****

**REPUBLIC OF KENYA**

**COMPETENCY-BASED MODULAR CURRICULUM**

**FOR**

**INSTRUMENTATION AND CONTROL** **OPERATIONS**

**KNQF LEVEL 4**

**PROGRAMME ISCED CODE: 0714 354A**

©2025

All rights reserved. No part of this Curriculum may be reproduced, distributed, or transmitted in any form or by any means, including photocopying, recording, or other electronic or mechanical methods without the prior written permission of ……..., except in the case of brief quotations embodied in critical reviews and certain other non-commercial uses permitted by copyright law. For permission requests, write to the Council Secretary/CEO/Chief Principal at the address below:

**FOREWORD**

The provision of quality education and training is fundamental to the Government’s overall strategy for social and economic development. Quality education and training contribute to the achievement of Kenya’s development blueprint and sustainable development goals.

Reforms in the education sector are necessary to achieve Kenya Vision 2030 and meet the provisions of the Constitution of Kenya 2010. The education sector had to be aligned to the Constitution, and this resulted in the formulation of the Policy Framework for Reforming Education and Training in Kenya (Sessional Paper No. 14 of 2012). A key feature of this policy is the radical change in the design and delivery of TVET training. This policy document requires that training in TVET be competency-based, curriculum development be industry-led, certification be based on demonstration of competence, and the mode of delivery allow for multiple entry and exit in TVET programmes.

These reforms demand that Industry takes a leading role in curriculum development to ensure the curriculum addresses its competence needs. It is against this background that this curriculum has been developed. For trainees to build their skills on foundational hands-on activities of the occupation, units of learning are grouped in modules. This has eliminated duplication of content and streamlined exemptions based on skills acquired as a trainee progresses in the up-skilling process, while at the same time allowing trainees to be employable in the shortest time possible through the acquisition of part qualifications.

It is my conviction that this curriculum will play a great role in developing competent human resources for the ………………… Sector’s growth and development.

**PRINCIPAL SECRETARY**

**STATE DEPARTMENT FOR TVET**

**MINISTRY OF EDUCATION**

**PREFACE**

Kenya Vision 2030 aims to transform Kenya into a newly industrializing middle-income country, providing high-quality life to all its citizens by the year 2030. Kenya intends to create globally competitive and adaptive human resource base to meet the requirements of a rapidly industrializing economy through lifelong education and training. TVET has a responsibility to facilitate the process of inculcating knowledge, skills, and worker behaviour necessary for catapulting the nation to a globally competitive country, hence the paradigm shift to embrace Competency-Based Education and Training (CBET).

TVET Act CAP 210A and Sessional Paper No. 1 of 2019 on Reforming Education and Training in Kenya for Sustainable Development emphasized the need to reform curriculum development, assessment, and certification. This called for a shift to CBET to address the mismatch between skills acquired through training and skills needed by industry, as well as increase the global competitiveness of the Kenyan labour force.

This curriculum has been developed in adherence to the Kenya National Qualifications Framework and CBETA standards and guidelines. The curriculum is designed and organized into Units of Learning with Learning Outcomes, suggested delivery methods, learning resources, and methods of assessing the trainee’s achievement. In addition, the units of learning have been grouped in modules to concretize the skills acquisition process and streamline upskilling.

I am grateful to all expert trainers and everyone who played a role in translating the Occupational Standards into this competency-based modular curriculum

**ACKNOWLEDGMENT**

This curriculum has been designed for competency-based training and has independent units of learning that allow the trainee flexibility in entry and exit. In developing the curriculum, significant involvement and support were received from expert trainers, institutions and organizations.

I recognize with appreciation the role of the ……… National Sector Skills Committee (NSSC) in ensuring that competencies required by the industry are addressed in the curriculum. I also thank all stakeholders in the …………. sector for their valuable input and everyone who participated in developing this curriculum.

I am convinced that this curriculum will go a long way in ensuring that individuals aspiring to work in the ……………… Sector acquire competencies to perform their work more efficiently and effectively.

**TABLE OF CONTENTS**

[**FOREWORD** iii](#_Toc196833072)

[**ACKNOWLEDGMENT** v](#_Toc196833073)

[**TABLE OF CONTENTS** vi](#_Toc196833074)

[**ACRONYMS AND ABBREVIATION** vii](#_Toc196833075)

[**KEY TO ISCED UNIT CODE** ix](#_Toc196833076)

[**COURSE OVERVIEW** x](#_Toc196833077)

[ELECTRICAL INSTALLATION 13](#_Toc196833078)

[INSTRUMENTATION AND CONTROL SYSTEM COMPONENTS INSTALLATION 21](#_Toc196833079)

[INSTRUMENTATION AND CONTROL SYSTEM OPERATIONS 30](#_Toc196833080)

[INSTRUMENTATION AND CONTROL SYSTEMS MAINTENANCE 36](#_Toc196833081)

**ACRONYMS AND ABBREVIATION**

**ISCED** – International Standard Classification of Education

**CEO** – Chief Executive Officer

**TVET** – Technical and Vocational Education and Training

**CBET** – Competency-Based Education and Training

**CBETA** – **Competency-Based Education and Training Authority**

**CDACC** – Curriculum Development, Assessment, and Certification Council

**AC** – Alternating Current

**CAD** – Computer-Aided Design

**CPU** – Central Processing Unit

**CV** – Curriculum Vitae

**DC** – Direct Current

**DOL** – Direct-On-Line

**DVI** – Digital Visual Interface

**HDMI** – High-Definition Multimedia Interface

**IEE** Institution of Engineering and Technology

**IET** – Institution of Engineering and Technology

**KCL** – Kirchhoff’s Current Law

**KCSE** – Kenya Certificate of Secondary Education

**KNQF** – Kenya National Qualifications Framework

**KVL** – Kirchhoff’s Voltage Law

**NEMA** – National Environment Management Authority

**NP** – Net Power

**OSHA** – Occupational Safety and Health Administration

**PPE** – Personal Protective Equipment

**RAM** – Random Access Memory

**RPL** – Recognition of Prior Learning

**SI** – International System of Units

**SMP** – Symmetric Multiprocessing

**SMS** – Short Message Service

**TV** – Television

**TVET** – Technical and Vocational Education and Training

**TVETA** – Technical and Vocational Education and Training Authority

**USB** – Universal Serial Bus

**UV** – Ultraviolet

**VGA** – Video Graphics Array

**PVC** – Polyvinyl Chloride

**VFD** – Variable Frequency Drive

**VGA** – Video Graphics Array

**VSD** – Variable Speed Drive

**PWM** – Pulse Width Modulation

**PCB** – Printed Circuit Board

**KEY TO ISCED UNIT CODE**



**COURSE OVERVIEW**

Instrumentation and Control Operations Level 4 consists of competencies that an individual must have to perform instrumentation and control activities. It involves performing electrical installation, installing instrumentation and control system components, operating instrumentation and control systems, and maintaining instrumentation and control systems.

**Summary of the Units of Learning**

|  |  |  |  |
| --- | --- | --- | --- |
| **Unit code** | **Unit title** | **Hours** | **Credit** |
| **Module 1** | | | |
| 0713 351 13A | Electrical Installation | 80 | 8.0 |
| 0714 351 14A | Instrumentation and Control System Components Installation | 160 | 16.0 |
| **Sub Total** | | **240** | **24.0** |
| **Module 2** | | | |
| 0714 351 15A | Instrumentation and Control System Operations | 160 | 16.0 |
| 0714 351 16A | Instrumentation and Control System Maintenance | 160 | 16.0 |
| **Sub Total** | | **320** | **32.0** |
| **Industrial Training** | | 480 | 48.0 |
| **GRAND TOTAL** | | **1040** | **104.0** |

**Entry Requirements**

An individual entering this course should have any of the following minimum requirements:

1. Kenya Certificate of Secondary Education (KCSE)

**Or**

1. Equivalent qualifications as determined by TVETA.

**Trainer Qualification**

Qualifications of a trainer for this course include:

1. Have a minimum of KNQF Level 5 qualification or its equivalent in the related area of specialization.
2. Be registered by TVETA.

**Industry Training**

An individual enrolled in this course will be required to undergo Industry training for a minimum period of 320 hours in the instrumentation and control sector. The industrial training may be taken after completion of all units for those pursuing the full qualification or be distributed equally in each unit for those pursuing part qualification. In the case of dual training model, industrial training shall be as guided by the dual training policy.

**Assessment**

The course shall be assessed formatively and summatively:

1. During formative assessment all performance criteria shall be assessed based on performance criteria weighting.
2. Number of formative assessments shall minimally be equal to the number of elements in a unit of competency
3. Assessment of basic and common competencies shall be integrated in the core units
4. Theoretical assessment shall be integrated in practical assessment and conducted orally in both formative and summative assessments.
5. Theoretical and practical weight shall be 10:90 respectively for each unit of learning.
6. Formative and summative assessments shall be weighted at 60% and 40% respectively in the overall unit of learning score
7. Assessment performance rating for each unit of competency shall be as follows:

|  |  |
| --- | --- |
| **MARKS** | **COMPETENCE RATING** |
| 80 -100 | Attained Mastery |
| 65 - 79 | Proficient |
| 50 - 64 | Competent |
| 49 and below | Not Yet Competent |
| Y | Assessment Malpractice/irregularities |

1. Assessment for Recognition of Prior Learning (RPL) may lead to award of part and/or full qualification.

**Certification**

A candidate will be issued with a Certificate of Competency upon demonstration of competence in a core Unit of Competency. To be issued with KenyaNational Certificate in Instrumentation and Control Operations Level 4 the candidate must demonstrate competence in all the Units of Competency as given in the qualification pack. A Statement of Attainment certificate may be issued upon demonstration of competence in a certifiable element within a unit.

The certificates will be issued by the …………… (Qualification Awarding Institution).

## ELECTRICAL INSTALLATION

**UNIT CODE:** 0713 351 13A

**Relationship to Occupational Standards**

**This unit addresses the unit of competency: Perform Electrical Installation**

**Duration of Unit:** 80 Hours

**Unit Description**

This unit specifies the competencies required for performing electrical installation. It involves preparing a list of tools equipment and materials, performing piping, and laying of cables, installing of electrical components, terminating of electrical installation, inspecting and testing the installation and documenting an electrical installation.

**Summary of Learning Outcomes**

By the end of this unit, the learner should be able to:

|  |  |  |
| --- | --- | --- |
| **S/NO** | **LEARNING OUTCOMES** | **DURATION(HOURS)** |
|  | Prepare list of tools, equipment, and materials | **10** |
|  | Perform piping and laying of cables | **20** |
|  | Install electrical components | **18** |
|  | Terminate electrical installation | **12** |
|  | Inspect and test installation | **10** |
|  | Document an Electrical installation | **10** |
|  | **TOTAL HOURS** | **80** |

**Learning Outcomes, Content and Suggested Assessment Methods**

| **Learning Outcome** | **Content** | **Suggested Assessment Methods** |
| --- | --- | --- |
| 1. Prepare a list of tools, equipment and materials | 1. Health and safety procedures 2. PPEs 3. Safety, Rules and, regulations 4. Hazards    1. Electrical installation tools and materials 5. Cutting tools 6. Measuring tools 7. Measuring equipment 8. Cables and conductors 9. Crimping tools 10. Conduits 11. Trunking 12. Consumables     1. Types, application, care, maintenance and storage of:        1. Tools           1. Cable strippers           2. Pliers           3. Screw drivers           4. Hammers           5. Chisels           6. Allen keys           7. Electrician knives           8. Crimping tools           9. Bending springs           10. Steel tapes           11. Draw wires           12. Hack saws           13. Drills        2. Equipment           1. Stock and die           2. Vice        3. Materials           1. Cables           2. Fittings           3. Accessories     2. Assemble electrical installation tools, equipment and materials | * Oral questioning * Written tests * Observation * Practical |
| 1. Perform piping and laying of cables | 1. Meaning of terms 2. Procedures for piping 3. Cables and cable joints 4. Wiring systems and accessories 5. Types and applications    * + 1. Conduits        2. Cable trays        3. Cable ducts        4. Trunking 6. Preparation of wiring systems    * + 1. Marking out        2. Cutting        3. Bending        4. Threading        5. Chiseling        6. Trenching    1. Draw –in/Lay of cables routes       1. Cable Identification    2. IEE regulations | * Written tests * Observation * Oral questioning * Practical test |
| 1. Install electrical components | 1. Meaning of terms 2. Electrical symbols and abbreviations 3. Meaning of electrical drawings 4. Drawing of electrical diagrams    * 1. block      2. schematic      3. circuit      4. line      5. wiring 5. Electrical components    * 1. Junction boxes      2. Ceiling rose      3. Switches      4. Socket outlets      5. Bulb holders      6. IEE regulations | * Written tests * Oral questioning * Practical tests * Observation |
| 1. Terminate electrical installation | 1. Meaning of Terms 2. Importance of termination 3. Cable labelling 4. Cable lugging 5. Tools used in cable termination e.g. 6. Crimping tool 7. Strip Knife    1. IEE regulations    2. Disposal of waste materials | * Written tests * Oral questioning * Practical tests * Observation |
| 1. Inspect and test installation | 1. Types of tests on an electrical installation system 2. IEE regulations in regard to electrical installation testing and inspection 3. Electrical testing instruments | * Written tests * Oral questioning * Practical tests * Observation |
| 1. Document an Electrical installation | * 1. Report preparation   2. Sharing of the installation report   3. Report filing | * Written tests * Oral questioning * Practical tests * Observation |

**Suggested Methods of Instruction**

* Demonstration by trainer
* Practice by the trainee
* Field trips
* On-job-training
* Discussions

**Recommended Resources for 25 trainees**

|  |  |  |  |  |
| --- | --- | --- | --- | --- |
| **S/No.** | **Category/Item** | **Description/ Specifications** | **Quantity** | **Recommended Ratio**  (Item: Trainee) |
| **A** | **Learning Materials** |  |  |  |
|  | Textbooks | 1. B. Scaddan Electrical installation work 2. J. Hyde Electrical Installation Principles and Practices 3. Electrical Theory for the Electrician**"** by Mike Holt 4. Electrical installation work by Brian Scaddan | 5 pcs | 1:5 |
|  | Installation manuals | IEEE regulation  BS3939  NEMA regulations  OSHA | 5 pcs | 1:5 |
|  | Charts | Single line diagram  Circuit diagrams  Colour codes | 1 pcs for each | 1:25 |
|  | Power point presentations | For trainer’s use | 1 | 1:25 |
| **B** | **Learning Facilities & infrastructure** |  |  |  |
|  | Lecture/theory room | 60m2 | 1 | 1:25 |
|  | Workshop | 150m2 | 1 | 1:25 |
|  | Site |  |  |  |
| **C** | **Consumable materials** |  |  |  |
|  | Electrical wires | 1.5mm2(red, black green) | 5 rolls | 1:5 |
| 2.5mm2(red, black green) | 5 rolls | 1:5 |
| 4.0 mm2(red, black green) | 3 rolls | 1:10 |
| 6.0 mm2(red, black green) | 2 rolls | 1:12 |
| 10 mm2(red, black green) | 2 rolls | 1:12 |
|  | Insulation tapes |  | 25 pcs | 1:1 |
|  | Accessories | Switches, sockets, Junction boxes, Consumer units, Lamp holders, Patrice boxes, Circuit breakers, energy meter, cut out, cooker unit, instant water heater switch, | 25 pcs | 1:1 |
|  | Conduits and trunkings | PVC conduits, Steel conduits, Mini trunking | 25 pcs | 1:1 |
|  | **Tools and Equipment** |  |  |  |
|  | Hacksaws |  | 25 pcs | 1:1 |
|  | Striping knives |  | 25 pcs | 1:1 |
|  | Side cutters |  | 25 pcs | 1:1 |
|  | Pliers |  | 25 pcs | 1:1 |
|  | Tape measure |  | 25 pcs | 1:1 |
|  | Try Square |  | 25 pcs | 1:1 |
|  | Spirit level |  | 25 pcs | 1:1 |
|  | Assorted Screw driver |  | 25 pcs | 1:1 |
|  | Assorted hammers |  | 25 pcs | 1:1 |
|  | PPEs |  | 25 pcs | 1:1 |
|  | Multimeters |  | 5 pcs | 1:5 |
|  | Clamp meters |  | 5 pcs | 1:5 |
|  | Earth resistance meter |  | 5 pcs | 1:5 |
|  | Stocks & Dies |  | 5 pcs | 1:5 |
|  | Vices |  | 5 pcs | 1:5 |
|  | Pipe bending Machine |  | 5 pcs | 1:5 |
|  | Bending spring |  | 5 pcs | 1:5 |
|  | Drilling machines |  | 5 pcs | 1:5 |
|  | Work stations |  | 25 | 1:1 |
|  | Installation boards |  | 13 pcs | 1:2 |

## INSTRUMENTATION AND CONTROL SYSTEM COMPONENTS INSTALLATION

**UNIT CODE:** 0714 351 14A

**Relationship to Occupational Standards**

This unit addresses the unit of competency: Install instrumentation and control components.

**Duration of Unit:** 160 Hours

**Unit Description**

This unit covers the competencies required to install instrumentation and control components. It involves preparing for installation of instrumentation and control system components, assembling instrumentation and control system components and testing instrumentation and control system components.

**Summary of Learning Outcomes**

By the end of this unit, the learner should be able to:

|  |  |  |
| --- | --- | --- |
| **S/NO** | **LEARNING OUTCOMES** | **DURATION (HOURS)** |
|  | Prepare for installation of instrumentation and control system component | 64 |
|  | Assemble instrumentation and control system components | 56 |
|  | Test instrumentation and control system components. | 40 |
|  | **TOTAL HOURS** | **160** |

**Learning Outcomes, Content and Suggested Assessment Methods**

|  |  |  |
| --- | --- | --- |
| **Learning Outcome** | **Content** | **Suggested Assessment Methods** |
| 1. Prepare for installation of instrumentation and control system component. | * 1. Site survey consideration  1. Temperature 2. Humidity 3. Distance 4. Dust 5. Light intensity 6. Pressure    1. Meaning of workshop tools, instruments and equipment    2. Uses of workshop tools, Instruments and equipment       1. Cutting tools       2. Fastening tools       3. Marking tools       4. Drilling tools       5. Crimping tools       6. Alignment tools       7. Measuring equipment       8. Testing equipment    3. Handling, care and maintenance of workshop tools and Instruments    4. Instrumentation and control system components    5. Type of instrumentation and control components and their specifications       * 1. Sensors         2. Controllers         3. Communication devices         4. Actuators    6. Types of electric motors       * 1. DC motors         2. AC motors    7. Transmitters    8. Motor control       * 1. DOL         2. Forward/Reverse         3. Star/Delta         4. Soft Starters         5. VFD/VSD    9. Signal processing    10. Signal conditioning    11. Display    12. Instrumentation transmission system components        1. Pressure system components        2. Flow rate measurement components        3. Level measurement components        4. Temperature measurement components | 1. Written Assessment 2. Oral Questioning 3. Practical Assessment 4. Project 5. Third party report 6. Portfolio of evidence |
| 1. Assemble instrumentation and control system components | 1. System components mounting.    * 1. Factors to consider when mounting. 2. Interpretation of installation documents    * 1. Line diagrams      2. Wiring diagrams      3. Layouts      4. Installation manuals 3. Mounting instrumentation devices and components    * 1. Environmental conditions      2. Vibration and shock      3. Weight and size of component      4. Electrical safety      5. Accessibility 4. Cable lugging and tagging    * 1. Types of cable lugs and tags      2. Cable lugging and tagging standards 5. Cable laying 6. Terminations and joints 7. Housekeeping activities    * 1. Cleaning      2. Tools and equipment storage      3. Waste disposal      4. Documentation | 1. Written Assessment 2. Oral Questioning 3. Practical Assessment 4. Project 5. Third party report 6. Portfolio of evidence |
| 1. Test instrumentation and control system components | 1. Importance of instrumentation system testing 2. Meaning of terms 3. Inspection 4. Testing 5. Types of tests e.g. 6. Electrical tests 7. Functionality tests    * + 1. Test Signal Conditioning Elements        2. Test Signal Processing elements        3. Test Data presentation elements 8. Testing tools and equipment 9. Multimeter 10. Insulation resistance tester 11. Signal generators 12. Troubleshooting techniques 13. Performance characteristics 14. Statics and dynamics 15. Error and loading effects 16. Accuracy 17. Precision 18. Linearity 19. Sensitivity 20. Resolution 21. Response time 22. Drift 23. Calibration 24. Functional integration 25. Instrumentation system test report | 1. Written Assessment 2. Oral Questioning 3. Practical Assessment 4. Project 5. Third party report 6. Portfolio of evidence |

**Suggested Methods of Instruction**

* Group discussions
* Demonstration
* Visit to manufacturing and processing industries

**Recommended Resources for 25 trainees**

|  |  |  |  |  |
| --- | --- | --- | --- | --- |
| **S/No.** | **Category/Item** | **Description/ Specifications** | **Quantity** | **Recommended Ratio**  (Item: Trainee) |
| **A** | **Learning Materials** |  |  |  |
|  | Reference books | A.K Sawhney  Electrical and Electronic Measurement and Instrumentation.  Arun. K Ghoshi  Introduction to Measurements and Instrumentation 2nd edition  R.K Rajput  Electrical Measurements and Instrumentation 2nd edition | 5 pcs | 1:5 |
|  | Installation manuals | Assorted Systems component Manufacturer’s manuals and data sheets  Instrumentation Handbooks | 5 pcs | 1:5 |
|  | Maintenance manuals | Assorted Systems component Manufacturer’s manuals and data sheets  Maintenance Handbooks | 5 pcs | 1:5 |
|  | Checklists | Assorted Systems checklists | 5 pcs | 1:5 |
|  | Audio visual presentations | Projector | 1 | 1:25 |
| **B** | **Learning Facilities & infrastructure** |  |  |  |
|  | Lecture/theory room | 60m2 | 1 | 1:25 |
|  | Workshop | 150m2 | 1 | 1:25 |
|  | Computer laboratory | 100m2 | 1 | 1:25 |
| **C** | **Consumable materials** |  |  |  |
|  | Installation materials | Insulation tapes and tubes, cleaning agents, Lubrication oil, assorted electrical cable rolls, cable tags and lags, soldering wire | 25 pcs each | 1:1 |
| **D** | **Tools and Equipment** |  |  |  |
|  | Assorted tools and equipment | Side cutters, Side cutters, Pliers, Screwdriver, Crimping tools, multi-meter, torque wrench, Oscilloscope, clamp meters, drilling tools | 25 pcs | 1:1 |
|  | PPEs | Safety boots, overall, helmets | 25 pcs | 1:1 |
|  | Work stations | Electrical works station with mounting boards, 3θ power source. | 25 pcs | 1:1 |
|  | Process control training | With simulations faults | 25 pcs | 1:1 |

## INSTRUMENTATION AND CONTROL SYSTEM OPERATIONS

**UNIT CODE: 0714 351 15A**

**Relationship to Occupational Standards**

This unit addresses the unit of competency: Operate instrumentation and control system **Duration of Unit:** 160 Hours

**Unit Description**

This unit covers the competencies required to operate instrumentation and control system. It involves performing instrumentation and control system start up, changing instrumentation and control system dies and running instrumentation and control systems.

**Summary of Learning Outcomes**

By the end of this unit, the learner should be able to:

|  |  |  |
| --- | --- | --- |
| **S/No.** | **Learning Outcomes** | **Duration (Hours)** |
|  | Perform instrumentation and control system start up | 60 |
|  | Changeover instrumentation and control system dies | 50 |
|  | Run instrumentation and control system | 50 |
|  | **TOTAL HOURS** | **160** |

**Learning Outcomes, Content and Suggested Assessment Methods**

|  |  |  |
| --- | --- | --- |
| **Learning Outcome** | **Content** | **Suggested Assessment Methods** |
| 1. Perform instrumentation and control system start up | 1. Instrumentation and control system inspection 2. Visual inspection 3. Functional inspection 4. Procedure of Instrumentation and control system start up 5. Types of instrumentation control alarms    * 1. Indicators 6. sirens 7. codes 8. Instrumentation and control system dry run | 1. Written Assessment 2. Oral Questioning 3. Practical Assessment 4. Project 5. Third party report 6. Portfolio of evidence |
| 1. Perform instrumentation and control system changeover dies | * 1. Instrumentation and control system dies  1. Moulds 2. Star wheels 3. Guide ways 4. Worm wheels    1. Tools and equipment       1. Cutting tools       2. Forming tools       3. Shaping tool       4. Fastening tools       5. Calibration equipment    2. System dies change over    3. System dies testing 5. Visual inspection 6. Functional test | 1. Written Assessment 2. Oral Questioning 3. Practical Assessment 4. Project 5. Third party report 6. Portfolio of evidence |
| 1. Run instrumentation and control system | 1. Factor to consider when selecting the recipe 2. Sequence of events 3. Process type 4. Factors to consider when loading raw materials 5. Safety 6. Environmental 7. System parameters 8. Temperature 9. Pressure 10. Flow rate 11. Level sensing 12. System parameter adjustment 13. Adjustment techniques 14. Parameter testing 15. System monitoring 16. Monitoring tools and indicators 17. Interpreting alarms and indicators 18. Data logging techniques 19. Documentation and record-keeping     * 1. Types of documentation          1. Installation manuals          2. Maintenance manuals          3. Checklists          4. Maintenance schedules | 1. Written Assessment 2. Oral Questioning 3. Practical Assessment 4. Project 5. Third party report 6. Portfolio of evidence |

**Suggested Methods of Instruction34I**

* Group discussions
* Demonstration
* Visit to manufacturing and processing industries

**Recommended Resources for 25 trainees**

|  |  |  |  |  |
| --- | --- | --- | --- | --- |
| **S/No.** | **Category/Item** | **Description/ Specifications** | **Quantity** | **Recommended Ratio**  (Item: Trainee) |
| **A** | **Learning Materials** |  |  |  |
|  | Reference books | A.K Sawhney  Electrical and Electronic Measurement and Instrumentation.  Arun. K Ghoshi  Introduction to Measurements and Instrumentation 2nd edition  R.K Rajput  Electrical Measurements and Instrumentation 2nd edition | 5 pcs | 1:5 |
|  | Installation manuals | Assorted Systems component Manufacturer’s manuals and data sheets  Instrumentation Handbooks | 5 pcs | 1:5 |
|  | Maintenance manuals | Assorted Systems component Manufacturer’s manuals and data sheets  Maintenance Handbooks | 5 pcs | 1:5 |
|  | Checklists | Assorted Systems checklists | 5 pcs | 1:5 |
|  | Audio visual presentations | Projector | 1 | 1:25 |
| **B** | **Learning Facilities & infrastructure** |  |  |  |
|  | Lecture/theory room | 60m2 | 1 | 1:25 |
|  | Workshop | 150m2 | 1 | 1:25 |
|  | Computer laboratory | 100m2 | 1 | 1:25 |
| **C** | **Consumable materials** |  |  |  |
|  | Installation materials | Indicators, sirens, insulation tape, cables | 25 pcs | 1:1 |
|  | Assorted dies | Moulds, star wheels, guide ways, worm wheels | 5 for each category | 1:5 |
| **D** | **Tools and Equipment** |  |  |  |
|  | Assorted tools and equipment | Side cutters, Side cutters, Pliers, Screw driver, Crimping tools, Mult-meter, torque wrench | 25 pcs | 1:1 |
|  | PPEs | Safety boots, overall | 25 pcs | 1:1 |
|  | Work stations |  | 25 | 1:1 |

## INSTRUMENTATION AND CONTROL SYSTEMS MAINTENANCE

**UNIT CODE: 0714 351 16A**

**Relationship to Occupational Standards**

This unit addresses the unit of competency: Maintain instrumentation and control systems. **Duration of Unit:** 160 Hours

**Unit Description**

This unit covers the competencies required to maintain instrumentation and control systems. It involves preparing instrumentation and control systems maintenance schedule, conducting instrumentation and control systems preventive maintenance, conducting instrumentation and control systems corrective maintenance, testing and commissioning instrumentation and control systems.

**Summary of Learning Outcomes**

By the end of this unit, the learner should be able to:

|  |  |  |
| --- | --- | --- |
| **S/NO** | **LEARNING OUTCOMES** | **DURATION (HOURS)** |
|  | Prepare instrumentation and control systems maintenance schedule | **35** |
|  | Conduct instrumentation and control systems preventive maintenance | **35** |
|  | Conduct instrumentation and control systems corrective maintenance | **45** |
|  | Test and commission instrumentation and control system | **45** |
|  | **TOTAL HOURS** | **160** |

**Learning Outcomes, Content and Suggested Assessment Methods**

|  |  |  |
| --- | --- | --- |
| **Learning Outcome** | **Content** | **Suggested Assessment Methods** |
| 1. Prepare instrumentation and control systems maintenance schedule | 1. Maintenance scheduling 2. Types of maintenance and procedures 3. Preventive maintenance 4. Predictive maintenance 5. Corrective maintenance 6. Condition based maintenance 7. Predetermined maintenance 8. Reactive maintenance 9. Maintenance Work plan 10. Risk Assessment and Job Safety Analysis 11. Permit-to-Work System 12. Lockout/Tagout Procedures 13. Maintenance Tasks 14. Documentation     * + 1. Date and time of maintenance         2. Equipment identification         3. Maintenance tasks performed         4. Spare parts used         5. Calibration results         6. Non-conformances and corrective actions 15. Spare Parts Management 16. Training and Competency 17. Continuous Improvement 18. Maintenance documents 19. Maintenance manual 20. Maintenance report 21. Maintenance logs 22. Maintenance checklist | 1. Written tests 2. Oral Questioning 3. Practical assessment 4. Project 5. Third party report 6. Portfolio of evidence |
| 1. Conduct instrumentation and control systems preventive maintenance | 1. Critical instrumentation and control system components for maintenance    * 1. Audio sensitive gauges      2. Optical gauges      3. Pressure gauges      4. Temperature gauges      5. Vibration analysers 2. Preventive maintenance activities    * 1. Regular inspections      2. Cleaning      3. Adjustments e.g. alignment, balancing      4. Wear components check      5. lubrication      6. Calibrations | 1. Written tests 2. Oral Questioning 3. Practical assessment 4. Project 5. Third party report 6. Portfolio of evidence |
| 1. Conduct instrumentation and control systems corrective maintenance | 1. Troubleshooting procedure in systems 2. Identification of maintenance activities 3. Types of faults    * 1. Sensor Faults:         1. Calibration drift         2. Sensor failure         3. Noise and interference      2. Signal Transmission Faults:         1. Signal attenuation         2. Signal distortion         3. Signal loss      3. Signal Conditioning Faults:         1. Gain error         2. Offset error         3. Nonlinearity      4. Data Acquisition Faults:         1. Sampling rate errors         2. Quantization errors         3. Data corruption      5. Processing Faults:         1. Algorithm errors         2. Computational errors         3. Software bugs      6. Human Error:         1. Incorrect calibration         2. Improper maintenance         3. Misinterpretation of data 4. Corrective maintenance activities    * 1. Replacement      2. Repair      3. Overhaul      4. Alignment      5. Reset      6. Readjustment      7. Software updates      8. Recalibration 5. System isolation points    * 1. Circuit breakers      2. Fuses      3. Isolators      4. Couplers      5. Fittings 6. Fault rectification | 1. Written tests 2. Oral Questioning 3. Practical assessment 4. Project 5. Third party report 6. Portfolio of evidence |
| 1. Test and Commission instrumentation and control system | 1. SI unit of various types of Electrical parameters    * 1. Power – Watts (W)      2. Current – Amperes (A)      3. Resistance – Ohms(Ω)      4. Voltage – Volts (V) 2. Electrical tests 3. Polarity test 4. Earth loop impedance test 5. Insulation resistance test 6. Earth electrode resistance test 7. Functionality test 8. Commissioning documents 9. Start up and shutdown procedures 10. Safety documentation 11. Handover report 12. Commissioning documents:     * 1. Pre-commissioning Checklist       2. Commissioning Test Procedures       3. Commissioning Data Sheets       4. Calibration Certificates:       5. Instrument Calibration Certificates       6. Calibration Procedures       7. Spare Parts List:       8. Vendor Information       9. Maintenance Schedules and Procedures:       10. Preventive Maintenance Schedule       11. Corrective Maintenance Procedures       12. Emergency Procedures       13. Operator Training Manuals       14. Safety Manuals | 1. Written tests 2. Oral Questioning 3. Practical assessment 4. Project 5. Third party report 6. Portfolio of evidence |

**Suggested Methods of Instruction**

* Demonstrations
* Simulation
* Role play
* Group Discussion
* Presentations
* Projects
* Case studies
* Assignments

**Recommended Resources for 25 trainees**

|  |  |  |  |  |
| --- | --- | --- | --- | --- |
| **S/No.** | **Category/Item** | **Description/ Specifications** | **Quantity** | **Recommended Ratio**  (Item: Trainee) |
| **A** | **Learning Materials** |  |  |  |
|  | Reference books | A.K Sawhney  Electrical and Electronic Measurement and Instrumentation.  Arun. K Ghoshi  Introduction to Measurements and Instrumentation 2nd edition  R.K Rajput  Electrical Measurements and Instrumentation 2nd edition | 5 pcs | 1:5 |
|  | Maintenance manuals | Assorted Systems component Maintenance reports, manufacture’s manuals and data sheets  Instrumentation Handbooks | 5 pcs | 1:5 |
|  | Charts | Assorted instrumentation systems circuit diagrams  P& ID charts | 1 pcs for each | 1:25 |
|  | Software | Assorted CAD software  e.g Circuit wizard, Auto CAD | 25 | 1:1 |
|  | Audio visual presentations | Projector | 1 | 1:25 |
| **B** | **Learning Facilities & infrastructure** |  |  |  |
|  | Lecture/theory room | 60m2 | 1 | 1:25 |
|  | Workshop | 150m2 | 1 | 1:25 |
|  | Computer laboratory | 100m2 | 1 | 1:25 |
| **C** | **Consumable materials** |  |  |  |
|  | Installation materials | Insulation tape, cables | 25 pcs | 1:1 |
|  | Assorted electrical components | Contactors, transformer, overload relays, timers | 25 pcs | 1:1 |
|  | Assorted instrumentation components | Sensors, transducers, actuators | 25 | 1:5 |
| **D** | **Tools and Equipment** |  |  |  |
|  | Assorted tools and equipment | Side cutters, Side cutters, Pliers, Screw driver, Crimping tools, Mult-meter, Oscilloscope, Solder guns | 25 pcs | 1:1 |
|  | PPEs | Safety boots, overall | 25 pcs | 1:1 |
|  | Function generator |  | 5 pcs | 1:5 |
|  | Variable power supply |  | 5 pcs | 1:5 |
|  | Trainers kit | Digital electronics, PWM kit | 5 pcs | 1:5 |
|  | PCB prototyping machine |  | 2 | 1:13 |
|  | Hot air gun |  | 5 pcs | 1:5 |
|  | Drilling machines |  | 5 pcs | 1:5 |
|  | Work stations |  | 25 | 1:1 |