to apply a design process, and with assembly and commissioning skills for maintaining the production of quality services.

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

This subject contains trade specific skills, knowledge, attitudes and values important for participation in the maintenance, repair and installation of mechatronic systems in the work place.

C. The link between Electro Technology Learning Outcomes 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 one's 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 energy flow, signal flow, block diagrams, manuals, system parameters and control requirements profile
- Analytical ability
- Ability to do mathematical calculations and manipulations
- Hand-skills (specifically assembly work)
- Practical improvisation abilities
- Design processes.

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

- Describe the fundamentals of three-phase machine and speed control in electrical drives.
- Design and modify three-phase electrical drive control circuits.
- Install and test electro-technical systems that employ electrical drives, switches, control gears and speed control devices.
- Modify three-phase electrical drive control technology circuits into PLC controlled applications.
- Maintain integrated electro-technical control systems.

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 43 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 4 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 4.*

4 WEIGHTED VALUES OF TOPICS

	TOPICS	WEIGHTED VALUE
1	Describe the fundamentals of three-phase machine and speed control in electrical drives	20%
2	Design and modify three-phase electrical drive control circuits	20%
3	Install and test electro-technical systems that employ electrical drives, switches, control gears and speed control devices	20%
4	Modify three-phase electrical drive control technology circuits into PLC controlled applications	20%
5	Maintain integrated electro-technical control systems	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

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 4, the student should have covered the following topics:

Topic 1: Describe the fundamentals of three-phase machine and speed control in electrical drives
Topic 2: Design and modify three-phase electrical drive control circuits
Topic 3: Install and test electro-technical systems that employ electrical drives, switches, control gears and speed control devices
Topic 4: Modify three-phase electrical drive control technology circuits into PLC controlled applications
Topic 5: Maintain integrated electro-technical control systems

7.1 Topic 1: Describe the fundamentals of three-phase machines and speed control in electrical drives

7.1.1 Subject Outcome 1: Describe three-phase electrical drive technology

Range: Fundamentals: three-phase principles. Electric drive types: AC drives: Synchronous and Asynchronous. Terminology: Induction motors; Rotating magnetic field; Slip; Star configuration; Delta configuration.

Learning Outcomes:
The student should be able to:

- Describe
  - the fundamental operation of three phase electric AC drives
  - and identify the basic construction of three phase electric AC drives
  - the control application of the various three phase electric drive types
- List the advantages and disadvantages of three-phase AC drives
- Explain the importance of name plates and indicate the meaning of information given.
- Describe how different terminal connections can be made to connect (star/delta) three phase motors
- Explain
  - the IP and temperature rating on various AC motor types
  - the various methods and procedures of mounting three-phase electric drives
  - three-phase related terminology
  - with the aid of drawings the construction of the various three-phase AC electric drive types
- List the possible defects that might occur in an AC motor (mechanical and electrical) and the related inspection procedures and tests
- Select the correct three-phase drive by means of the name plate
- connect three-phase motor types in delta and/or star configurations
- Select a motor in accordance with application and power requirements and/or torque requirements
- Determine by calculation electric drive efficiency
- Perform basic inspection and tests on three-phase AC drives

7.1.2 Subject Outcome 2: Describe electric drive speed control technology.

Range: Transistor chopper; Thyristor control; Power electronic converters; Switching control; PWM; Inverter switching; Microprocessor speed control.

Learning Outcomes:
The student should be able to:

- Identify
  - and describe the operation of various electric drive speed control types.
  - and set up electronic and microprocessor speed controllers.
- Determine drive speed by means of calculation and loading requirements.
- Identify electric speed control types as per instruction/application.

7.2 Topic 2: Design and modify three-phase electric drive control circuits

7.2.1 Subject Outcome 1: Design and modify three-phase electrical drive control engineering technology

Range: Contactor circuits: Control of motor (automatic control); Control of motor from two actuators; Contactor circuit with motor protection relay and fault signal; Jumper of a motor protective relay during start up; Automatic KUSA circuit; Reversing contactor circuit; Automatic reversing contactor; Positive sequence starting; Dahlander circuit; Pendulum contactor circuit with delay; Automatic star-delta control; Automatic two step starting circuit of a three-phase induction motor with slip ring rotor.

Learning Outcomes:

The student should be able to:

- Draw and explain the operation and function of listed contactor circuits
- List and discuss
  - the component functions and purposes in the various listed contactor control circuits
  - the various control and switch gears used in related control applications
  - safety features related to three phase control applications
- Identify and list the various components used for contactor control circuits
- Modify the existing contactor control circuit to solve drive related problems (simplification, safety regulation)
- Select appropriate control and switch gears
- Adjust and programme related sensors

7.3 Topic 3: Install and test electro-technical systems that employ electrical drives, switches, control gears and speed control devices

7.3.1 Subject Outcome 1: Plan, install and test three-phase electrical drive control systems

Learning Outcomes:

The student should be able to:

- Plan the installation procedure of three-phase control circuits (input elements, protection devices, control/ linking elements and operating elements to be controlled)
- Describe the function of the control circuit (switching on/off)
- Explain
  - what an emergency stop is
  - the difference between manual and software driven electronic speed control devices
- Draw up a materials list of electrical component requirements for three-phase electrical drive control applications
- Set up the complete circuit and test for function (apply relevant safety)
- Apply relevant speed control to task if and when required
- Set up
  - relevant speed, control be it manual electronic control or software electronic control
  - and level various electric drive types for system application
- Adjust drive system to meet quality standards
- Identify any problems and take appropriate action

7.4 Topic 4: Modify three-phase electrical drive control technology circuits into PLC controlled applications

7.4.1 Subject Outcome 1: Apply and modify PLC analogy of electrical three phase drive technology control circuits

Learning Outcomes:

The student should be able to:

- Explain
  - why it is important to modify existing contactor control circuits to PLC based control applications
  - the importance of understanding relay control logic circuits
  - what is meant by final drive control components and list these components
  - what is meant by smart sensors

- Modify contactor control circuits
  - to PLC control
  - to meet new safety regulations
  - to improve productivity and quality

7.5 Topic 5: Maintain integrated electro-technical control systems

7.5.1 Subject Outcome 1: Describe and apply assembly and commissioning

Learning Outcomes

- Describe
  - the importance of the maintenance plan
  - the advantages of the elements in a maintenance, assembly and commissioning plan
  - the consequences of not adhering to a maintenance plan
- Explain
  - what is meant by EMC and the importance thereof
  - the impact of EMC on mechatronic components
  - the test and procedures for EMC measurements
  - how to reduce EMC disturbances
  - the various shielding methods
  - causes for over voltages and related counter measures
- Prepare devices, equipment, components and materials for assembling (transport means, hoisting gears and assembly aids considered)
- Apply safety measures and checks
- Adjust operations
- Determine tolerance and positions
- Investigate the readiness and operation of mechanical, electrical and software components for commissioning
- Detect error in analogue and digital circuitry
- Repair and/or replace faulty parts
- Determine a maintenance plan
- Perform EMC tests in accordance with procedure
- Apply various related shielding methods
- Apply over voltage counter measures

7.5.2 Subject Outcome 2: Apply quality control

Learning Outcomes

- Explain
  - the impact of pollution, fatigue, wear and tear
  - system reliability
- Describe
  - methods for checking system safety.
  - what is meant by quality standards
  - various stages of quality sequences
  - the time scheduling techniques for maintenance
- Apply
  - measures to avoid production loss and product quality
  - system safety checking methods
  - quality checking sequences
  - time scheduling techniques

8 RESOURCE NEEDS FOR THE TEACHING OF ELECTRO TECHNOLOGY LEVEL 4.

8.1 Physical resources

- **Infrastructure (building infrastructure, fixtures, networks)**

Well equipped workshops are essential for this practically orientated subject. If possible, using the facilities of employers in the manufacturing field for training purposes is preferred.

- Building to be appropriately designed for workshop and laboratory type presentations that comply with building regulations and safety standards.
- The tables below show broadly the laboratory and work area requirements, related training equipment for allocated students and the relevant facilitator training that may be required for the delivery of this vocational training:

	Mechatronics (Vocational Training)	
1	**ELECTRICAL INSTALLATION AND MACHINE LABORATORY**	for 20 learners
1a	**Classroom Facilities**	
	Workplace	20
	Teaching	20
	General	1
	Computer hardware	1
1b	**Electrical installation**	
	Safety and protection	2
	Industrial installation and control	2
1c	**Electrical Machines**	
	DC machines	2
	AC machines	2
	Three phase machines	2
	Fault simulator three phase machines	2
	Frequency drives (three-phase machines)	2
1d	**Commissioning and training**	
	Teacher training - electrical	1
2	**MOTION AND CONTROL LABORATORY**	
2a	**Classroom Facilities**	
	Workplace	20
	Teaching	20
	General	1
	Computer hardware	10
2b	**Pneumatics**	
	Basic pneumatics	5
	Advanced pneumatics	5
	Workstation pneumatics	2
	Software pneumatics	20

2c	**Electro-pneumatics**	
	Basic electro-pneumatics	5
	Advanced electro-pneumatics	5
	Measurement in pneumatics	2
	Workstation – electro-pneumatics	2
2d	**Hydraulics**	
	Basic hydraulics	5
	Workstation hydraulics	1
	Software hydraulics	20
2e	**Electro-Hydraulics**	
	Basic electro-hydraulics	2
	Advanced electro-hydraulics	2
	Workstation electro-hydraulics	1
2f	**Sensor Technology**	
	Proximity sensors	2
	Distance and displacement sensors	2
	Force and pressure sensors	2
	Workstation sensor technology	2
2g	**Basic and Advanced PLC**	
	Advanced PLC	2
2h	**Fieldbus and electric drives**	
	Fieldbus profibus-DP	2
	Electro-servo drives	2
	Electro-stepper drives	2
	Workstation fieldbus and drives	1
2i	**Commissioning and training**	
	Teacher training – Motion and control	1
3	**ELECTRONIC AND SOFTWARE LABORATORY**	
4a	**Classroom Facilities**	
	Workplace	20
	Teaching	20
	Computer hardware	20
3b	**Courses**	
	Desktop laboratory	20
	Electrical engineering	20
	Electronics	20
	Project work	20

3c	**Advanced Courses**	
	Digital Electronics	3
	Microcomputer	3
	Power electronics	3
	Electrical machines	3
	Communication technology	3
3d	**E-learning**	
	Electronics	3
	Mechatronics	20
3e	**Commissioning and Training**	
	Teacher training	1
4	**CNC AND CIM/ FMS LABORATORY**	
4a	**Classroom facilities**	
	Workplace	20
	General	20
	Computer hardware	1
4b	**CNC Manufacturing**	
	CNC turning	1
	CNC milling	1
	CNC trainers and CAD/ CAM	1
4c	**FMS – Production Modules**	
	FMS - Pallet Transport	1
	FMS- Material input	1
	FMS - Material output	1
	FMS - Processing	1
	FMS - Assembly	1
	FMS - Automated warehouse	1
	FMS - Quality Assurance	1
	FMS - Control	1
	FMS - Programming	1
4d	**Commissioning and training**	
	Teacher training – CIM/ FMS	1
5	**COMPUTER LABORATORY**	
5a	**Classroom facilities**	
	Workstations	20
	Computer hardware	20
	Software (Microsoft Office)	20
	Internet access	20
6	**CENTRAL TOOL STORE**	
7	**ABLUTIONS**	

8.2 Equipment and machinery

The equipment as indicated above is the suggested minimum although other equipment can be used to obtain the same outcomes. Access by the student and lecturer 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 Human resources

- The minimum qualification requirements for educators who deal with the learning and teaching of this subject will be qualification as a mechatronic mechanician/ technician/ technologist, or in one or more of the following sub-fields: electrician, electrician (signals), millwright, IT specialist, etc.
- Lecturers should be registered, and appointed on Post Level 1 or higher at a FET institution. Ideally they should be qualified as educators capable of teaching up to NQF level 6 at least. They should be creative and have a sound knowledge of learner centred education.
- It is essential that educators working in this environment attend seminars and upgrading workshops regularly in order to be updated and re-skilled in respect of the latest developments in technology.
- The recommended number of students for workshop practice is 20.

8.4 Financial resources

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