INTRODUCTION

A. What is Instrumentation Technology?
Instrumentation Technology (IT) will allow learners to prepare themselves for employment in a range of occupations in the processing industry as well as instrumentation supply and maintenance companies. The processing industry consists of many fields including chemical, petrochemical, pulp and paper, water treatment, beverage processing, minerals processing, paint manufacturing, pharmaceuticals productions, personal care products manufacturing, household products manufacturing etc. This qualification suite will equip a learner to immediately, on completion, be considered for a position within any one of the mentioned fields.

B. Why is Instrumentation Technology important in the learning programme?
Instrumentation Technology introduces students to:
- Level measurement
- Mass measurement
- In-line process analysers
- Control systems

C. The link between Instrumentation Technology and the Critical and Developmental Outcomes
- Instrumentation Technology will develop students’ problem-solving skills by requiring them to continually collect, analyse and evaluate data.
- The subject will instil and enhance team spirit by affirming the importance of teamwork.
- Through communication using visual, mathematical, scientific and technological means, students will learn effective reporting methods in this subject.
- Instrumentation Technology will also create a sense of respect and responsibility towards the environment as well as the health and safety of fellow human beings.

D. Factors that contribute to achieving Learning Outcomes in Instrumentation Technology
- An effective simulated instrumentation installation or a real engineering workplace where students can display their competencies
- Qualified and competent lecturers and assessors who not only aid and facilitate teaching, training and learning but who are readily available to provide moral support
- Patience, self-discipline and teamwork skills
- Critical thinking and problem-solving skills to readily evaluate data systems and processes
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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 describe level measurement, mass measurement, in-line process analysers and control systems.

Exit Level Outcome 1: Describe level measurement and mass measurements as applied in instrumentation technology.

Associated Assessment Criteria:

- Different types of measurements are explained and applied.
  - Range: Hydrostatic-, ultrasonic-, microwave- and nucleonic level measurements as well as loadcell based and mass measurements.

Exit Level Outcome 2: Describe and apply different types of in-line-process analysers and control systems.

Associated Assessment Criteria:

- The purpose and maintenance of different types of analysers are explained.
- Different types of process control systems and safety devices are explained and applied.

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 Instrumentation Technology Level 4 takes the form of observation, class questions, group work, individual discussions with students, class, topic and semester tests and internal examinations. Lecturers can observe students when marking exercises from the previous day and when responses are given.

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 Instrumentation Technology Level 4 takes the form of assignments, practical exercises, case studies and practical examinations in a simulated engineering 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)
B. Exhibition by students
C. Visits undertaken by students based on a structured assignment task
D. Research
E. Task performance in a simulated/structure 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 students’ Portfolio of Evidence (PoE). The tools and instruments constructed and used to conduct these assessments must be clear from 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 (40 percent) and the practical component (60 percent) of the internal continuous assessment (ICASS).

3.1.3 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: Instrumentation Technology Level 4.

4. **WEIGHTED VALUES OF TOPICS**

<table>
<thead>
<tr>
<th>TOPICS</th>
<th>WEIGHTED VALUE</th>
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<tbody>
<tr>
<td>1. Level measurement</td>
<td>25%</td>
</tr>
<tr>
<td>2. Mass measurement</td>
<td>20%</td>
</tr>
<tr>
<td>3. In-line process analysers</td>
<td>30%</td>
</tr>
<tr>
<td>4. Control systems</td>
<td>25%</td>
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<tr>
<td><strong>TOTAL</strong></td>
<td><strong>100</strong></td>
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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 percent (50%) in ICASS and fifty percent (50%) in the examination.

7 SUBJECT AND LEARNING OUTCOMES
On completion of Instrumentation Technology Level 4, the student should have covered the following topics:

7.1 Topic 1: Level measurement
7.2 Topic 2: Mass measurement
7.3 Topic 3: In-line process analysers
7.4 Topic 4: Control systems

7.1 Topic 1: Level measurement

7.1.1 Subject Outcome 1: Describe hydrostatic level measurement

Learning Outcomes:
The student must be able to:

- Describe the purpose and application range and limitations of a typical hydrostatic level measurement instrument.
- Produce a freehand drawing and describe the major components, system configurations and basic working principles of hydrostatic level measurement instruments.
- Install hydrostatic level measurement instruments.
- Commission hydrostatic level measurement instruments.
- Zero-check hydrostatic level measurement instruments.
- Calibrate and verify hydrostatic level measurement instruments.
- Fault find and describe common hydrostatic level measurement instrument problems.
- Describe the maintenance requirements of hydrostatic level measurement instruments.
- Dismantle a hydrostatic level measurement instrument safely.
- Test a hydrostatic level measurement instrument safely.
- Repair basic problems of a hydrostatic level measurement instrument safely.
- Re-assemble a hydrostatic level measurement instrument safely.

7.1.2 Subject Outcome 2: Describe ultrasonic level measurement

Learning Outcomes:
The student must be able to:

- Describe the purpose and application range and limitations of a typical ultrasonic level measurement instrument.
- Produce a freehand drawing and describe the major components, system configurations and basic working principles of ultrasonic level measurement instruments.
- Install ultrasonic level measurement instruments.
- Commission ultrasonic level measurement instruments.
• Zero-check ultrasonic level measurement instruments.
• Calibrate and verify ultrasonic level measurement instruments.
• Fault find and describe common bellows ultrasonic level measurement instrument problems.
• Describe the maintenance requirements of ultrasonic level measurement instruments.
• Dismantle an ultrasonic level measurement instrument safely.
• Test an ultrasonic level measurement instrument safely.
• Repair basic problems of an ultrasonic level measurement instrument safely.
• Re-assemble an ultrasonic level measurement instrument safely.

7.1.3 Subject Outcome 3: Describe microwave level measurement

Learning Outcomes:
The student must be able to:
• Describe the purpose and application range and limitations of a typical microwave level measurement instrument.
• Produce a freehand drawing and describe the major components, system configurations and basic working principles of microwave level measurement instruments.
• Install microwave level measurement instruments.
• Commission microwave level measurement instruments.
• Zero-check microwave level measurement instruments.
• Calibrate and verify microwave level measurement instruments.
• Fault find and describe common microwave level measurement instrument problems.
• Describe the maintenance requirements of microwave level measurement instruments.
• Dismantle a microwave level measurement instrument safely.
• Test a microwave level measurement instrument safely.
• Repair basic problems of a microwave level measurement instrument safely.
• Re-assemble a microwave level measurement instrument safely.

7.1.4 Subject Outcome 4: Describe nucleonic level measurement

Learning Outcomes:
The student must be able to:
• Describe the purpose and application range and limitations of a typical nucleonic level measurement instrument.
• Produce a freehand drawing and describe the major components, system configurations and basic working principles of nucleonic level measurement instruments.
7.2 Topic 2: Mass measurement

7.2.1 Subject Outcome 1: Describe the basics of mass measurement

Learning Outcomes:
The student must be able to:

- Describe the origins and purpose of mass measurement.
- Describe the principles and essential theory of mass measurement.
- Describe the concepts and relationship between mass, weight, volume and density.
- Describe how measurement is applied to the mass, weight, level, pressure and mass flow.
- Convert various units applicable to volume, mass and weight.
  Range: mg, g, kg, ton, lb, oz, imperial tons, N, lbf, g/ cm³, kg/ m³, s.g., lb/ n³, lb/ ft³.

7.2.2 Subject Outcome 2: Describe load cell based mass measurement

Learning Outcomes:
The student must be able to:

- Describe the purpose, application range and limitations of a typical loadcell.
- Produce a freehand drawing and describe the major components, system configurations and basic working principles of loadcells.
- Install loadcells.
- Commission loadcells.
- Zero-check loadcells.
- Calibrate and verify loadcells.
- Fault find and describe common loadcell problems.
- Describe the maintenance requirements of loadcells.
- Dismantle a loadcell safely.
- Test a loadcell safely.
- Repair basic problems of a loadcell safely.
- Re-assemble a loadcell safely.

7.3 Topic 3: In-line process analysers

7.3.1 Subject Outcome 1: Describe the basics of analysers

Learning Outcomes:
The student must be able to:

- Explain the purpose and importance of in-line process analysers in a process environment.
- List the different types of in-line process analysers and their typical application in the process industry.
  Range: viscosity, humidity, pH, redox (ORP), composition, conductivity, dewpoint, turbidity, dissolved oxygen, chlorine.
- List the different types of chemical composition analysers and their application in industry.
  Range: H₂S, SO₂, CO, CO₂, H₂, O₂.
• Explain the difference between continuous and intermittent (discrete) analysers.
• Explain the reasons for using continuous and intermittent (discrete) analysers.
• Explain the advantages of using continuous and intermittent (discrete) analysers.
• Discuss some of the typical supporting systems and maintenance requirements of in-line analysers.
  
  Range: Consumables, analytical chemicals, cleaning/flushing materials, calibration standards.

7.3.2 Subject Outcome 2: Describe conductivity analysers

Learning Outcomes:

The student must be able to:

• Explain the purpose, application range and limitations of in-line conductivity analysers in the process industry.
• Produce a labelled freehand drawing and describe the major components of a typical conductivity analyser used in the process industry.
• Explain the working principles of an in-line conductivity analyser including basic chemical, physical and mechanical issues.
• Install an in-line conductivity analyser.
• Commission an in-line conductivity analyser.
• Zero-check an in-line conductivity analyser.
• Calibrate and verify an in-line conductivity analyser.
• Fault find and describe common in-line conductivity analyser problems.
• Describe the maintenance requirements of in-line conductivity analysers.
• Dismantle an in-line conductivity analyser safely.
• Test an in-line conductivity analyser safely.
• Repair basic problems of an in-line conductivity analyser safely.
• Re-assemble an in-line conductivity analyser safely.

7.3.3 Subject Outcome 3: Describe turbidity analysers

Learning Outcomes:

The student must be able to:

• Explain the purpose, application range and limitations of in-line turbidity analysers in the process industry.
• Produce a labelled freehand drawing and describe the major components of a typical turbidity analyser used in the process industry.
• Explain the working principles of an in-line turbidity analyser including basic chemical, physical and mechanical issues.
• Install an in-line turbidity analyser.
• Commission an in-line turbidity analyser.
• Zero-check an in-line turbidity analyser.
• Calibrate and verify an in-line turbidity analyser.
• Fault find and describe common in-line turbidity analyser problems.
• Describe the maintenance requirements of in-line turbidity analysers.
• Dismantle an in-line turbidity analyser safely
• Test an in-line turbidity analyser safely.
• Repair basic problems of an in-line turbidity analyser safely.
• Re-assemble an in-line turbidity analyser safely

7.3.4 Subject Outcome 4: Describe humidity (dewpoint) analysers

Learning Outcomes:
The student must be able to:
• Explain the purpose, application range and limitations of in-line humidity analysers in the process industry.
• Produce a labelled freehand drawing of major components of a typical humidity analyser used in the process industry.
• Identify and describe the major components of a typical humidity analyser used in the process industry.
• Explain the working principles of an in-line humidity analyser including basic chemical, physical and mechanical issues.
• Install an in-line humidity analyser.
• Commission an in-line humidity analyser.
• Zero-check an in-line humidity analyser.
• Calibrate and verify an in-line humidity analyser.
• Fault find and describe common in-line humidity analyser problems.
• Describe the maintenance requirements of in-line humidity analysers.
• Dismantle an in-line humidity analyser safely.
• Test an in-line humidity analyser safely.
• Repair basic problems of an in-line humidity analyser safely.
• Re-assemble an in-line humidity analyser safely.

7.3.5 Subject Outcome 5: Describe pH analysers

Learning Outcomes:
The student must be able to:
• Explain the purpose, application range and limitations of in-line pH analysers in the process industry.
• Produce a labelled freehand drawing of major components of a typical pH analyser used in the process industry.
• Identify and describe the major components of a typical pH analyser used in the process industry.
• Explain the working principles of an in-line pH analyser including basic chemical, physical and mechanical issues.
• Install an in-line pH analyser.
• Commission an in-line pH analyser.
• Zero-check an in-line pH analyser.
- Calibrate and verify an in-line pH analyser.
- Fault find and describe common in-line pH analyser problems.
- Describe the maintenance requirements of in-line pH analysers.
- Dismantle an in-line pH analyser safely.
- Test an in-line pH analyser safely.
- Repair basic problems of an in-line pH analyser safely.
- Re-assemble an in-line pH analyser while working safely.

7.4 Topic 4: Control systems

7.4.1 Subject Outcome 1: Describe control system basics

Learning Outcomes:
The student must be able to:

- Explain the purpose and importance of control systems in a process environment.
- Explain the terminology used in process control.
  Range: variables, parameters, setting, set-point, deviation, PLC.
- Interpret primary instrument labels and acronyms.
  Range: $T$ (temperature), $P$ (pressure), $L$ (level), $F$ (flow), $M$ (mass), $dP$ (differential pressure), $I$ (indicator), $E$ (element), $C$ (controller), $R$ (recorder), PIC, TRC etc.
- Interpret equipment, symbols and labels used in piping and instrument diagrams (P&IDs).
- Interpret equipment, symbols and labels used in process flow diagrams (PFDs) and loop diagrams.
- Interpret instrument labels and acronyms used to indicate instrument functions.
- Assign labels according to instrument functions.
- Produce simple freehand drawings showing piping and instrumentation labels and symbols.

7.4.2 Subject Outcome 2: Describe process control

Learning Outcomes:
The student must be able to:

- Explain the basic logic applicable to control loops.
  Range: measuring, comparing and adjusting.
- List and explain the function of each element in a process control system.
  Range: measurement elements/ sensors, indicators, recorders, converters, transmitters, impulse lines, controllers, PLCs, positioners, actuators, control valves.
- Explain the operation of each element in a process control system.
  Range: measurement elements/ sensors, indicators, recorders, converters, transmitters, impulse lines, controllers, PLCs, positioners, actuators, control valves.
- Explain the main types of control loops with examples.
  Range: feedback, feed forward, split range, open loop, closed loop.
- Explain the different control modes used in process control.
  Range: automatic, manual and cascade control.
7.4.3 Subject Outcome 3: Describe DCS, loop controllers, PLC and SCADA systems

Learning Outcomes:
The student must be able to:

- Explain the purpose and difference between a DCS, loop controller, PLC and a SCADA system in a process environment.
- Explain the purpose of pneumatic and electrical signal transfer elements.
- Explain the applications of pneumatic and electrical signal transfer elements.
- Explain the advantages and disadvantages of pneumatic and electrical signal transfer elements.
- Explain the basic functioning of signal transfer elements in a process environment.
- Explain the growth, principles and opportunities for digital communication systems.
- List and explain the purpose of different screen functions available on typical DCS, loop controller, PLC and SCADA systems. *Range: display and control of process conditions, data capture, data retrieval, graphical representation, statistical process control.*
- Prepare a simple system from a DCS/loop controller/PLC or SCADA system.
- Start a simple system from a DCS/loop controller/PLC or SCADA system.
- Run a simple system from a DCS/loop controller/PLC or SCADA system.
- Shut down a simple system from a DCS/loop controller/PLC or SCADA system.

7.4.4 Subject Outcome 4: Describe safety devices

*Range: alarms, trips, interlocks and fail safe devices*

Learning Outcomes:
The student must be able to:

- Explain the purpose of incorporating safety devices in control loops.
- Explain typical alarm configurations used in control systems.
- Explain the typical configurations used for trips in control systems.
- Explain typical interlock configurations used in control systems.
- Explain fail safe positions and configurations used in control systems. *Range: open, closed and percentage.*

8 RESOURCE NEEDS FOR TEACHING OF INSTRUMENTATION TECHNOLOGY LEVEL 4

8.1 Physical resources

Building infrastructure, fixtures, networks, plant and machinery, for example:

- Storeroom
- Tool room
- Lecture room(s)
- Training area or work area
• Simulated environment
• Ablution facilities
• Instrumentation is essential to this subject. Therefore, input from industry is required to make it feasible to present this subject.

8.2 Human resources

The lecturer for Instrumentation Technology Level 4 must be:

An expert in process instrumentation. This lecturer should at least be in possession of an N5 or N6 in process instrumentation.

However, these candidates rarely have any background in education – these skills would need to be provided through short courses or other suitable mechanisms.

Lecturers must attend seminars and upgrading workshops to keep up-to-date with the latest developments in technology.

8.3 Other resources

Consumables, individual tool and equipment requirements and learning materials and resources, for example:

• Literature and learning material which address tasks
• Learning materials on projection equipment
• Educational tours to relevant learning venues
• Educational and motivational talks from industry
• Visual and audio-visual material
• Workshop manuals and documentation for theoretical knowledge
• Models and demonstrations

Funds from the learning provider or funding bodies for the procurement of consumables, tools and equipment must be readily available to ensure the effective operation of a Simulated Environment where students are individually equipped with the necessary tools.