education

Department:
Education
REPUBLIC OF SOUTH AFRICA

NATIONAL CERTIFICATES (VOCATIONAL)

SUBJECT GUIDELINES

MANUAL MANUFACTURING

NQF Level 2

April 2008

MANUAL MANUFACTURING - LEVEL 2

CONTENTS

INTRODUCTION

A. What is the subject Manual Manufacturing about?

This subject covers the basics of practical mechatronics experience and is designed to be an introduction to the technical field. It will equip the student with hand-skills for the manufacturing industry. Workshop and fieldwork procedures that conform to safety regulations and safe working practices will be learned.

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

This subject contains trade specific skills, knowledge, attitudes and values so that student can maintain, repair and construct basic mechatronic systems in practice.

C. The link between the subject Manual Manufacturing 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 ones 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 Learning Outcomes

- An understanding of technical (electro-mechanical) principles
- An analytical ability
- An 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 and health care during work.
- Read, interpret, produce and apply engineering drawings to manufacture mechatronic sub-systems.
- Identify, select, use and care for safety equipment, hand tools and power tools in the manufacture of mechatronic sub-systems.
- Identify, select and use correct soldering and welding techniques when joining metals.
- Identify, plan and select correct work processes and materials when manufacturing and assembling mechatronic sub-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 Manual Manufacturing Level 2 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 Manual Manufacturing Level 2 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 Portfolio of Evidence.

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: Manual Manufacturing Level 2.*

4 WEIGHTED VALUES OF TOPICS

	TOPICS	WEIGHTED VALUE
1	Identify and apply safety and health care during work.	15%
2	Read, interpret, produce and apply engineering drawings to manufacture mechatronic sub-systems.	10%
3	Identify, select, use and care for safety equipment, hand tools and power tools in the manufacture of mechatronic sub-systems.	25%
4	Identify, select and use correct soldering and welding techniques when joining metals.	30%
5	Identify, plan and select correct work processes and materials when manufacturing and assembling mechatronic sub-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 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 Manual Manufacturing Level 2, the student should have covered the following topics:

Topic 1: Identify and apply safety and health care during work.
Topic 2: Read, interpret, produce and apply engineering drawings to manufacture mechatronic sub-systems.
Topic 3: Identify, select, use and care for safety equipment, hand tools and power tools in the manufacture of mechatronic sub-systems.
Topic 4: Identify, select and use correct soldering and welding techniques when joining metals.
Topic 5: Identify, plan and select correct work processes and materials when manufacturing and assembling mechatronic sub-systems.

7.1 Topic 1: Identify and apply safety and health care during work.

7.1.1 Subject Outcome 1: Identify and apply safety- and health care during work.

Range: NOSA, Occupational Health and Safety Act and Safety-, Health- and Environment programmes. General safety in workplace and responsibility thereof, elevated positions, grinding, drilling, machining, maintenance on electrical equipment.

Learning Outcomes:

The student should be able to:

- Explain
  - why safety is important
  - what safety precautions to take under various working conditions
  - and describe the basic first aid procedures for various related common accidents
  - and describe the basic procedures for fire fighting
  - and describe the purpose of the Occupational, Health and Safety (SHE) Act
  - and describe the SHE related worksite programme
  - NOSA and related gradings in factories/workshops
  - various related safety equipment used in manufacturing processes.
- Identify safety and health hazards at the work place and initiate preventative measures.
- Adhere to work place related safety regulations and procedures.
- Describe and demonstrate appropriate actions in the case of accidents and initiate first aid procedures.
- Apply fire prevention measures whist working.
- Apply preventative measure whilst working with tools, equipment and machinery.
- Work safely with consideration for self and others.
- Inspect, use and care for hand tools in the prescribed manner.
- Produce an accident report.
- Use safety equipment while working.

7.1.2 Subject Outcome 2: Describe and apply environment protection at work.

Learning Outcomes:

The student should be able to:

- Describe
  - possible environmental hazards caused by industry
  - contributions that industry should make to environmental protection and reasons for these
  - contributions towards the prevention of environmental hazards in the area of work.
- List environmental protection regulations that companies must adhere to.
- Adhere to regulations for the protection of the environment.
- Make use of possibilities of economic and environmentally-friendly uses of energy and materials.
- Prevent wastage, recycle materials and substances in an environmentally-friendly way.

7.2 Topic 2: Read, interpret, produce and apply engineering drawings to the manufacture of mechatronic sub-systems.

7.2.1 Subject Outcome 1: Read and interpret working drawings.

Range: Perception, freehand, component, sub-assembly and general assembly drawing.

Learning Outcomes:

The student should be able to:

- Explain the reason and purpose of engineering drawings.
- Explain and apply:
  - drawing types, lines and lettering standards
  - representation of plane, straight-line limited work pieces
  - fundamentals of dimensioning
  - dimensioning in accordance to a reference plane
  - dimensioning of symmetrical work-pieces
  - dimensioning of angles and slanted edges
  - the use and importance of material lists.
  - plane work-pieces rounded with circles and boreholes
  - circle construction
  - bisecting to establish a vertical centre line
  - bisecting an angle
  - determination of circle mid-point
  - construction of a regular hexagon
  - connecting circles and straight line
  - dimensioning of circles and radii.
- Explain and apply work-pieces drawn in various views (prismatic, cylindrical and sectional):
  - Perception
  - Free-hand
  - Projection
- Read and interpret engineering drawings for marking off purposes, manufacturing purposes and assembly purposes.

7.2.2 Subject Outcome 2: Produce and apply a working drawing.

Range: Perception, freehand, component, sub-assembly and general assembly drawing.

Learning Outcomes:

The student should be able to:

- Explain
  - the purpose and application of drawing apparatus
  - drawing paper sizes, measurements and scales
  - graphical representation of information
  - CAD systems and principles.
- Explain standard parts and mechanical connections:
  - Outer/inner thread and dimensioning rules
  - Screw nuts and washers
  - Screw connection related to assembly drawings
  - Rivet connections
- Produce quality working drawings at an acceptable standard.

7.3 Topic 3: Identify, select, use and care for safety equipment, hand tools and power tools in the manufacture of mechatronic sub-systems.

7.3.1 Subject Outcome 1: Describe, measure, mark and check mechatronic sub-system tools.

Range: Rulers, vernier callipers, scribers, centre-punches, micrometers, vernier height gauges, feeler gauges, thread gauges, angle gauges, dividers, engineers' squares, surface gauges, measuring tapes and protractors (digital and conventional types).

Learning Outcomes:

The student should be able to:

- Explain
  - terminology: measurement, dimension, radii, angle, and explain how they are read from measuring, marking and checking tools
  - how to care for different measuring, marking and checking tools
  - and apply reference and datum lines
  - various air-gap checking techniques.
- Identify
  - different measuring, marking and checking tools and explain how to use them
  - select and use measuring equipment for testing and measurement of lengths, angles and surfaces.
- Measure lengths with rulers, vernier callipers, to check adherence to tolerances and fits.
- Use the light gap method to check surfaces for smoothness, angle and form, visually check surface finish in accordance with machine symbols and drawing instructions.
- Scribe, centre punch and mark off work pieces with consideration for material characteristics.
- Measure and mark angles with a protractor and check with an angle gauge.

7.3.2 Subject Outcome 2: Describe and perform cutting and forming.

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/power fixed/manual), related cutting fluids, grindstones and grinding machines.

Learning Outcomes:

The student should be able to:

- Name and identify
  - hand tools that may be used when cutting and forming
  - and explain various parts of a drilling machine and a grinding machine
- Explain
  - how to care for cutting and forming tools
  - how to use cutting and forming tools
  - various processes that are used when cutting and forming
  - various thread types
  - the purpose of work holding and how it is done
  - the various aspects of safety when using chip making machinery
  - what is meant by the following terms: chip making processes, friction, speed/strokes per second, revolutions per second, grinding, reaming, drilling, cutting, forming, filing, tapping
- Saw plastic and metal sheets, plates and profiles as prescribed.
- File and deburr surfaces and shapes of work pieces flat, square, parallel and angled to a measure and accuracy of +/- 2mm and to a surface finish of Rz of between 6.3 and 40µm.
- Drill holes to a location tolerance of +/- 0.2mm by drilling, enlarging and profile countersinking and reaming, drilling holes to an accuracy as per IT7 and surface finish RZ of between 4 -10µm.
- Cut
  - internal and external threads with taps and dies.
  - sheet metal and plastic with hand lever cutters.
  - pipes and tubing to length.
- Make cold form metals sheets, pipes and profiles from ferrous and non-ferrous metals.
- Read, interpret and apply component drawings.

7.3.3 Subject Outcome 3: Describe and perform joining and assembly.

Range: Assembly tools: screwdrivers (flat and Phillips), pliers (general purpose, long nose, pipe, circlip), spanners (adjustable wrenches, chain tongs, ring spanners, flat spanners, socket wrenches and sockets, allen keys, stillson wrenches, torque wrenches).
Fasteners: Threaded fasteners (screws, bolts, nuts), auxiliary fasteners (split pins, washers, locking wires, locking fluid), general fasteners (glues, resins, anchoring systems).

Learning Outcomes:

The student should be able to:

- Identify, name and explain the use
  - and care of assembly tools
  - and purpose of various fasteners.
- Explain
  - the care that must be taken when using particular fasteners (adhesives etc)
  - what is meant by the following terminology: force, pressure, torque, shear force, tension, neck-out, fatigue, stretched, limit of elasticity, mechanical advantage
- Make connections using screws, nuts and washers, securing with spring washers, tooth-lock washers and resins.
- Make connections in consideration of assembly sequences.
- Pin parts with form fits, considering surface characteristics.
- Identify parts in accordance to materials list and pre-assemble.
- Assembly applications:
  - Installation of lubricating and cooling devices.
  - Connecting pipe and tubing and checking for leaks.
  - Fit components, align and secure for function.
  - Install drive gears and couplings.
  - Install protective devices, guards and covers and insulation.
  - Install ducts, cable trays, pipes.
- Read, interpret and apply assembly drawings.

7.4 Topic 4: Identify, select and use correct soldering and welding techniques when joining metals.

7.4.1 Subject Outcome 1: Explain and perform joining of metals by means of welding.

Range: arc welding, gas welding, gas cutting and MIG/TIG welding.

Learning Outcomes:

The student should be able to:

- Explain
  - gas welding fuel requirements.
  - what makes up the gas, TIG/MIG and /or arc welding system.
  - setting up process of gas, MIG/TIG and/or arc welding equipment.
  - metals and their properties and the weldability thereof.
  - the arc welding process.
  - the elements that make up an arc welding system.
  - gas and arc welding joining techniques to produce work-pieces.
  - problems that can occur when gas or arc welding or cutting.
- Describe and list supplies for gas and arc welding.
- Read and interpret welding drawings
- Assess weldability of materials.
- Determine and select welding methods, apparatus and materials for welding, material preparation and work area preparation for the safe welding of sheets, pipes, profiles in the correct position
- Select brazing tools and fluxes so as to perform safe brazing functions.
- Apply
  - safety procedures and use personal safety equipment whilst working.
  - gas cutting techniques.

7.4.2 Subject Outcome 2: Explain and perform joining of metals by means of soldering.

Range: joining of cables and components to circuit boards and joining of sheet metals.

Learning Outcomes:

The student should be able to:

- Explain
  - what tools and equipment are required to perform soldering tasks.
  - how the selection of solder and fluxes take place.
  - how surface preparation is achieved.
  - various soldering techniques used in industry.
  - safety considerations related to soldering.
- Identify and select soldering tools and fluxes so as make soldered joints safe.
- Apply
  - surface preparation and soldering techniques.
  - safety considerations whilst working.

7.5 Topic 5: Identify, plan and select correct work processes and materials when manufacturing and assembling mechatronic sub-systems.

7.5.1 Subject Outcome 1: Describe and apply housekeeping procedures in the workplace.

Range: joining of cables, components to circuit boards and joining of sheet metals.

Learning Outcomes:

The student should be able to:

- Describe
  - what is meant by housekeeping.
  - the beneficial effect of good housekeeping.
  - how good housekeeping can be achieved.
- List possible accidents due to poor housekeeping.
- Describe the value and purpose of
  - colour coding.
  - symbolic signs.
- Apply housekeeping procedures in the work area.
- Report any unsafe acts or conditions.

7.5.2 Subject Outcome 2: Name and apply job-process and job procedure planning.

Learning Outcomes:

Range: Marking off, checking, measuring, forming, cutting and assembly processes, safety procedures, evacuation and accident reporting.

The student should be able to:

- List
  - job processes and tasks as used in a given manufacturing project.
  - the various job processes to be undertaken to complete a given project.
- Produce
  - written work task process cards as given projects/instructions are achieved.
  - work plan of given work projects (work plans and process cards are to be signed off by the facilitator and the learner).

7.5.3 Subject Outcome 3: Describe and use metals and plastics.

Range: ferrous and non-ferrous metals, plastics used in mechanical and electrical applications.

Learning Outcomes:

The student should be able to:

- Explain and describe
  - the classification of ferrous and non-ferrous metals.
  - the main properties of ferrous and non-ferrous metals.
  - how to identify different metals using techniques such as sound, spark, strength tests and by machining.
  - the colour code of metals used in industry.
  - characteristics of metals when heated.
- Describe the properties and uses of plastics such as tufnol and nylon.
- Select and use the correct material in the specific manufacturing process.

8 RESOURCE NEEDS FOR THE TEACHING OF MANUAL MANUFACTURING - LEVEL 2.

8.1 Physical resources

Mechatronics (Vocational Training) Level 2		
1	**MECHANICAL FUNDAMENTALS LAB/WORKSHOP**	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
1c	**Materials testing**	
	Material testing	1

2	**ELECTRICAL INSTALLATION AND MACHINE LAB**	
2a	**Classroom Facilities**	
	Workplace	20
	Teaching	20
	General	1
	Computer hardware	1
2b	**Electrical installation**	
	Safety and protection	2
	Industrial installation and control	2
	Domestic circuit installation and testing	2
2c	**Electrical Machines**	
	Transformers	2
3	**MOTION AND CONTROL LAB**	
3a	**Classroom Facilities**	
	Workplace	20
	Teaching	20
	General	1
	Computer hardware	10
3b	**Pneumatics**	
	Basic pneumatics	5
	Workstation pneumatics	2
	Software pneumatics	20
3c	**Electro-pneumatics**	
	Basic electro-pneumatics	5
	Workstation – electro-pneumatics	2
3d	**Hydraulics**	
3e	**Sensor Technology**	
	Proximity sensors	2
	Distance & displacement sensors	2
	Force and pressure sensors	2
	Workstation sensor technology	2
3f	**Basic and Advanced PLC**	
	Basic PLC	7

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
	Communication technology	3
4d	**E-learning**	
	Electronics	3
	Mechatronics	12
6	**COMPUTER LABORATORY**	
6a	**Classroom facilities**	
	Workstations	20
	Computer hardware	20
	Software (Microsoft office)	20
	Internet access	20

8.2 Equipment and machinery

The Mechatronic equipment as indicated above is the suggested minimum and other equipment can be used to obtain the same outcomes. Access by the learner and facilitator 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 Stationery

Files for Portfolio of Evidence and assessments, notes and learner materials are required.

8.4 Human resources

The lecturer should ideally be a fitter and turner or millwright with knowledge and experience in metal work, welding, gas welding and cutting, turning, milling, assembling both manually and CAD/ CAM and CNC. The lecturer should ideally be a lecturer registered on post level 1 or higher at a FET Institution, having relevant experience.

8.2 Financial resources

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