



**education**

Department:  
Education  
REPUBLIC OF SOUTH AFRICA

# **NATIONAL CERTIFICATES (VOCATIONAL)**

## **SUBJECT GUIDELINES**

### **WELDING**

### **NQF Level 3**

October 2007



# **WELDING – LEVEL 3**

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## INTRODUCTION

### A. What is Welding?

The purpose of this subject is to provide students with an insight into the welding industry as student welders. This subject extends the welding knowledge and skills gained in the Level 2 Welding programme.

Welding Level 3 forms part of the progression which overall exposes the student to the most common welding technologies available within the Manufacturing and Engineering Industry. Additional welding processes are introduced at this level. They include Gas Brazing and Gas Metal Arc Welding (GMAW). Skills are also enhanced at this level, for Shielded Metal Arc Welding (SMAW) and Gas Welding.

### B. Why is Welding important in the Engineering and Related Design learning programme?

This subject focuses on the intermediate skills, knowledge and values acquired by students involved in welding. The purpose of this subject (integrated with other subjects within this qualification), is to develop abilities to:

- Use and apply mechanical and welding technology, techniques, processes and skills, as applied in the fabrication and welding industry, using the appropriate tools and measuring equipment;
- Use and apply a variety of fillet welding, oxy-fuel cutting and oxy-fuel joining processes;
- Demonstrate knowledge of the welding industry and its productivity requirements, by applying appropriate work-procedures;
- Communicate effectively in order to achieve personal, business and organizational objectives.  
*Range: Reading and interpreting work instructions, documents and drawings; maintaining effective relationships; exploring options for further learning.*

Welding is regarded as a scarce skill in South Africa.

### C. The link between the Learning Outcomes for Welding and the Critical and Developmental Outcomes

- **Identify and solve problems and make decisions using critical and creative thinking**
  - During planning and preparation procedures
  - Recognising of hazards and defects and responding appropriately
  - During inspection of completed welding procedure.
- **Work effectively with others as members of a team, group, organisation or community**
  - Welders are usually part of a team. Working with others is an important part of a career in engineering.
- **Organise and manage themselves and their activities responsibly and effectively**
  - Preparation of the welding equipment and the work environment
  - Planning the welding work by reading and interpreting the work instructions or welding procedure specifications.
- **Work with information, that is, collect, analyse organise and critically evaluate information**
  - Interpretation of engineering drawings, work instructions and welding procedure specifications
- **Communicate effectively using visual, symbolic and language skills in different modes**
  - Communication in a high noise-level environment
  - Completion of welding reports and task documentation
  - Verbal reports at work / site meetings
- **Use science and technology effectively and critically showing responsibility towards the environment and the health of others**
  - The laws of physics apply to all engineering occupations
  - Exposure to health, safety and environmental hazards demand a sound knowledge of science and technology.
- **Demonstrate and explain the world as a set of related systems, by recognising that problem solving contexts do not exist in isolation**

- Welding is a single part of the manufacturing and engineering industry. Its role is integrated with occupations like fabricators (boilermakers or sheet-metalworkers), fitters, machinists, electricians, etc.
- The design of engineered products or machines, integrates with various technologies. The welding task also integrates with various parts of the design and manufacturing process.

In so doing, students should also be able to:

- Reflect and explore a variety of strategies to learn more effectively
- Participate as responsible citizens in this life of local, national and global communities
- Be culturally and aesthetically sensitive across a range of social contexts
- Explore education and training opportunities
- Develop entrepreneurial opportunities.

#### **D. Factors that contribute to achieving Welding Learning Outcomes**

Students choosing to enter a career in welding, require:

- Mechanical technology orientation
- Associated hand skills (dexterity and mental alertness)
- The ability to work in a team

## 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

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

- Explain and discuss the principles of arc welding with specific reference to plate welding
- Demonstrate an understanding and an ability to weld carbon steel work-pieces (fillet and grooves) using a variety of welding processes, namely Shielded Metal Arc; Gas and Gas Metal Arc Welding processes in the vertical, inclined and flat rotational positions.
- Demonstrate an understanding and an ability to perform Gas Brazing processes

## 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 Welding 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 Welding 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:**

- A. Presentations (lectures, demonstrations, group discussions and activities, practical work, observation, role-play, independent activity, synthesis and evaluation)
- B. Exhibitions by students
- C. Visits undertaken by students based on a structured assignment task
- D. Research
- E. 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 PoE. 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.

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. The practical component will also be assessed.

External assessment details and procedures are set out in the *Assessment Guidelines: Welding (Level 3)*.

**4 WEIGHTED VALUES OF TOPICS**

TOPICS	WEIGHTED VALUE
1. Principles of arc welding (plate)	10%
2. Shielded metal arc welding (all positions)	20%
3. Gas welding (all positions)	20%
4. Gas brazing	20%
5. Gas metal arc welding (down hand position)	30%
<b>TOTAL</b>	<b>100</b>

**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, moderating and the verification purposes.

**6 PASS REQUIREMENTS**

A student must obtain at least fifty (50) percent in ICASS and fifty (50) percent in the examination.

## 7 SUBJECT AND LEARNING OUTCOMES

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

- Topic 1: Principles of arc welding (plate)
- Topic 2: Shielded metal arc welding (all positions)
- Topic 3: Gas welding (all positions)
- Topic 4: Gas brazing
- Topic 5: Gas metal arc welding (down hand position)

### 7.1 Topic 1: Principles of arc welding (plate)

**7.1.1 Subject Outcome 1:** Discuss and explain the basics of welding steel.

#### Learning Outcomes

The student should be able to:

- Describe the processes when making steel
- Explain the influence of welding on steel.
- Discuss the differences between non-alloy, stainless steels and other alloy steels.
- Briefly explain the influence of alloying elements on the properties of steel.

**7.1.2 Subject Outcome 2:** Explain and discuss welded joints in plates and their terminology.

#### Learning Outcomes

The student should be able to:

- Identify various weld joints
- Use and explain welding terminology.
- Perform welding calculations

**7.1.3 Subject Outcome 3:** Explain the weld-ability of steels.

#### Learning Outcomes

The student should be able to:

- Explain the influence of alloying elements on the properties of weld-able steel
- Describe the effect of plate thickness on the properties of weld-able steel
- Calculate the heat input and mention its use.

**7.1.4 Subject Outcome 4:** Discuss and explain the effects of welding in terms of shrinkage, residual stresses and distortion, and demonstrate how to minimize distortion before, during and after welding

#### Learning Outcomes

The student should be able to:

- Describe the thermal cycle during welding.
- Describe the main causes of weld shrinkage.
- Describe distortion and residual stresses.

**7.1.5 Subject Outcome 5:** Identify and explain imperfections in welds

#### Learning Outcomes

The student should be able to:

- Discuss the causes of weld imperfections.

**7.1.6 Subject Outcome 6:** Explain the most frequently used fusion welding processes

#### Learning Outcomes

The student should be able to:

- Describe and explain the manual metal arc (MMA) welding process
- Describe and explain the metal inert gas and the metal active gas (MIG/MAG) welding processes
- Describe and explain tungsten inert gas (TIG) welding
- Describe and explain the plasma arc welding process
- Describe and explain the submerged arc welding process

**7.1.7 Subject Outcome 7:** Explain and demonstrate safe welding on a construction site.

**Learning Outcomes**

The student should be able to:

- Identify the hazards associated with welding on site
- Discuss and describe the precautions to be taken when welding on site

**7.1.8 Subject Outcome 8:** Explain the principles of basic non-destructive testing (NDT) methods used in welding

**Learning Outcomes**

The student should be able to:

- Perform simple visual inspection methods
- Describe the following destructive and non-destructive methods of testing welds

**7.1.9 Subject Outcome 9:** Explain the function of quality assurance (QA) in welding

**Learning Outcomes**

The student should be able to:

- Explain the need for quality assurance in welding
- Explain and discuss the standards for welding personnel and welding procedures in terms of assurance

**7.2 Topic 2: Shielded metal arc welding (all positions)**

**7.2.1 Subject Outcome 1:** Describe the shielded metal arc welding (SMAW) process

**Learning Outcomes**

The student should be able to:

- Explain the terminologies associated with shielded metal arc welding procedures.
- Explain the actual chemical and mechanical processes that take place during welding.
- Explain the shielded metal arc welding (SMAW) process (all positions)
- Identify the various welding parameters, in relation to the thickness of materials (steel) being welded.
- Demonstrate setting up procedures

**7.2.2 Subject Outcome 2:** Plan and prepare for the welding process

**Learning Outcomes**

The student should be able to:

- Explain the safety aspects of shielded metal arc welding (SMAW) in the fabrication workshop.
- Prepare the shielded metal arc welding (SMAW) equipment
- Prepare the work-piece prior to welding
- Prepare the welding environment.

**7.2.3 Subject Outcome 3:** Weld materials

*Range: Weld positions include: Fillet welding: Flat/Horizontal Vertical. Groove welding: Flat/Horizontal Vertical*

**Learning Outcomes**

The student should be able to:

- Describe and adhere to safety precautions when welding, according to workshop requirements and OHS Act
- Demonstrate the shielded metal arc welding (SMAW) process, using knowledge and skills attained.
- Inspect welded work-piece for defects and apply quality checks on process.

**7.2.4 Subject Outcome 4:** Care and storage of welding equipment

**Learning Outcomes**

The student should be able to:

- Explain the care and storage procedures for tools, equipment in accordance with work site practices and specifications.
- Explain the dismantling and storage procedures for welding equipment in accordance with manufacturer's specifications and requirements.

### **7.3 Topic 3: Gas welding (all positions)**

#### **7.3.1 Subject Outcome 1: Describe the oxy-acetylene welding process**

##### **Learning Outcomes**

The student should be able to:

- Identify and describe gas welding and related equipment
- Explain the actual chemical and mechanical processes that take place during welding.
- Explain the gas-welding method (all positions).
- Identify the various welding pressures and the correct nozzles associated with each, in relation to the thickness of materials (steel) being welded.
- Demonstrate start up and shut down procedures
- Identify, select and classify welding consumables
- Explain and discuss safety precautions associated with gas welding
- Explain the terminologies associated with oxygen-acetylene gas welding procedures.

#### **7.3.2 Subject Outcome 2: Plan and prepare for the gas welding process**

##### **Learning Outcomes**

The student should be able to:

- Explain the safety aspects of gas welding in the fabrication workshop.
- Prepare the welding equipment
- Prepare the work-piece prior to welding
- Prepare the welding environment

#### **7.3.3 Subject Outcome 3: Weld materials**

##### **Learning Outcomes**

The student should be able to:

- Describe and adhere to all safety precautions according to workshop requirements and OHS Act
- Demonstrate the gas welding process, using knowledge and skills attained by welding the work-piece.
- Inspect the welded work-piece for defects and apply quality checks on the welding process.

#### **7.3.4 Subject Outcome 4: Care for and store welding equipment**

##### **Learning Outcomes**

The student should be able to:

- Explain the care and storage procedures for tools and equipment in accordance with work site practices and specifications.
- Describe the dismantling and storage procedures in accordance with manufacturer's specifications and requirements.

### **7.4 Topic 4: Gas brazing**

#### **7.4.1 Subject Outcome 1: Describe the oxy-fuel brazing process**

##### **Learning Outcomes**

The student should be able to:

- Explain the actual chemical and mechanical processes that take place during brazing.
- Explain the brazing method.
- Identify the various brazing pressures and the correct nozzles associated with each, in relation to the thickness of materials (steel) being brazed.
- Demonstrate start up and shut down procedures
- Identify, select and classify brazing consumables
- Explain and discuss the safety precautions associated with gas brazing
- Explain the terminologies associated with oxygen-acetylene gas brazing procedures.

#### **7.4.2 Subject Outcome 2:** Plan and prepare for the gas brazing process

##### **Learning Outcomes**

The student should be able to:

- Explain the safety aspects of brazing in the fabrication workshop.
- Prepare the brazing equipment
- Prepare the work-piece prior to brazing
- Prepare the brazing environment

#### **7.4.3 Subject Outcome 3:** Braze the work-piece/s

##### **Learning Outcomes**

The student should be able to:

- Adhere to all safety precautions according to workshop requirements and OHS Act
- Demonstrate the gas brazing process, using knowledge and skills attained.
- Inspect brazed work-piece for defects and apply quality checks on process.

#### **7.4.4 Subject Outcome 4:** Care and storage of brazing equipment

##### **Learning Outcomes**

The student should be able to:

- Explain the care and storage procedures for tools, equipment in accordance with work site practices and specifications.
- Dismantle and store gas brazing equipment in accordance with manufacturer's specifications and requirements.

### **7.5 Topic 5: Gas metal arc welding (down hand position)**

#### **7.5.1 Subject Outcome 1:** Describe the gas metal arc welding (GMAW) process

##### **Learning Outcomes**

The student should be able to:

- Explain the terminologies associated with gas metal arc welding procedures.
- Explain the actual chemical and mechanical processes that take place during welding.
- Explain the gas metal arc welding (GMAW) process (down hand position)
- Identify the various welding parameters, in relation to the thickness of materials (steel) being welded.
- Demonstrate setting up procedures

#### **7.5.2 Subject Outcome 2:** Plan and prepare for the welding process

##### **Learning Outcomes**

The student should be able to:

- Explain the safety aspects of GMAW in the fabrication workshop
- Prepare the gas metal arc welding (GMAW) equipment
- Prepare the work-piece prior to welding
- Prepare the welding environment

#### **7.5.3 Subject Outcome 3:** Weld materials

##### **Learning Outcomes**

The student should be able to:

- Explain and adhere to all safety precautions according to workshop requirements and OHS Act when welding.
- Demonstrate the gas metal arc welding (GMAW) process, using knowledge and skills attained by welding the work-piece
- Inspect welded work-piece for defects and apply quality checks on process.

#### **7.5.4 Subject Outcome 4: Care for and store welding equipment**

##### **Learning Outcomes**

The student should be able to:

- Explain the care and storage procedures for tools and equipment in accordance with work site practices and specifications.
- Welding equipment dismantled and stored in accordance with manufacturer's specifications and requirements.

### **8. RESOURCE NEEDS FOR THE TEACHING OF WELDING - LEVEL 3**

#### **8.1 Physical resources**

- A classroom environment with necessary teaching aids (includes but not limited to black/white-board; tables, chairs, OHP and/or data-projector, video/DVD machine and including audio-visual learning materials)
- A workshop dedicated to welder training, able to accommodate separated arc-welding and oxy-acetylene welding and cutting facilities.
- Hand and power tools,
- Marking-off and measuring tools,
- Metal cutting machine
- AC or DC welding machines for shielded metal arc welding (SMAW) and metal inert gas welding (GMAW)
- Shielding gases (argo-CO5 / CO2 – MIG) and a small baking oven
- Oxygen and acetylene gas cylinders; welding electrodes (2mm/ 12 gauge wire for 3mm plate); cutting nozzles (0.8 mm nozzles); extension cables (20 metre); grinding discs (115mm and 230mm); steel cutting discs (115mm and 230 mm)
- Adequate equipment for implementation of safety measures: Protective sight screens; personal protective equipment; suitably ventilated workspace

#### **8.2 Human resources**

- Welder training educator/instructors (trade tested educator and adequately prepared/trained in NCV / OBE vocational learning programmes and methodology).

#### **8.3 Other resources**

- Learning material for NCV: Welding Level 3
- Non-destructive test materials (dye-penetrant) for assessing weld-quality.
- Adequate ventilation or an extraction system is important health and safety factor.
- Fire extinguishers