education

Department:
Education
REPUBLIC OF SOUTH AFRICA

NATIONAL CERTIFICATE (VOCATIONAL)

SUBJECT GUIDELINES

ENGINEERING

FABRICATION - SHEET METAL WORK

NQF Level 4

September 2007

CONTENTS

INTRODUCTION

A. What is Engineering Fabrication - Sheet Metal Work?

Engineering Fabrication and Sheet Metal Work deals with the various processes involved in making or producing steel components required in the manufacturing, engineering and technological environments. Students are trained to take factors such as safety, planning and preparation for fabricating, choice of tools and equipment and various other factors into account.

B. Why is Engineering Fabrication - Sheet Metal Work important in the Engineering and Related Design programme?

In this programme, students will be expected to make or produce steel components relating to the requirements of industry. Therefore, Engineering Fabrication and Sheet Metal Work will prepare students with the required confidence levels to fabricate components to a high degree of accuracy and efficiency. Students will be required to fully understand the principles of drawing that are critical to the fabrication processes.

In the South African context, sugar mills, oil refineries, mines, harbours and ports and agricultural industries all require steel components for various manufacturing, experimental, maintenance and storage purposes at all times; consequently, students must be trained to fabricate and produce components.

C. The link between the Learning Outcomes for Engineering Fabrication - Sheet Metal Work and the Critical and Developmental Outcomes

The Learning Outcomes addressed in this subject address many of the Critical and Developmental Outcomes as follows:

- Identify and solve problems showing responsible decisions have been taken.
- Work effectively with others in a group or team.
- Organise oneself in a responsible and effective manner.
- Collect, analyse and evaluate information.
- Realise the world is a set of interrelated systems by showing solutions of problems do not exist in isolation.

D. Factors that contribute to achieving the Engineering Fabrication - Sheet Metal Work Learning Outcomes

Students who show an interest in the interpretation of engineering drawings and who appreciate analytical and critical evaluation of processes and systems are likely to do well I this subject. Also, students who have a developed sense of creativity will enjoy this subject. Problem-solving skills are an advantage when achieving the Learning Outcomes. Students who have managerial and leadership qualities will also be likely to succeed.

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 all the assessment requirements are adhered to.

Students with special education needs (LSEN) must be catered for in a way that eliminates barriers to learning.

2 SUBJECT LEVEL FOCUS

The student should be able to:

- Produce components using fabrication processes.
- Join components using a variety of welding techniques to produce steel tanks and transition pieces to given specifications.
- Select and apply fabrication procedures to evaluate the end products to ensure conformance to specifications.

3 ASSESSMENT REQUIREMENTS

The purpose of assessment is to determine the student's progress in learning and to make a judgement about the student's work. The judgement should be based on sufficient evidence in respect of the Learning Outcomes being considered. Evidence can be collected at different times and places and with the use of various methods, instruments, modes and media. Assessment of learning for promotion or certification in the National Certificate (Vocational) comprises two components. A comprehensive Portfolio of Evidence (PoE) of achievements gathered during the year and an external assessment in the form of a theoretical examination are used to assess students.

Assessment should take place within a framework of good assessment principles that are underpinned by the objectives of the National Qualifications Framework (NQF). These objectives are to:

- Create an integrated national framework for learning achievements.
- Facilitate access to and mobility and progression within education, training and career paths.
- Enhance the quality of education and training.
- Contribute to the full personal development of each student and the social and economic development of South Africa.

3.1 Internal assessment (50 percent)

All assessment must be moderated according to the internal moderation policy of the Further Education and Training (FET) college. Moderation is a continuous process from planning the assessment methods and instruments to providing continuous support to the assessors.

Before a lecturer assesses students, it is crucial that the purpose of the assessment is clearly and unambiguously established. The purpose of the assessment must be understood to ensure that an appropriate match exists between the purpose and method of assessment, in order that decisions and conclusions based on the assessment are fair and appropriate for the particular purpose.

3.1.1 Theoretical component

The theoretical component forms 40 percent of the internal assessment mark.

Internal assessment of the theoretical component in Engineering Fabrication and Sheet Metal Work 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 Engineering Fabrication and Sheet Metal Work 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 (PoE). The tools and instruments used to conduct these assessments must be part of the evidence contained in the Portfolio of Evidence (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: Engineering Fabrication and Sheet Metal Work* (Level 4).

4 WEIGHTED VALUES OF TOPICS

TOPICS		WEIGHTED VALUE
1.	Join stainless steel with the Tungsten Inert Gas (TIG) welding process	30%
2.	Design and develop sheet metal work components with the use of computer-aided drawing software. (CAD)	30%
3.	Computer numerical control (CNC) sheet metal work fabrication	40%
	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

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

7 SUBJECT AND LEARNING OUTCOMES

On completion of Engineering Fabrication and Sheet Metal Work Level 4, the student should have covered the following topics:

Topic 1: Join stainless steel with the Tungsten Inert Gas (TIG) welding process
Topic 2: Design and develop sheet metal work components with the use of computer-aided drawing software. (CAD)
Topic 3: Computer numerical control (CNC) sheet metal work fabrication

7.1 Topic 1: Join stainless steel with the Tungsten Inert Gas (TIG) welding process

7.1.1 Subject Outcome 1: Prepare for the work activity.

Learning Outcomes

The student should be able to:

- Explain general safety precautions and fire prevention measures applicable to the TIG welding process.
- Identify and describe the functions of TIG welding equipment.
- Identify and describe the properties of the different shielding gases used for TIG welding.
- Set up TIG welding equipment in accordance with manufacturer's instructions.
- Carry our pre-operational checks and tests on TIG welding equipment.
- Demonstrate start-up and shut down procedure.
- Prepare the material for welding.

7.1.2 Subject Outcome 2: Weld work pieces.

Learning Outcomes

The student should be able to:

- Prepare the work area (provide for ventilation, fume extraction and fire hazards).
- Select and examine tungsten electrodes and filler rods to suit material that is to be welded.
- Adjust amperage to suit the type and thickness of metal that is to be welded.
- Adjust and set the regulator or flowmeter to suit the type and thickness of metal that is to be welded.
- Select the correct tungsten electrode to weld the work pieces.
- Weld stainless steel components in a down hand position using knowledge and skills acquired.
- Identify and use the correct personal protective equipment.

7.1.3 Subject Outcome 3: Apply quality checks on welded work pieces.

Learning Outcomes

The student should be able to:
- Restore passivity of welded joint by applying the cleaning, pickling and passivating treatments correctly.
- Explain the nature and causes of TIG welding defects.
- Determine whether welded joints comply with WSP and drawing specifications.

7.1.4 Subject Outcome 4: Care and store TIG welding equipment and consumables.

Learning Outcomes

The student should be able to:
- Explain caring and storing procedure for tools and equipment according to worksite procedure.
- Dismantle TIG welding equipment as per worksite procedure.
- Store tools and equipment according to worksite practices.
- Store gas cylinders safely in accordance with safety regulations.

7.2 Topic 2: Design and develop sheet metal work components with the use of computer-aided drawing software (CAD)

7.2.1 Subject Outcome 1: Explain sheet metal work components for air-conditioning and ventilation duct layout.

Learning Outcomes

The student should be able to:
- Explain the terminology applicable to square/rectangular ductwork and identify the fittings used.
- Explain the terminology applicable to round ductwork and identify the fittings used.

7.2.2 Subject Outcome 2: Identify and draw a schematic duct layout drawing.

Learning Outcomes

The student should be able to:
- Identify materials for construction of ductwork.
- Explain standards, types of joints and connections for the manufacturing of ductwork.
- Identify and explain the types and methods of thermal and acoustic acquisition.
- Produce schematic ductwork layouts to scale.

7.2.3 Subject Outcome 3: Draw ductwork schematic within an architectural layout drawing.

Learning Outcomes

The student should be able to:
- Produce ductwork components and fittings within an architectural building layout drawing.
- Draw to scale a ductwork layout within an architectural layout which includes dimensioning.
- Identify the terminology for air diffusion terminals within the ductwork layout.
- Produce a schematic layout within agreed timeframes.

7.2.4 Subject Outcome 4: Identify and describe air conditioning and ventilation plant and equipment in relation to a duct layout.

Learning Outcomes

The student should be able to:
- Identify and describe the applicable terminology for air movement equipment.
- Draw and describe a schematic plant layout for an air conditioning and ventilation plant.
- Insert mark numbers, equipment sizes and dimensions on the drawing.
- Produce a layout of plant and equipment with flow symbols and dimensions within agreed time frames.
- Identify and describe air diffusion terminals within the ductwork layout.

7.3 Topic 3: Computer numerical control (CNC) sheet metal work fabrication

7.3.1 Subject Outcome 1: Explain and demonstrate various aspects of CNC technology.

Learning Outcomes

The student should be able to:
- Identify and describe different types of CNC machines and controls used in industry.
- Compare conventional machine operation methods with CNC machine operations.
- Choose between conventional method or CNC method.
- Understand the cost difference between the different operating systems.

7.3.2 Subject Outcome 2: Prepare and write CNC programme.

Learning Outcomes

The student should be able to:
- Interpret drawings and define tool-path geometry calculations.
- Calculate tool part co-ordinates.
- Define programme elements and machine codes.
- Select appropriate tools for CNC operation.
- Write and simulate the programme.

7.3.3 Subject Outcome 3: Prepare and set machine.

Learning Outcomes

The student should be able to:
- Produce freehand sketches.
- Interpret engineering drawings.
- Set up tools.
- Prepare, lubricate and perform pre-operational checks on the machine.
- Check, select and adjust clamping pressures appropriate for the task.

7.3.4 Subject Outcome 4: Programme machine.

Learning Outcomes

The student should be able to:
- Apply basic geometry for CNC machining (axis directions, co-ordinate systems, zero and reference points).
- Explain and apply G-codes and M-codes and their functions.
- Transfer programme from PC to the CNC machine.
- Read and understand the machine control panel.
- Edit programme.

7.3.5 Subject Outcome 5: Operate CNC machine

Learning Outcomes

The student should be able to:
- Select the correct tools for a specific job.
- Monitor, adjust and replace worn or damaged tooling.
- Remove and measure components.
- Identify lubricants and coolants needed to maintain machine.
- Clean the machine.

8 RESOURCE NEEDS FOR THE TEACHING OF ENGINEERING FABRICATION - SHEET METAL WORK - LEVEL 4

8.1 Physical resources

- Light steel fabrication workshops
- Guillotine and bending break
- Partitioned room adjacent to workshops to serve as templating or drawing loft/office
- Computer-equipped drawing rooms
- Computer with internet networks
- Hand and power tools
- Marking and measuring tools
- Cutting equipment
- AC or DC welding machines
- Gantries with heavy duty slings and chain and block tackles

8.2 Human resources

- Certificated educators with at least a National Professional Diploma in Education
- Preferably a trade tested educator with competencies in this field
- Assessor and Moderator competencies
- Workshops, courses and other upskilling activities

8.3 Other resources

- Welding electrodes (2mm/12 gauge wire for 3mm plate)
- Cutting nozzles (0.8 mm nozzles)
- Extension cables (20 meter)
- Grinding discs (115mm and 230mm)
- Steel cutting discs (115mm and 230 mm)
- Principles of developments (handbook for boilermakers)