education

Department:
Education
REPUBLIC OF SOUTH AFRICA

NATIONAL CERTIFICATES (VOCATIONAL)

SUBJECT GUIDELINES

MACHINE MANUFACTURING

NQF Level 3

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MACHINE MANUFACTURING - LEVEL 3

CONTENTS

INTRODUCTION

A. What is the subject Machine Manufacturing about?

This subject covers the basics of practical experience and is designed to be an introduction to the technical field. It will equip the student with necessary machining skills for the maintenance of systems in the manufacturing industry. Workshop and field work procedures that conform to safety regulations and safe working practices will be learned.

B. Why is Machine Manufacturing important in the Mechatronics learning programme?

This subject contains trade specific skills, knowledge, attitudes and values so that students learn how to maintain, repair and construct basic mechatronic systems in practice.

C. The link between Machine Manufacturing 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 student.

D. Factors that contribute to achieving Machine Manufacturing Learning Outcomes

- An understanding of technical (electro-mechanical) principles
- Analytical ability
- Ability to do mathematical calculations and manipulations
- Hand-skills
- Practical improvisation abilities
- Read and interpret working drawings

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

- Identify and apply safety regulations when maintaining and using machine control systems
- Read, interpret, produce and apply engineering drawings to machine mechatronic sub-systems
- Identify and explain function and selection of tooling requirements, speed setting and materials for related machining applications
- Identify and explain function, and safely machine components while using a milling machine and lathe
- Identify, explain and use basic CAD application software to produce simple component machine drawings

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 Machine Manufacturing Level 3 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 Machine Manufacturing Level 3 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 clear from 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. A practical component will also be assessed.

External assessment details and procedures are set out in the *Assessment Guidelines: Machine Manufacturing Level 3.*

4 WEIGHTED VALUES OF TOPICS

TOPICS	WEIGHTED VALUE
1 Identify and apply safety regulations when maintaining and using machine control systems	15%
2 Read, interpret, produce and apply engineering drawings to machine mechatronic sub-systems	15%
3 Identify and explain function and selection of tooling requirements, speed setting and materials for related machining applications	15%
4 Identify and explain function, and safely machine components while using a milling machine and lathe	40%
5 Identify, explain and use basic CAD application software to produce simple component machine drawings	15%
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 in order to achieve a pass in this subject.

7 SUBJECT AND LEARNING OUTCOMES

On completion of Machine Manufacturing Level 3, the student should have covered the following topics:

Topic 1: Identify and apply safety regulations when maintaining and using machine control systems
Topic 2: Read, interpret, produce and apply engineering drawings to machine mechatronic sub-systems
Topic 3: Identify and explain function and selection of tooling requirements, speed setting and materials for related machining applications
Topic 4: Identify and explain function, and safely machine components while using a milling machine and lathe
Topic 5: Identify explain and use basic CAD application software to produce simple component machine drawings

7.1 Topic 1: Identify and apply safety regulations when maintaining and using machine control systems

7.1.1 Subject Outcome 1: Identify and apply machine safety design and operating regulations

Learning Outcomes:

The student should be able to:

- Explain why machine safety is important.
- Identify and apply machine safety regulations whilst working.
- Know and describe
  - safety precautions during use of a machine
  - the relevant safety function on machines
  - basic machine safety requirements and related possible special requirements.
- Make suggestions for improving machine safety within regulations
- Produce an accident or incident report.
- Identify hazards
- Perform
  - a basic machine hazard analysis.
  - a machine risk assessment
- Describe
  - fundamental safety requirements in machine control.
  - related safety regulations from the OHS Act 85 of 1983 (Machine Safety).

7.2 Topic 2: Read, interpret, produce and apply engineering drawings to machine mechatronic sub-systems

7.2.1 Subject Outcome 1: Read and interpret engineering machine drawings and produce a machine drawing

Range: machines: grinding machines, drilling machines, centre lathes and milling machines; Processes: grinding, milling, turning operations, boring, drilling, screw cutting

Learning Outcomes:

The student should be able to:

- Explain
  - the difference between a free hand working drawing and an engineering drawing
  - tolerance specification in relation to quality
  - machining processes and related symbols
  - different materials that are commonly machined and their related characteristics
  - and apply machine symbols types
  - and apply the use and importance of material lists.
- Read and interpret engineering drawings for marking off purposes and machining purposes.
- Produce an engineering drawing of a simple component to be machined.

7.3 Topic 3: Identify and explain function and selection of tooling requirements, speed setting and materials for related machining applications

7.3.1 Subject Outcome 1: Select, maintain and use tooling

Range: Tooling: twist drills, reamers, chip breaking, cutting, parting, turning, milling, boring, chamfering, tapping, knurling;

Accessories: tool holders, clamps

Learning Outcomes:

The student should be able to:

- Explain
  - chip making process of drilling
  - the various cutting angles of twist drills for different materials
  - the purpose of cutting fluids and coolants, and their related properties during machining
  - the purpose of various accessories and work holding fixtures.
  - the importance of clamping work pieces.
- Identify, select and sharpen tooling for the correct machining process.
- Identify machine accessories for the relevant machine processes.
- Observe relevant safety when dressing and sharpening tooling.
- Plan work processes and relevant requirement lists (materials, tooling, accessories, speeds, safety).

7.3.2 Subject Outcome 2: Select and determine cutting speeds and feeds

Range: Hammers, files, hacksaws, chisels, hole-punches, hand taps and tap wrenches, stocks and dies, reamers, sheet metal cutters, clamping devices, drill bits, drilling machines (hand held or power, fixed or manual), related cutting fluids, grindstones and grinding machines.

Learning Outcomes:

The student should be able to:

- Explain the importance of selecting the correct cutting speeds and feeds.
- Explain consequences of not selecting the correct cutting speeds and feeds.
- Set up correct cutting speed and feeds on related machinery.
- Determine correct cutting speeds and feeds by calculations and application.

7.3.3 Subject Outcome 3: Identify and apply materials and machining

Learning Outcomes:

The student should be able to:

- Identify
  - and name materials that can be machined
  - and explain relationships of speeds and feeds for different material types
  - and select material according to their characteristics
- Explain characteristics of materials that are commonly machined
- Select correct materials in accordance to instruction or drawing
- Determine and select speeds and feed according to material type.

7.4 Topic 4: Identify and explain function, and safely machine components using a milling machine and a lathe

7.4.1 Subject Outcome 1: Use a centre lathe to produce a component

Range: Turning operations: facing off, drilling, parallel cutting, parting off, radius cutting, boring, cutting, tapping, knurling, chamfering reaming and tapered turning. Components: headstock, carriage, tail stock, tool post, compound slide, cross slide, apron, feed shaft, lead screw, motors and gear drives

Learning Outcomes:

The student should be able to:

- Explain the purpose of using a centre lathe.
  - with the aid of sketches the parts and components that make up the lathe.
  - the different turning operations that can be performed on a lathe and where relevant the advantages and disadvantages.
- Identify and explain
  - the function of the centre lathe with respect to energy flow.
  - the function and operation of the components that make up a centre lathe.
- List
  - the advantages and disadvantages of work pieces being held between centres.
  - safety measures that are to be considered when operating a lathe.
  - four different type of lathe centres.
- Plan for work activity.
- Read and interpret machine engineering drawings and instruction.
- Prepare machine for operation (pre-operational checks).
- Ensure that tooling and materials are on hand.
- Set up lathe for work activity.
- Perform turning operations.
- Check that machined components meets specifications and document conformance.
- Report any discrepancies, problems, malfunctions whilst working.
- Maintain a clean and tidy work area.
- Apply safety considerations whilst working.

7.4.2 Subject Outcome 2: Use a milling machine to produce a component

Range: Components: arbour support, spindle, column, table, saddler, knee, base, gear drive, motors. Operations: profile, flat, shaped surfaces, drilling, boring, gear cutting, spiral shapes, cams, vertical work, slotting, grooving, keyways not to deep

Learning Outcomes:

The student should be able to:

- Explain
  - the purpose of using a milling machine.
  - with the aid of sketches the parts and components that make up a milling machine.
- Identify and explain the operation of a milling machine with respect to energy flow.
- List safety measures for operating a milling machine.
- Plan for work activity.
- Read and interpret machine engineering drawings and instructions.
- Prepare machine for operation (pre-operational checks).
- Ensure that tooling and materials are on hand.
- Set up milling machine for work activity.
- Perform milling operations.
- Check that machined components meet specifications and document conformance.
- Apply safety considerations whilst working.
- Report any discrepancies, problems, malfunctions whilst working.
- Maintain a clean and tidy work area.

7.5 Topic 5: Identify, explain and use a basic CAD application software program to produce simple component machine drawings

7.5.1 Subject Outcome 1: Describe and use computer aided drafting

Range: System elements: Hardware: input, processing and output devices. Software: any relevant CAD application package. Elementary CAD commands: layers, line types, geometrical figures, tangential lines, sectional views, insertion of dimension, stretch, mirror, modify, fillets, chamfers, radii, enlarging/reducing, patterns and blocks, insertion of text, copy, move, rotate, measurements, scales, lengths, angles, areas, zoom in/out, trim, snap

Learning Outcomes:

The student should be able to:

- Describe
  - what is meant by CAD.
  - the purpose of CAD in manufacturing.
- Identify and describe the function of the various elements that make up a CAD system.
- List
  - CAD applications in industry.
  - the advantage and possible disadvantages of CAD applications.
- Explain various elementary terminology and applications used in CAD.
- Set up a CAD system
- Use elementary CAD commands.

7.5.2 Subject Outcome 2: Produce a CAD engineering drawing

Learning Outcomes:

Range: Drawing types: general, electrical, electronic, mechanical

The student should be able to:

- Explain the procedure to produce a CAD drawing.
- Explain the purpose of CAD drawing symbols.
- Demonstrate understanding of using the tool box of a CAD application program.
- Produce and modify a simple 2D engineering drawing using CAD.

8 RESOURCE NEEDS FOR THE TEACHING OF MACHINE MANUFACTURING - LEVEL 3

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	**MECHANICAL FUNDAMENTALS LABORATORY AND WORKSHOP**	for 20 learners
1a	**Classroom Facilities**	
	Workplaces	20
	Teaching	20
	General facilities	20
1b	**Hand Tools**	
	Workbenches, double	10
	Technical drawing	20
	Basic handtools	20
	Safety and house keeping	20
	Measurement and marking	10
	Sheet metal work	10
1c	**Power Tools**	
	Work benches, double	10
	Cutting and forming	10
	Drilling and tapping	10
	Welding and joining	10
	Electrical soldering	10
1d	**Machining**	
	Drilling	1
	Turning	1
	Milling	1
1e	**Training of facilitator**	
	Mechanical	1
2	**ELECTRICAL INSTALLATION AND MACHINE LABORATORY**	
2a	**Electrical installation**	
	Safety and protection	2
	Industrial installation and control	2
	Domestic circuit installation and testing	2

2b	**Electrical Machines**	
	DC machines	2
	AC machines	2
2c	**Commissioning and training**	
	Teacher training - electrical	1
3	**MOTION AND CONTROL LAB**	
3a	**Classroom Facilities**	
	Workplace	20
	Teaching	20
	General	1
	Computer hardware	10
3b	**Pneumatics**	
	Advanced pneumatics	5
	Workstation pneumatics	2
	Software pneumatics	20
3c	**Electro-pneumatics**	
	Basic electro-pneumatics	5
	Advanced electro-pneumatics	5
	Measurement in pneumatics	2
	Workstation – electro-pneumatics	2
3d	**Hydraulics**	
	Basic hydraulics	5
	Workstation hydraulics	1
	Software hydraulics	20
3e	**Electro-Hydraulics**	
	Basic electro-hydraulics	2
	Advanced electro-hydraulics	2
	Workstation electro-hydraulics	1
3f	**Sensor Technology**	
	Proximity sensors	2
	Distance and displacement sensors	2
	Force and pressure sensors	2
	Workstation sensor technology	2
3f	**Basic and Advanced PLC**	
	Basic PLC	10
	Advanced PLC	2
3g	**Fieldbus and electric drives**	
	Fieldbus profibus-DP	2
	Electro-servo drives	2
	Electro-stepper drives	2

3h	**Commissioning and training**	
	Teacher training – motion and control	1
4	**ELECTRONIC AND SOFTWARE LAB**	
4a	**Classroom Facilities**	
	Workplace	20
	Teaching	20
	Computer hardware	20
4b	**Courses**	
	Desktop laboratory	20
	Electrical engineering	20
	Electronics	20
	Project work	20
4c	**Advanced Courses**	
	Digital Electronics	3
	Microcomputer	3
	Power Electronics	3
	Electrical Machines	3
	Communication Technology	3
4d	**E-learning**	
	Electronics	3
	Mechatronics	20
4e	**Commissioning and Training**	
	Teacher training	1
5	**CNC AND CIM/ FMS LABORATORY**	
5a	**Classroom facilities**	
	Workplace	20
	General	20
	Computer hardware	1
5b	**CNC Manufacturing**	
	CNC trainers and CAD/ CAM	1
6	**COMPUTER LABORATORY**	
6a	**Classroom facilities**	
	Workstations	20
	Computer hardware	20
	Software (Microsoft Office)	20
	Internet access	20
7	**CENTRAL TOOL STORE**	
8	**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.