education

Department:
Education
REPUBLIC OF SOUTH AFRICA

NATIONAL CERTIFICATES (VOCATIONAL)

SUBJECT GUIDELINES

WELDING

NQF Level 2

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INTRODUCTION

A. What is Welding?

Metals are the most important materials available in the field of manufacturing and engineering today, and have also been used for thousands of years, for metal tools, weapons and structures.

Welding is a joining process used mainly for joining metals, yet all the important welding processes used today were developed within the last fifty to seventy-five years. Because of the development of different welding processes and also the development of new steels and other materials that can be welded, welding has become a most important process in manufacturing, engineering and the fabrication of plate, pipe and structural steel components.

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

This subject recognises the basic skills, knowledge and values acquired by students involved in welding. The purpose of this subject (integrated with other subjects of the learning programme) is to develop students who demonstrate the ability 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.

The purpose of this subject is to provide students with the necessary orientation into the welding industry.

The subject is characterized by the provision of engineering services and support by engineering companies and individuals across various industry sectors, namely:

- Manufacturing and engineering (metals, plastics, tyre and rubber, automotive manufacturing)
- Chemical and petrochemical
- Mining
- Transport (maritime, road, rail and aviation);
- Civil engineering and construction
- Food and beverages; and
- Other engineering-related industry sectors

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
- Communication skills.

WELDING – LEVEL 2

CONTENTS

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 fillet welding
- Demonstrate an understanding of and an ability to weld carbon steel work-pieces using a variety of welding processes, namely shielded metal arc; gas and gas metal arc welding 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 of Welding 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 Welding 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:**
  - 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 such 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: Welding Level 2.*

4 WEIGHTED VALUES OF TOPICS

TOPICS	WEIGHTED VALUE
1. Principles of arc welding (fillet welding)	10
2. Shielded metal arc welding (downhand position)	45
3. Oxy-acetylene cutting (gas cutting)	20
4. Oxy-acetylene welding (gas welding: downhand position)	25
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 (50) percent in ICASS and fifty (50) percent in the examination.

7 SUBJECT AND LEARNING OUTCOMES

On completion of Welding Level 2, the student should have covered the following topics:

Topic 1: Principles of arc welding (fillet welding)
Topic 2: Shielded metal arc welding
Topic 3: Gas cutting
Topic 4: Gas welding

7.1 Topic 1: Principles of arc welding (fillet welding)

7.1.1 Subject Outcome 1: Describe the use of electricity for arc welding

Learning Outcomes

The student should be able to:
- Describe the principles of arc welding
- Explain the basic terms in welding
- Briefly explain heat generation in the arc
- Briefly explain material transfer through the arc
- Briefly explain the formation of the weld pool

7.1.2 Subject Outcome 2: Describe the operating principles of welding equipment for arc welding.

Learning Outcomes

The student should be able to:
- Describe the major components of welding equipment and their function.
- Describe polarity and change of polarity
- Name the important parameters of arc welding

7.1.3 Subject Outcome 3: Explain the hazards and basic safety requirements when welding

Learning Outcomes

The student should be able to:
- Identify dangerous situations related to electricity (humidity, DC and AC).
- Describe health risks associated with welding fumes.
- Identify signals for escape routes.
- Identify and use personal protective equipment.
- Identify measures to prevent a fire.
- Identify measures to prevent noise from being a hazard.
- Explain rules and regulations

7.1.4 Subject Outcome 4: Describe how to perform welding activities safely in the fabrication shop.

Learning Outcomes

The student should be able to:
- Explain and discuss general hazards in the fabrication shop.
- Explain the need for ventilation.
- Explain the risk of explosions.
- Describe and explain the safe handling of gas cylinders.

7.1.5 Subject Outcome 5: Explain the basic principles of the use of welding consumables.

Learning Outcomes

The student should be able to:
- Identify and explain the types and functions of welding consumables and their applications.
- Explain the reasons for and explain how to dry, store and handle welding consumables.
- Identify the designation of welding consumables as used on a Welding Procedure Specification (WPS) of a training program.

7.1.6 Subject Outcome 6: Describe how to work to a welding procedure specification (WPS) and using welding parameters

Learning Outcomes

The student should be able to:
- Explain and discuss the function and purpose of a welding procedure specification.

- Explain the various welding parameters and welding positions.
- Demonstrate an understanding of welding symbols (ISO 2553)

7.1.7 Subject Outcome 7: Describe the effect of welding parameters on performance and their influence on welding surface.

Learning Outcomes

The student should be able to:
- Explain and discuss weld imperfections.
- Discuss the control of welding parameters
- Explain the effect of magnetic arc blow.

7.1.8 Subject Outcome 8: Explain and apply methods of joint preparation for welding

Learning Outcomes

The student should be able to:
- Discuss the methods used for joint preparation and their specific application
- Explain the parameters and results associated with thermal cutting (plasma and flame cutting)
- Identify suitable cutting and gouging processes for the main types of steel.

7.1.9 Subject Outcome 9: Explain the basics of a welder qualification according to ISO 9606

Learning Outcomes

The student should be able to:
- Describe the range of a qualification in a welder's certificate.
- Outline the essential variables for a welder qualification test.

7.2 Topic 2: Shielded metal arc welding l2

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

Learning Outcomes

The student should be able to:
- Comprehensively explain the terminologies associated with shielded metal arc welding procedures.
- Briefly explain the actual chemical and mechanical processes that take place during welding.
- Explain the down-hand SMAW method.
- 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 SMAW in the fabrication workshop.
- Prepare the SMAW equipment
- Prepare the welding environment.

7.2.3 Subject Outcome 3: Weld the materials

Learning Outcomes

The student should be able to:
- Explain the safety precautions when welding, according to workshop requirements and OHS Act
- Demonstrate the SMAW process by welding the work-piece, using the knowledge and skills attained,
- Inspect the welded work-piece for defects and apply quality checks on process.

7.2.4 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, equipment in accordance with work site practices and specifications.
- Dismantle and store the welding equipment in accordance with manufacturer's specifications and requirements.

7.3 Topic 3: Gas cutting

7.3.1 Subject Outcome 1: Describe the oxy-acetylene cutting process

Learning Outcomes

The student should be able to:

- Explain the terminologies associated with oxygen-acetylene gas cutting procedures
- Identify the various cutting pressures and the correct nozzles associated with each in relation to the thickness of materials (steel) being cut
- Explain the actual chemical and mechanical processes that take place during cutting
- Explain and implement the procedures for carrying out pre-operational checks
- Demonstrate start up and shut down procedures

7.3.2 Subject Outcome 2: Cut materials

Learning Outcomes

The student should be able to:

- Explain and implement the safety precautions when gas cutting materials, according to workshop requirements and OHS Act
- Demonstrate the cutting operation using the knowledge and skills attained, by cutting the material.
- Explain the application of quality checks on the gas cutting process.

7.3.3 Subject Outcome 3: Care for and store tools and cutting equipment

Learning Outcomes

The student should be able to:

- Explain the care and storage procedures for tools and equipment in accordance with worksite practices and specifications.
- Describe and implement the dismantling and storage of oxy-fuel cutting equipment in accordance with manufacturer's specifications and requirements.

7.4 Topic 4: Gas Welding

7.4.1 Subject Outcome 1: Describe the oxy-acetylene welding process

Learning Outcomes

The student should be able to:

- Explain the terminologies associated with oxygen-acetylene gas welding procedures.
- Identify and describe gas welding and related equipment
- Explain the actual chemical and mechanical processes that take place during welding.
- Explain the down-hand gas-welding method.
- 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 the safety precautions associated with gas welding.

7.4.2 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 welding environment

7.4.3 Subject Outcome 3: Weld materials

Learning Outcomes

The student should be able to:

- Explain and implement the safety precautions when welding, according to workshop requirements and OHS Act
- Demonstrate the gas welding process, using the knowledge and skills attained, by welding the work-piece

- Explain and implement the inspection process of welded work-pieces for defects and the application of quality checks.

7.4.4 Subject Outcome 4: Care and storage of tools and equipment

Learning Outcomes

The student should be able to:

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

8. RESOURCE NEEDS FOR THE TEACHING OF WELDING - LEVEL 2

- **Physical resources**
  - A classroom environment with necessary teaching aids (includes but not limited to black/white-board; tables, chairs, overhead projector and/or data-projector, video/DVD machine and including audio-visual learning materials)
  - A workshop dedicated to welder training suitable 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; 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

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

- **Other resources**
  - Learning material for NCV: Welding Level 2
  - Non-destructive test materials (dye-penetrant) for assessing weld-quality.
  - Adequate ventilation or an extraction system is an important health and safety factor.
  - Fire extinguishers