education

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REPUBLIC OF SOUTH AFRICA

NATIONAL CERTIFICATE (VOCATIONAL)

SUBJECT GUIDELINES

ENGINEERING FABRICATION - BOILERMAKING

NQF Level 3

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ENGINEERING FABRICATION - BOILERMAKING – LEVEL 3

CONTENTS

INTRODUCTION

A. What is Engineering Fabrication - Boilermaking?

Engineering Fabrication / 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 programme?

In this programme, students will be expected to make or produce steel components relating to the requirements of industry. Therefore, Engineering Fabrication / 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 that are critical to fabrication processes.

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

C. The link between the Engineering Fabrication - Boilermaking Learning Outcomes and the Critical and Developmental Outcomes

The Learning Outcomes addressed in this subject link to 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 - Boilermaking Learning Outcomes

Students should be interested in the interpretation of engineering drawings and appreciate analytical and critical evaluation of processes and systems. 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 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 with fabrication processes.
- Join components using a variety of welding techniques to produce steel tanks and transition pieces to specifications.
- Select and apply fabrication procedures to evaluate the end products to ensure conformance to specifications.

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 Engineering Fabrication / Boilermaking 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 PoE.

Internal assessment of the practical component in Engineering Fabrication / Boilermaking 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:**
  - 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 PoE. The tools and instruments constructed and used to conduct these assessments must be clear from 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 (40 percent) and the practical component (60 percent) 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. A practical component will also be assessed.

External assessment details and procedures are set out in the *Assessment Guidelines: Engineering Fabrication / Boilermaking* (Level 3).

4 WEIGHTED VALUES OF TOPICS

TOPICS	WEIGHTED VALUE
1. Structural steel fabrication	20%
2. Perform basic welding or joining of metals	30%
3. Steel tank fabrication	25%
4. Transition piece fabrication	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 Engineering Fabrication / Boilermaking Level 3, the student should have covered the following topics:

Topic 1: Structural steel fabrication
Topic 2: Perform basic welding or joining of metals
Topic 3: Steel tank fabrication
Topic 4: Transition piece fabrication

7.1 Topic 1: Structural steel fabrication

7.1.1 Subject Outcome 1: Explain and demonstrate various aspects of structural steel fabrication.

Learning Outcomes

The student should be able to:

- Identify and explain various welding symbols.
- Explain various terminologies associated with the fabrication of structural steel.
- Demonstrate an ability to select the correct structural sections according to drawing specifications.
- Correctly and comprehensively describe the marking out procedures using templates.
- Explain and use the various calculations involved in the fabrication processes.

7.1.2 Subject Outcome 2: Laying out and marking off structural steel sections.

Learning Outcomes

The student should be able to:

- Correctly select and use marking off tools for structural steel.
- Demonstrate the establishing of datum points as well as setting out points (SOP) for fabrication of roof trusses, girders and gussets.

7.1.3 Subject Outcome 3: Fabricate structural steel.

Learning Outcomes

The student should be able to:

- Explain the use of a jig where one is required.
- Demonstrate the ability to tack pieces of steel together to form sections of a structure.
- Correctly select and use measuring tools to fabricate sections.
- Correctly select and use checking tools after fabrication.
- Correctly perform necessary calculations to the product to ensure accuracy at all times.
- Complete the fabrication process and indicate its readiness for welding.

7.2 Topic 2: Perform basic welding or joining of metals

7.2.1 Subject Outcome 1: Prepare for work activity.

Learning Outcomes:

The student should be able to:

- Select tools and equipment required for welding or joining of metals.
- Check whether tools and equipment are in good working condition.
- Check whether the machine is in good working condition.
- Practice workshop safety.

7.2.2 Subject Outcome 2: Weld or join metals.

Learning Outcomes:

The student should be able to:

- Select the electrode size (welding rod).
- Set the desired amperage.
- Adjust the shielding gas flow.
- Adjust the rate of electrode feed.
- Control the torch movement and electrode extension.
- Wear welder’s clothing.
- Ventilate welding area.
- Clean metals before welding or joining.

7.2.3 Subject Outcome 3: Apply quality checks on completed weld or joint.

Learning Outcomes:

The student should be able to:

- Examine weld for defects
- Determine whether the weld conforms to the drawing specifications.
- Identify values to be checked.
- Check for warping and twisting of work piece.
- Check dimensions against drawing.

7.2.4 Subject Outcome 4: Perform finishing activities.

Learning Outcomes:

The student should be able to:

- Clean surplus weld and spatter.
- Clean work piece surface and apply required surface coating.

7.2.5 Subject Outcome 5: Report incompliant or unsafe conditions while working.

Learning Outcomes:

The student should be able to:

- Inspect the working conditions.
- Identify any problems.
- List the unsafe conditions.
- Prepare a report on incompliant or unsafe conditions.

7.2.6 Subject Outcome 6: Work safely with due care for self, fellow workers, equipment,materials and environment.

Learning Outcomes:

The student should be able to:

- Apply worksite health and safety practices.
- Clean equipment, materials and machines after use.
- Wear safety clothes.
- Clean work area after completion of the task.
- Apply good housekeeping.

7.3 Topic 3: Steel tank fabrication

7.3.1 Subject Outcome 1: Explain and demonstrate various aspects of steel tank fabrication.

Learning Outcomes:

The student should be able to:

- Explain the necessary calculations and templates required for fabricating including circumferential and thickness of material considerations when performing calculations.
- Demonstrate the ability to tack pieces of steel together to form sections of a tank using the correct type and gauge of electrodes.
- Correctly select and use cutting equipment and tools including amongst others a straight line cutter and a profile cutter.
- Correctly select and use measuring tools to fabricate the tank.
- Correctly select and use checking tools after fabrication.
- Correctly perform necessary calculations to the product to ensure accuracy at all times.
- Complete the fabrication process and indicate its readiness for welding.

7.3.2 Subject Outcome 2: Laying out and marking off the shell.

Learning Outcomes:

The student should be able to:

- Identify and use lifting equipment correctly in order to transport the steel for rolling.
- Prepare the workplace for rolling out the shell by ensuring hazards are eliminated and a safe working distance is maintained all around the steel.
- Perform the necessary calculations to mark out the shell using correct formulae.

- Correctly mark off the floor according to the diameter of the tank in order to fabricate the required strakes.

7.3.3 Subject Outcome 3: Using the plate rolls.

Learning Outcomes:

The student should be able to:
- Set up the rolling machine according to job specifications.
- Make a rolling template by using the outside and inside diameters of the tank.
- Correctly feed the plate into the rolls by controlling the overhead crane accordingly.
- Use clamping tools correctly to maintain the shape of the shell once rolling is complete.
- Safely remove the shell and place on marked out floor for fabrication.

7.3.4 Subject Outcome 4: Fabricating the tank.

Learning Outcomes:

The student should be able to:
- Correctly select the required fittings as per the drawing's specifications.
- Tack weld the shell onto the marked out area.
- Brace the shell with spider legs and measure the diameter to maintain the specifications.
- Complete all necessary developments required for the fittings such as pipes, conical hoods, transition pieces etc.
- Complete the tank with all its fittings for welding.
- Ensure that the drawings specifications together with the engineering designs are maintained at all times.
- Identify and correct any irregularities before welding begins.

7.4 Topic 4: Transition piece fabrication

7.4.1 Subject Outcome 1: Explain and demonstrate various aspects of transition pieces fabrication.

Learning Outcomes:

The student should be able to:
- Explain the differences between mild steel and stainless steel.
- Identify and select the correct grade of stainless steel required for the fabrication.
- Explain the necessary calculations and templates required for fabricating including true length calculations and thickness of material considerations when performing calculations.
- Demonstrate the ability to tack pieces of steel together to form sections of the transition piece using the correct type and gauge of electrodes.
- Correctly select and use cutting equipment and tools including amongst others a straight line cutter, the hand-held cutting torch and plasma cutting.
- Correctly select and use measuring tools fabricate the transition piece.
- Correctly select and use checking tools after fabrication.
- Correctly perform necessary calculations to the product to ensure accuracy at all times.

7.4.2 Subject Outcome 2: Laying out and marking off the transition piece.

Learning Outcomes:

The student should be able to:
- Perform the necessary calculations to mark out the shell using correct formulae including true length calculations and bend line calculations.
- Identify and correct use lifting equipment in order transport the steel for bending.
- Prepare the workplace for bending the shell by ensuring hazards are eliminated and a safe working distance is maintained all around the steel.

7.4.3 Subject Outcome 3: Using the bending brake.

Learning Outcomes:

The student should be able to:
- Set up the machine according to job specifications.
- Make a bending template by using the outside and inside angles/slopes of the transition piece.
- Correctly feed the plate into the bending machine by controlling the overhead crane accordingly.

- Use clamping tools correctly to maintain the shape of the shell once bending is complete.
- Safely remove the shell and place on marked out floor for fabrication.

7.4.4 Subject Outcome 4: Fabricating the transition piece.

Learning Outcomes:

The student should be able to:

- Correctly select the required fittings as per the drawing's specifications.
- Tack weld the shell onto the marked out area.
- Brace the shell with spider legs and measure the diameters/angles/slopes to maintain the specifications.
- Complete all necessary developments required for the fittings such as pipes, conical hoods, flanges etc.
- Complete the transition piece with all its fittings for welding.
- Ensure that the drawings specifications together with the engineering designs are maintained at all times.
- Identify and correct any irregularities before welding begins.
- Oversee the cleaning, pickling and passivating process.

8 RESOURCE NEEDS FOR THE TEACHING OF ENGINEERING FABRICATION / BOILERMAKING – LEVEL 3

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)
- Annexure A where applicable