education

Department:
Education
REPUBLIC OF SOUTH AFRICA

NATIONAL CERTIFICATES (VOCATIONAL)

SUBJECT GUIDELINES

ENGINEERING

FABRICATION - BOILERMAKING

NQF Level 4

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INTRODUCTION

A. What is Engineering Fabrication - Boilermaking about?

Engineering Fabrication and Boilermaking 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 - Boilermaking important in the Engineering and Related Design learning programme?

In this programme, students will be expected to produce steel components relating to the requirements of industry. Engineering Fabrication and Boilermaking will equip students with the required confidence levels to fabricate components to a high degree of accuracy and efficiency. Students will be required to understand fully the principles of drawing critical to 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 - Boilermaking 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.
- Working effectively with others in a group or team.
- Organising 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 Engineering Fabrication - Boilermaking Learning Outcomes

Students who show an interest in the interpretation of engineering drawings and who appreciate analytical and critical evaluation of processes and systems will do well in 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.

ENGINEERING FABRICATION - BOILERMAKING - LEVEL 4

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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

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 specifications.
- Select and apply fabrication procedures and 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.

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.

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 Boilermaking Level 4 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 the PoE.

Internal assessment of the practical component in Engineering Fabrication and Boilermaking 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:**

  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 is 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 tools 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 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: Engineering Fabrication and Boilermaking* (Level 4).

4 WEIGHTED VALUES OF THE TOPICS

TOPICS	WEIGHTED VALUE
1. Explain and demonstrate the fabrication of pressure vessels	20%
2. Erecting fabricated structural steel	20%
3. Pipe work fabrication and assembly	20%
4. Computer Numerical Control (CNC) 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 Boilermaking Level 4, the student should have covered the following topics:

Topic 1: Explain and demonstrate the fabrication of pressure vessels
Topic 2: Erecting fabricated structural steel
Topic 3: Pipe work fabrication and assembly
Topic 4: Computer Numerical Control (CNC) fabrication

7.1 Topic 1: Describe, explain and discuss pressure vessels

7.1.1 Subject Outcome 1: Explain and demonstrate the fabrication of pressure vessels.

Learning Outcomes

The student should be able to:
- Identify and explain various welding symbols as per Welding Institute.
- Explain and apply the calculations required for weld thicknesses as determined by the vessel specifications in order to facilitate the welding process.
- Select the correct structural sections according to drawing specifications.
- Correctly and comprehensively describe the marking out procedures using templates.
- Use the various calculations involved in the fabrication processes.

7.1.2 Subject Outcome 2: Explain and demonstrate fabrication for dished-ends.

Learning Outcomes

The student should be able to:
- Choose the correct formulae to produce the required cut out for fabricating a dished-end.
- Demonstrate the establishing of datum points as well as setting out points (SOP) for fabrication of dished-ends.
- Select and use the correct marking off tools for fabricating a dished-end.
- Correctly operate the machine and equipments used to press a dished end.
- Assess the accuracy of the final product.

7.1.3 Subject Outcome 3: Pressure testing of vessels.

Learning Outcomes

The student should be able to:
- Interpret various actions and define correctly the terminologies associated with pressure testing.
- Operate pressure testing equipment as per job specifications.
- Prepare a report on the results of the test and hand to facilitator.
- Explain the reasons for commonly using water as the medium for testing pressure.

7.2 Topic 2: Erecting fabricated structural steel

7.2.1 Subject Outcome 1: Interpret erection drawings.

Learning Outcomes:

The student should be able to:

- Examine erection drawings to gain an overview of the job.
- Apply understanding of the drawing to create a mental picture.
- Examine the drawings and interpret symbols, data and specifications in regard to gradients, levels and heights.

7.2.2 Subject Outcome 2: Planning and preparing for erection.

Learning Outcomes:

The student should be able to:

- Explain the importance of planning and preparing the steelwork for erection.
- Separate the various sections from each other to differentiate between columns, rafters, bracings and other members.
- Examine each member to see if it is stamped or marked according to the drawing.
- Set the steelwork according to primary and secondary erection lists.
- Explain the reasons for erecting columns first followed by ties.

7.2.3 Subject Outcome 3: Erecting the steelwork.

Learning Outcomes:

The student should be able to:

- Apply all safety knowledge gained prior to erection.
- Explain and demonstrate basic rigging hand signals.
- Use basic hand signals to direct the crane operators to lift the required steelwork and place in position.
- Choose the correct lifting equipment in accordance with the job requirements.
- Constantly make reference to the drawing to sequentially place the correct steelwork in the respective positions.
- Correctly choose the fasteners required as per the job/drawings specifications.
- Inspect the process to ensure that the correct steel and procedures are used.
- Mark off the completed sections on the drawing to obviate duplication and confusion.
- Leave the worksite neat and devoid of safety hazards.

7.3 Topic 3: Pipe work fabrication and assembly.

7.3.1 Subject Outcome 1: Explain and demonstrate various aspects of pipe work fabrication.

Learning Outcomes:

The student should be able to:

- Read and interpret isometric, orthographic, general arrangement drawings and flow sheet diagrams.
- Identify and explain various symbols and abbreviations used in pipe work.
- Explain terminologies associated with pipe work fabrication and assembly.
- Demonstrate the ability to describe the functions, and select correctly the fittings, components and supports used in pipe work systems.
- Correctly and comprehensively interpret pipe work specifications from flow sheet diagrams.

7.3.2 Subject Outcome 2: Laying out and marking off pipe work sections.

Learning Outcomes:

The student should be able to:

- Correctly select marking off tools for pipe work layout.
- Explain and demonstrate the correct use of all relevant drawing and measuring tools and equipment.
- Establish setting out points and datum line.
- Lay out pipe work sections by applying correct laying out techniques.
- Produce material and cutting list for pipe work fabrication.

7.3.3 Subject Outcome 3: Perform calculations for pipe work fabrication.

Learning Outcomes:

The student should be able to:

- Apply elementary trigonometric concepts in pipe work calculations.
- Calculate lengths of piping, making necessary allowances for fittings.
- Calculate tank capacities and pressures under different heads of water.
- Correctly use conversion factors.

7.3.4 Subject Outcome 4: Set-up, align and tack weld pipes and fittings for pipe work assembly.

Learning Outcomes:

The student should be able to:

- Select and use measuring tools for pipe work assembly.
- Select and use checking tools at completion of pipe work assembly.
- Set-up, align and tack weld short and long lengths of pipe in position.
- Complete the pipe work assembly and indicate readiness for welding.
- Explain the importance of completing and signing off documentation.

7.4 Topic 4: Computer Numerical Control (CNC) fabrication

7.4.1 Subject Outcome1: 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.
- Explain the cost difference between the different operating systems.

7.4.2 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 path co-ordinates.
- Define programme elements and machine codes.
- Select appropriate tools for CNC operation.
- Write and simulate the programme.

7.4.3 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.

7.4.4 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 machine.
- Read and understand the machine control panel.
- Edit programme.

7.4.5 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 - BOILERMAKING – 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)