education

Department:
Education
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NATIONAL CERTIFICATES (VOCATIONAL)

SUBJECT GUIDELINES

MECHATRONIC SYSTEMS

NQF Level 4

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MECHATRONIC SYSTEMS - LEVEL 4

CONTENTS

INTRODUCTION

A. What is Mechatronic Systems?

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

B. Why is Mechatronic Systems important in the Mechatronics programme?

This subject contains trade specific skills, knowledge, attitudes and values to equip learners sufficiently to participate in the maintenance, repair and installation of mechatronic sub-systems in the workplace.

C. The link between the Learning Outcomes for Mechatronic Systems 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 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 Mechatronic Systems Learning Outcomes

- An understanding of energy flow, signal flow, block diagrams, manuals, system parameters and requirements profiles.
- Analytical ability.
- Ability to do mathematical calculations and manipulations.
- Hand-skills (specifically assembly work).
- 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 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

- Understand the mechatronic system design process.
- Design a mechatronic system.
- Assemble a mechatronic system.
- Commission a mechatronic system.
- Maintain and apply quality assurance to a mechatronic system.

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 Mechatronic Systems Level 4 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 Mechatronic Systems 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 tools and 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 subject 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. The practical component will also be assessed.

External assessment details and procedures are set out in the *Assessment Guidelines: Mechatronic Systems Level 4.*

4 WEIGHTED VALUES OF TOPICS

TOPICS	WEIGHTED VALUE
1 Describe and analyse the mechatronic system design process	10%
2 Design a mechatronic system	25%
3 Assemble a mechatronic system	30%
4 Commission a mechatronic system	15%
5 Maintain and apply quality assurance to a mechatronic system	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 internal continuous assessment and fifty percent in the examination to achieve a pass in this subject.

7 SUBJECT AND LEARNING OUTCOMES

On completion of Mechatronic Systems Level 4, the student should have covered the following topics:

Topic 1: Describe and analyse the mechatronic system design process
Topic 2: Design a mechatronic system
Topic 3: Assemble a mechatronic system
Topic 4: Commission a mechatronic system
Topic 5: Maintain and apply quality assurance to a mechatronic system

7.1 Topic 1: Describe and analyse the mechatronic system design process

7.1.1 Subject Outcome 1: Explain the mechatronic system design process

Range: Design processes; Design problem and brief; Analysis and synthesis; Planning (time chart and flow chart)
Research (materials, ergonomics, safety factors, research techniques (library, internet, recorded interviews, local manufacturers); Specifications; Draw up ideas; Development of best idea (safety, colour scheme, cost, spread sheets, shape, materials, mechanisms, circuit, energy, system diagrams, environment, consumer safety, control programmes, circuit diagrams, etc); Solution (working drawings, materials lists, constructional details, etc). Manufacture/ assembly planning process, flow chart, time chart, sequence drawing, make the solution execute the task, evaluation - good and bad points, effectiveness of meeting the design brief.
Learning Outcomes:
The student should be able to:

- List and describe the design processes
- State the design problem and explain how it should be solved
- Analyse the project task (all elements to be considered)
- Describe the functions of time charts and flow charts
- Describe the various research techniques and their importance
- Explain
  - the importance of specifications
  - the purpose of drawing up ideas
  - how a best idea would be developed
  - the purpose of developing related drawings, lists, etc for a solution
  - why it is necessary to evaluate the task
- Interpret a design problem and design brief
- Explain how you would solve the problem

7.2 Topic 2: Design a mechatronic system

7.2.1 Subject Outcome 1: Design a mechatronic system task solution

Range: Design processes; Design problem and brief; Analysis and synthesis; Planning; Specifications; Draw up ideas; Development of best idea; Documented solution.

Learning Outcomes:

The student should be able to:

- Explain
  - the importance of the budget
  - the reason for economic considerations
  - the reason for control of the project with respect to time frames
  - what is meant by the term “brain storming” when creating ideas
- List as many related questions as possible
- Answer the questions asked in the analysis
- Plan all aspects of the process and time management considerations
- Perform research
- Draw up the project and sub section specifications
- Draw up approximately six closely related ideas to solve the project task
- Develop the best idea
- Produce the relevant diagrams for the solution

7.3 Topic 3: Assemble a mechatronic system

7.3.1 Subject Outcome 1: Describe and perform assembling of a mechatronic system

Range: Manufacture/ assembly (planning process, flow chart, time chart, sequence drawing) Find the solution; Execute the task

Learning Outcomes:

The student should be able to:

- Describe
  - the importance of the sequence diagram and how it is developed
  - the importance of planning the execution
- Explain
  - the purpose of flow charts in process and programming applications
  - why it is necessary to produce an evaluation check list
- Interpret related circuit and sequence diagrams
- Execute the design task solution
- Install components
- Connect components
- Integrate hardware and software
- Interface the hardware and software
- Perform programming functions

7.4 Topic 4: Commission a mechatronic system

7.4.1 Subject Outcome 1: Perform commissioning protocols with respect to mechatronic systems

Range: Evaluation of good and bad points; Has the design brief been answered?

Learning Outcomes

The student should be able to:

- Explain
  - and discuss why it is necessary to perform adjustments to various control elements
  - why it is necessary to perform function tests
  - the importance of producing a commissioning check list
  - what the commissioning protocols are
- Ensure that all relevant safety measures are considered
- Ensure that correct energy specifications are met
- Calibrate sensor units
- Tune relevant drive components
- Adjust control units
- Investigate errors and disturbances
- Debug programming if necessary
- Perform hardware and software tests
- Correct failure to the design, work scheduling production and/or assembly
- Perform function operational tests

7.5 Topic 5: Maintain and apply quality assurance to a mechatronic system

7.5.1 Subject Outcome 1: Maintain mechatronic systems

Range: Diagnostic tools (hydraulic, pneumatic, electrical and control equipment programs); Fault tree analysis; Demand analysis (schematic sketches, flowcharts, function charts).

Learning Outcomes:

The student should be able to:

- Describe various testing and measurement methods
- Explain what is meant by preventive maintenance
- Define what is meant by the following terms: “error analysis”, “error correction and fault clearance”
- Describe
  - the various tools that can be used to assist in the maintenance of mechatronic systems
  - what and how troubleshooting and debugging procedures are used
  - maintenance planning, diagnostic procedures and how systems are maintained
- Inspect mechatronic systems, check function of safety equipment, and document inspections
- Maintain mechatronic systems in accordance with maintenance and repair plans
- Exchange worn parts in the framework of preventative maintenance
- Remove malfunctions by reworking or exchange of parts
- Remove software malfunctions
- Compare system parameters with pre-set values and adjust accordingly
- Repair mechatronic systems by adhering to operational processes
- Adjust mechatronic systems to changing operational conditions
- Make use of diagnostic and maintenance systems and procedures

7.5.2 Subject Outcome 2: Apply quality assurance of mechatronic systems

Range: ISO 9000 – 9004 (quality assurance methods, quality planning, quality checks, quality control).

Learning Outcomes:

The student should be able to:

- Explain
  - what a technical manual is and its purpose
  - the importance of standards and specifications with respect to safety quality
  - the effects of pollution, fatigue, wear and tear on quality
  - the effects of system reliability on quality
- Describe Quality Standards referenced by ISO 9000-9004
- Assess quality management and its efficiency in relation to technical manuals, and apply procedures
- Apply relevant safety whilst working
- Ensure that specification standards are adhered to whilst working
- Find and remedy document malfunctions and quality flaws
- Contribute to a continuous improvement of work processes in one's own field of work
- Document how quality defects are eliminated

8 RESOURCE NEEDS FOR THE TEACHING OF MECHATRONIC SYSTEMS - LEVEL 4

8.1 Physical resources

- **Infrastructure (building infrastructure, fixtures, networks)**
  - Building to be appropriately designed for workshop types and/or 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**	
	Workplaces	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 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 ideally 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.