**A lion with two spears and a rooster

Description automatically generated**

**REPUBLIC OF KENYA**

**COMPETENCY BASED MODULAR CURRICULUM**

**FOR**

**INDUSTRIAL AUTOMATION AND ROBOTICS TECHNOLOGY**

**KNQF LEVEL 6**

**PROGRAMME ISCED CODE: 0714 554A**

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**Council Secretary/CEO/Chief Principal**

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# FOREWORD

Provision of quality education and training is fundamental to the Government’s overall strategy for socio-economic development. Quality education and training contribute to achievement focused on Kenya’s development blueprint and sustainable development goals.

Reforms in the education and training sector are necessary for achievement of Kenya Vision 2030 and meeting the provisions the Constitution of Kenya. The education sector had to be aligned to the Constitution and this resulted in formulation of the Policy Framework for Reforming Education and Training (Sessional Paper No. 1 of 2019). A key feature of this policy is the 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 mode of delivery that allows for multiple entry and exit in TVET programs.

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.

It is my conviction that this curriculum will play a great role towards development of competent human resource for the Industrial Automation and Robotics sector’s growth and sustainable development.

**PRINCIPAL SECRETARY**

**STATE DEPARTMENT FOR TVET**

**MINISTRY OF EDUCATION**

**PREFACE**

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

The Technical and Vocational Education and Training Act No. 29 of 2013 and the Sessional Paper No. 1 of 2019 on Reforming Education and Training in Kenya, emphasized the need toreform 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 Kenyan labour force.

This curriculum has been developed in adherence to the Kenya National Qualification Framework and CBETA standards and guidelines. The curriculum is designed and organized into Units of Learning with Learning Outcomes; suggested delivery methods, training/learning resources and methods of assessing the trainee’s achievement. The curriculum is competency-based and allows multiple entry and exit to the course.

I am grateful to the Council Members, Council Secretariat, …….. NSSC, expert workers and all those who participated in the development of this curriculum.

**Council Secretary/CEO/Chief Principal**

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**Email:** ………

# ACKNOWLEDGEMENT

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 was received from industry and various organizations.

I appreciate National Industrial Automation and Robotics Sector Skills Committee who enabled the development of this curriculum. I recognize with appreciation the role of the SSC in ensuring that competencies required by the industry are addressed in this curriculum.

I also thank all stakeholders in the industrial automation and robotics sector for their valuable input and all those who participated in the process of developing this curriculum.

I am convinced that this curriculum will go a long way in ensuring that workers in industrial automation and robotics sector will acquire competencies that will enable them perform their work more efficiently.

**Council Secretary/CEO/Chief Principal**

**………………………………….**

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# ABBREVIATIONS AND ACRONYMS

CAD Computer Aided Design

CCTV Closed Circuit Tele Vision

EHS Environment Health and Safety

HVAC Heating Ventilation and Air Conditioning

IBMS Integrated Building Management System

IEE Institute of Electrical Engineers

K.C.S. E Kenya Certificate of Secondary Education

KEBS Kenya Bureau of Standards

KNQA Kenya National Qualification Authority

KNQF Kenya National Qualification Framework

KPLC Kenya Power and Lighting Company

NCA National Construction Authority

NEMA National Environment Management Authority

OSHA Occupational Safety and Health Act

PPE Personal Protective Equipment

PV Photo Voltaic

TVET Technical and Vocational Education and Training

WIBA Work Injury Benefits Act

# KEY TO ISCED UNIT CODE



# COURSE OVERVIEW

This Industrial Automation and Robotics Technology Level 6 curriculum is designed to equip an industrial automation and robotics operator with the competencies required to: Operate Industrial Automation and Robotic Systems, Maintain Industrial Automation and Robotic Systems and Maintain Product Quality

**SUMMARY OF UNITS OF COMPETENCY**

**INDUSTRIAL AUTOMATION AND ROBOTICS LEVEL 6**

|  |  |  |  |  |
| --- | --- | --- | --- | --- |
| **MODULE** | **UNITS** | | | |
| **UNIT**  **CATEGORY** | **UNIT CODE** | **UNIT NAME** | **DURATION(Hours)** |
| **ONE (I)** | CORE | 0714 351 09A | Industrial Automation and Robotic Systems Operations | 250 |
| CORE | 0714 351 11A | Product Quality Maintenance | 140 |
| **SUB TOTAL** | | | **390** |
| **TWO (II)** | **CORE** | 0714 351 10A | Industrial Automation and Robotic Systems Maintenance | 220 |
| **SUB TOTAL** | | | **220** |
| **THREE(III)** | **BASIC** | 0611 441 01A | Digital Literacy | 40 |
| **COMMON** | 0541 441 05A | Engineering mathematics | 150 |
| **CORE** | 0714 451 12A | Industrial automation electrical systems installation and maintenance | 170 |
| **SUB TOTAL** | | | **360** |
| **FOUR(IV)** | **CORE** | 0714 451 13A | Stand-alone controlled systems installation and maintenance. | 200 |
| **CORE** | 0714 451 14A | Pneumatic System Installation and Maintenance | 220 |
| **SUB TOTAL** | | | **420** |
| **FIVE(V)** | **BASIC** | 0031 441 02A | Communication Skills | 40 |
| **BASIC** | 0413 441 04A | Entrepreneurial Skills | 40 |
| **BASIC** | 0417 441 03A | Work Ethics and Practices | 40 |
| **CORE** | 0714 451 15A | Hydraulic systems installation and maintenance. | 220 |
|  | **SUB TOTAL** | | | **340** |
| **SIX(VI)** | **COMMON** | 0715 541 06A | Engineering mechanics | 150 |
| **COMMON** | 0713 541 07A | Electrical and electronics principles | 150 |
| **CORE** | 0714 551 16A | Electrical drives installation and maintenance | 180 |
|  | **SUB TOTAL** | | | 480 |
| **SEVEN(VII)** | **COMMON** | 0732 551 08A | Computer aided drawing | 150 |
| **CORE** | 0714 551 17A | Programmable logic Controllers installation and maintenance. | 220 |
|  | **SUB TOTAL** | | | 370 |
| **EIGHT(VIII)** | **CORE** | 0714 551 18A | Distributed control systems installation and maintenance. | 240 |
| **CORE** | 0714 551 19A | Industrial robotic systems installation and maintenance. | 220 |
|  | **SUB TOTAL** | | | 460 |
|  | **INDUSTRIAL ATTACHEMENT** | | | 480 |
|  |  |  |  | **Grand Total:**  **3520HRS** |

The total duration for this course is 3520 hours.

**Entry Requirements**

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

1. Kenya certificate of secondary education (K.C.S.E.) with a minimum mean grade of C (minus) or KCE division 3 or its equivalent as determined by the KNQA.

**Or**

1. Industrial automation and robotics KNQF level 5 certificate or its equivalent as determined by TVETA.

**Trainer Qualification**

Qualifications of a trainer for this course include:

1. Have a minimum of KNQF Level 7 qualification or its equivalent in a related trade area.
2. Be licensed by TVETA.

**Industry Training**

An individual enrolled in this course will be required to undergo Industry training for a minimum period of ……480… hours in … industrial automation and robotics …… 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. During summative assessment basic and common units may be integrated in the core units or assessed as discrete units.
4. Theoretical and practical weighting for each unit of learning shall be as follows:
5. 10 :90 for units in module 1 and module 2
6. 30:70 for units in module 3 to module 5
7. 40:60 for units in module 6 to module 8
8. Formative and summative assessments shall be weighted at 60% and 40% respectively in the overall unit of learning score
9. For a candidate to be declared competent in a unit of competency, the candidate must meet the following conditions:
10. Obtained at least 40% in theory assessment in formative and summative assessments.
11. Obtained at least 60% in practical assessment in formative and summative assessment where applicable.
12. Obtained at least 50% in the weighted results between formative assessment and summative assessment where the former constitutes 60% and the latter 40% of the overall score.
13. 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 unit of competency. To attain a Certificate in industrial automation and robotics KNQF Level 5, the candidate must demonstrate competence in all the units of competency as given in qualification pack. Statement of Attainment certificate may be awarded upon demonstration of competence in certifiable element within a unit

These certificates will be issued by ……… (QAI)

MODULE ONE

## INDUSTRIAL AUTOMATION AND ROBOTIC SYSTEMS OPERATION

**UNIT CODE:** 0714 351 09A

**UNIT DURATION: 250 HOURS**

**Relationship to Occupational Standards**

**This unit addresses the unit of competency**: Operate industrial automation and robotic systems

**Unit Description**

UNIT DESCRIPTION

This unit covers the competencies required in operation of an industrial automation and robotics systems. The competencies include; operating computer devices, applying digital electronic principles, controlling industrial automation and robotic systems, monitoring industrial automation and robotic systems and setting industrial automation and robotic system parameters.

**Summary of Learning Outcomes**

**By the end of this unit of learning, the trainee will be able to:**

|  |  |  |
| --- | --- | --- |
| S/No | Learning Outcomes | **Duration (Hrs.)** |
| 1 | Operate computer devices | **30** |
| 2 | Apply digital electronic principles | **30** |
| 3 | Control industrial automation and robotic system | **80** |
| 4 | Monitor industrial automation and robotic system robotic system parameters | **50** |
| 5 | Set industrial automation and robotic system parameters | **60** |
|  |  | **TOTAL 250 HRS** |

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

|  |  |  |
| --- | --- | --- |
| **Learning Outcome** | **Content** | **Suggested Assessment Methods** |
| 1. Operate computer devices | * 1. Meaning and importance of digital literacy      1. Procedure for turning/off a computer      2. Types of computer devices (tablets, desktop, and laptop computers).   2. Components of a computer system   3. Computer Hardware      1. The System Unit E.g. motherboard, CPU, casing,      2. Input devices e.g. pointing, keying, scanning, voice/speech recognition, direct data capture devices.      3. Output devices e.g. hardcopy output and softcopy output      4. Storage devices e.g. main memory e.g. RAM, secondary storage (Solid state devices, hard drives, CDs & DVDs, memory cards, flash drives      5. Computer ports e.g. HDMI, DVI, VGA, USB type C, etc.   4. Start menu commands and desktop manipulation   5. Mouse use techniques   6. Keyboard parts and use techniques   7. File and files management using an operating system   8. Computer internet connection options      1. Mobile networks/data plans      2. Wireless hotspots      3. Cabled (Ethernet)   9. Mechanisms for storing files (flash drives, hard drives).   10. Computer external devices management       1. Device connections       2. Device controls (volume controls and display properties) | * Observation * Oral assessment * Portfolio of evidence * Third party report * Written assessment * Practical |
| 1. Apply digital electronic principles | * 1. Number system concepts      1. Introduction to number systems: binary, decimal, hexadecimal      2. Conversion between number systems      3. Applications in digital electronics   2. Digital logic gate concepts      1. Introduction to logic gates: AND, OR, NOT, NAND, NOR, XOR      2. Truth tables and Boolean algebra | * Observation * Oral assessment * Portfolio of evidence * Third party report * Written assessment * Practical |
| 1. Control industrial automation and robotic system | * 1. Applications of industrial automation and robotics control systems:      1. Programmable logic controllers      2. Human machine interface      3. Sensors      4. Actuators      5. Robotic arms      6. Robotic manipulators      7. Robotic end effectors      8. Motion control systems   2. PPEs      1. Apron      2. Safety boots      3. Goggles      4. Hand gloves      5. Helmet         1. Industrial automation and robotic system operational manual interpretation         2. Start up and shut down of industrial automation and robotic systems         3. Material flow control         4. Uses of industrial automation and robotic system safety devices      6. Guards      7. Interlocks      8. Emergency push buttons   3. Practice: control industrial automation and robotics system | * Observation * Oral assessment * Portfolio of evidence * Third party report * Written assessment * Practical |
| 1. Monitor industrial automation and robotic system robotic system parameters | * 1. Uses of industrial automation and robotic monitoring systems.      1. Functions of industrial monitoring sensors         1. Pressure sensors         2. Position sensors         3. Infra-red sensors         4. Proximity sensors         5. Level sensors         6. Speed sensors         7. 2.1.2 Dashboards         8. Dash board types      2. Human machine interfaces      3. Display monitors         + 1. Utilisation of industrial automation and robotic system visualisation tools   2. Robotic system monitoring and control software      1. Industrial automation and robotic system technical parameters         1. Temperature         2. Pressure         3. Flow rate         4. Displacement         5. Speed         6. Vibration         7. Load and force         8. Power consumption         9. Environmental conditions   3. Practice: Monitor industrial automation and robotic system parameters | * Observation * Oral assessment * Portfolio of evidence * Third party report * Written assessment * Practical |

|  |  |  |
| --- | --- | --- |
| 1. Set industrial automation and robotic system parameters | * 1. Industrial automation and robotics      1. System process recipe      2. Selecting recipe from the database      3. Reviewing the recipe settings      4. Applying the recipe to the system   2. Industrial automation and robotic system process parameters identification      1. Temperature      2. Pressure      3. Level      4. Material amount   3. Process parameters configuration:      1. Preparations for configuration      2. Process parameters Identification      3. Setting up parameters on the control interface      4. Calibration and tuning of the system      5. Performing safety checks      6. Monitoring and fine-tuning during operation      7. Documenting the configuration   4. Practice: Set industrial automation and robotic system parameters | * Project * Practical * Oral questioning * Third party report * Portfolio of evidence * Written tests |

**Recommended Resources for 25 trainees**

|  |  |  |  |  |
| --- | --- | --- | --- | --- |
| **S/No.** | **Category/Item** | **Description/Specifications** | **Quantity** | **Recommended Ratio (Item: Trainee)** |
| **A** | **Tools** | | | |
|  | Screwdriver Sets | Assorted screwdrivers for various applications | 2 sets | 2:25 |
|  | Wrench Sets | Assorted wrenches for mechanical work | 2 sets | 2:25 |
| **B** | **Learning Facilities & Infrastructure** | | | |
|  | Lecture/Theory Room | Spacious, equipped with projectors and seating for 25 trainees, approximately 60 sqm | 1 | 1:25 |
|  | Workshop | Hands-on training area with workbenches, tools, and safety equipment, approximately 80 sqm | 1 | 1:25 |
|  | Laboratory | Equipped with robotics training kits for experiments, approximately 50 sqm | 1 | 1:25 |
| **C** | **Materials and Supplies** | | | |
|  | Guards | Safety guards for equipment operation | 1 | 1:25 |
|  | Interlocks | Safety interlocks for machinery | 1 | 1:25 |
|  | Emergency Push Buttons | Emergency stop buttons for training setups | 1 | 1:25 |
| **D** | **Equipment** | | | |
|  | Industrial Automation Kits | Complete training kits for automation and robotics | 2 | 2:25 |
|  | User Manuals | Manuals for industrial automation training | 2 | 2:25 |
|  | Hydraulic Training Kits | Kits for hydraulic systems training | 2 | 2:25 |
|  | Pneumatics Training Kits | Kits for pneumatic systems training | 2 | 2:25 |
|  | PPE Sets | Personal protective equipment for all trainees | 25 sets | 1:1 |
|  | PLC Panels | Programmable logic controller panels for training | 2 | 2:25 |
|  | HMI Panels | Human-machine interface panels for training | 2 | 2:25 |
| **E** | **Reference Materials** | | | |
|  | OSHA Documentation | Occupational Safety and Health Act resources | 1 | 1:25 |
|  | Automation Books | Books on industrial automation and robotics systems operation | 1 | 1:25 |

## PRODUCT QUALITY MAINTANANCE

**ISCED UNIT CODE:** 0714 351 11A

**UNIT DURATION: 140 HOURS**

**Relationship to Occupational Standards**

**This unit addresses the unit of competency:** Maintain product quality

**Unit Description**

This unit covers the competencies required by an industrial automation and robotics system operator to maintain quality of products produced through an industrial automated system. These competencies include; conducting product quality checks, adjusting industrial automation and robotics machinery stetting and documenting production quality activities.

**Summary of Learning Outcomes**

**By the end of this unit of learning, the trainee will be able to:**

|  |  |  |
| --- | --- | --- |
| S/No | Learning Outcome | **Duration (Hrs.)** |
| 1 | Conduct product quality checks | **40** |
| 2 | Document production quality activities | **40** |
| 3 | Adjust industrial automation and robotics machinery settings | **60** |
|  | **TOTAL** | **140 HRS** |

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

|  |  |  |
| --- | --- | --- |
| **Learning Outcome** | **Content** | **Suggested Assessment Methods** |
| 1. Conduct product quality checks | * 1. Workplace procedures and inspection.   2. Preparation of the inspection area and equipment   3. Inspection of product according to procedures   4. Uses of product quality monitoring equipment      1. Dimensional measurement systems      2. Automated cameras      3. Vision sensors      4. Surface profilometers      5. Ultrasonic testing equipment   5. Handling defective products   6. Practice: conducting quality checks on by products | * Project * Practical * Oral questioning * Third party report * Portfolio of evidence * Written tests |
| 1. Document production quality activities | * 1. Recording of industrial automation and robotics conforming products      1. Criteria for conformance definition      2. Utilization of automation systems to capture conformance data      3. Setting up data logging for conforming products      4. Verification and validation of product conformance      5. Generation of reports for conforming product   2. Recording of industrial automation and robotics non-conforming products      1. Criteria for non-conformance definition      2. Utilization of automation systems to capture non-conformance products      3. Setting up data logging for non-conforming products      4. Non-conforming products separation and labelling      5. Documentation of non-conformance details      6. Analyzing and classifying non-conformance records      7. Generating non-conformance Reports   3. Recording of industrial automation and robotics machine setting deviations.      1. Reporting and documentation of settings deviations.      2. Preventive measures implementation   4. Practice: Product quality documentation   5. Excursion on product quality maintenance | * Project * Practical * Third party report * Portfolio of evidence * Oral questioning * Written tests |
| 1. Adjust industrial automation and robotics machinery settings | * 1. Uses of PPE      + 1. Apron        2. Safety boots        3. Goggles        4. Hand gloves        5. Helmet   2. Industrial automation and robotics machine setting deviations      + 1. Identification of the source of the deviation        2. Assessment of the impact of the deviation        3. Investigation of potential causes of the deviation   3. Uses of industrial automation and robotics machinery setting adjustment tools and equipment      1. Tools         1. Hand tools            1. Calibrators            2. Thermometers            3. Pressure gauges            4. Micrometres            5. Vernier callipers            6. Tachometers            7. Accelerometers      2. Equipment         1. Lifting gear         2. Change parts         3. Personal computers         4. PPE         5. Product quality monitoring equipment         6. Human machine interfaces Practical assessment   4. Elimination of industrial automation and robotics machine setting deviations      + 1. Cleaning and maintenance of inspection equipment        2. Deviation correction and Settings reconfiguration        3. System monitoring after correction   5. Practice: setting and adjust industrial automation and robotics machinery settings | * Project * Practical * Third party report * Portfolio of evidence * Oral questioning * Written tests |

**Recommended Resources for 25 trainees**

|  |  |  |  |  |
| --- | --- | --- | --- | --- |
| **S/No.** | **Category/Item** | **Description/Specifications** | **Quantity** | **Recommended Ratio (Item: Trainee)** |
| **A** | **Tools** | | | |
|  | Assorted Tools | General tools for various applications | Adequate |  |
|  | Calibrators | For ensuring accuracy of measurement instruments | 2 | 2:25 |
|  | Thermometers | For measuring temperature | 2 | 2:25 |
|  | Pressure Gauge | For measuring pressure in systems | 1 | 1:25 |
|  | Micrometers | For precise measurement of small dimensions | 5 | 1:5 |
|  | Vernier Calipers | For measuring internal and external dimensions | 5 | 1:5 |
|  | Tachometers | For measuring rotational speed | 2 | 2:25 |
|  | Accelerometers | For measuring acceleration | 1 | 2:25 |
| **B** | **Learning Facilities & Infrastructure** | | | |
|  | Lecture/Theory room | Spacious, equipped with projectors and seating for 25 trainees, approximately 60 sqm | 1 | 1:25 |
|  | Workshop | Hands-on training area with workbenches, tools, and safety equipment, approximately 80 sqm | 1 | 1:25 |
|  | Laboratory | Equipped with robotics training kits for experiments, approximately 50 sqm | 1 | 1:25 |
| **C** | **Materials and Supplies** | | | |
|  | Dimensional measurement systems | Systems for measuring dimensions accurately | 1 | 1:25 |
|  | Automated cameras | For visual inspection and monitoring | 1 | 1:25 |
|  | Vision sensors | For detecting and measuring visual parameters | 1 | 1:25 |
| **D** | **Equipment** | | | |
|  | Industrial automation kits | Complete training kits for automation and robotics | 2 | 2:25 |
|  | User manuals | Manuals for available industrial automation training | 2 | 2:25 |
|  | Service manuals | Manuals for servicing training equipment | 1 | 1:25 |
|  | PPE sets | Personal protective equipment for all trainees | 25 sets | 1:1 |
|  | PLC panels | Programmable logic controller panels for training | 2 | 2:25 |
|  | HMI panels | Human-machine interface panels for training | 2 | 2:25 |
|  | Product quality monitoring equipment | For monitoring quality in production processes | 1 | 1:25 |
|  | Surface profilometers | For measuring surface roughness and texture | 1 | 1:25 |
|  | Ultrasonic testing equipment | For non-destructive testing of materials | 1 | 1:25 |
| **E** | **Reference Materials** | | | |
|  | OSHA documentation | Occupational Safety and Health Act resources | 1 | 1:25 |
|  | Online course materials | Access links, user guides, and handouts from platforms | 1 set | 1:25 |
|  | Printed reference booklets | Summarizing quality control and assurance essentials | 1 set | 1:25 |
|  | Workbooks | Exercises on inspection, defect analysis, and corrective actions | 1 set | 1:25 |

MODULE TWO

## INDUSTRIAL AUTOMATION AND ROBOTIC SYSTEMS MAINTENANCE

**UNIT CODE:** 0714 351 10A

**UNIT DURATION: 220 HOURS**

**Relationship to Occupational Standards**

**This unit addresses the unit of competency**: Operate industrial automation and robotic systems

**Unit Description**

This unit covers the competencies required by an operator to carry out maintenance of industrial automation and robotic systems. These competencies include; applying workshop safety, performing housekeeping, carrying out industrial automation and robotic system autonomous maintenance, carrying out industrial automation and robotic system troubleshooting and replacing industrial automation and robotic system parts

**Summary of Learning Outcomes**

**By the end of this unit of learning, the trainee will be able to:**

|  |  |  |
| --- | --- | --- |
| S/No | Learning Outcome | **Duration (Hrs.)** |
| 1 | Apply workshop safety | **40** |
| 2 | Perform housekeeping | 30 |
| 3 | Carry out industrial automation and robotic system autonomous maintenance |  |
| 4 | Carry out industrial automation and robotic system troubleshooting | 70 |
| 5 | Replace industrial automation and robotic system parts | 80 |
|  |  | **TOTAL 220HRS** |

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

|  |  |  |
| --- | --- | --- |
| **Learning Outcome** | **Content** | **Suggested Assessment Methods** |
| * + - 1. Apply workshop safety | * 1. Workshop safety      1. Definition      2. Types and uses of PPE’s   2. Emergence responses steps      1. Common emergencies         1. Fire         2. Chemical spills         3. Injury response   3. Fire safety      1. Fire extinguishers types and uses      2. Flammable materials identification      3. Fire prevention   4. Safe handling and disposal of chemicals and materials      1. Chemical hazard identification      2. Safe handling procedure      3. Storage and labelling of chemicals      4. Chemical disposal procedures      5. Emergency response for chemical exposure   5. Identifying and marking hazardous zones      1. Common hazardous zones         1. Flammable zones         2. High traffic zones         3. Electrical hazard zones         4. Chemical storage areas   6. Work area organization and maintenance      1. Setting up      2. Proper storage and labelling of tools and equipment   7. Workplace hazards      1. Physical hazards         1. Noises         2. Vibration         3. Heat         4. Sharp object      2. Chemical hazards         1. Fuels         2. Oils         3. Cleaning agents      3. Electric hazards         1. Live wires         2. Batteries         3. Electrical systems   8. Workshop accidents, causes and responses      1. Slip, strips and falls      2. Cuts and abrasion      3. Burns      4. Electrical shocks | * Practical * Project * Portfolio of evidence * Third party report * Written tests. |
| * + - 1. Perform housekeeping | * 1. Housekeeping.      1. Definition      2. Importance of housekeeping   2. Housekeeping activities and their importance      1. Tool and equipment organization      2. Work area cleanliness      3. Safe handling and disposal of hazardous materials      4. Inspection and maintenance of equipment      5. Personal protective equipment management      6. Air and ventilation maintenance      7. Incident prevention and reporting   3. Housekeeping tools and equipment      1. Uses and maintenance      2. Brooms and brushes         1. Dustpans and squeegees         2. Vacuum cleaners         3. Mops and mop buckets         4. Waste bins and recycling containers   4. Housekeeping materials      1. Cleaning cloths and rags      2. Cleaning agents and solvents      3. Lubricants      4. Gloves and PPE’s      5. Disposable bags and liners   5. Workshop waste sorting and disposal      1. Types of waste         1. General waste         2. Hazardous waste         3. Recyclable waste         4. Organic waste         5. E-waste      2. Waste sorting procedure         1. Designated bins for different types of waste         2. Sorting by material         3. Pre-sorting hazardous waste      3. Hazardous waste disposal         1. Chemical waste         2. Used oil and solvents         3. Paints and finishes | * Practical * Project * Portfolio of evidence * Third party report * Written tests. |
| * + - 1. Carry out industrial automation and robotic system autonomous maintenance | * 1. Identification of industrial automation and robotic system autonomous maintenance tasks:   Routine inspection   * + 1. Cleaning     2. Degreasing     3. Lubrication     4. Tightening     5. Aligning   1. Uses of industrial automation and robotic system autonomous maintenance tools and equipment   2. Tools      1. Flashlights      2. Hand tools      3. Thermal imaging cameras      4. Grease guns      5. Oil guns      6. Oil dispensers      7. Tachometers      8. Vibration meters      9. Multimeters   3. Equipment      1. Air compressors      2. Solvent sprayers      3. Safety equipment   4. Uses of PPE      1. Apron      2. Safety boots      3. Goggles      4. Hand gloves      5. Helmet   5. Interpretation of industrial automation and robotic system service manual   6. Industrial automation and robotic system autonomous maintenance tasks:      1. Routine inspection      2. Cleaning      3. Degreasing      4. Lubrication      5. Tightening      6. Aligning   7. Industrial automation and robotic system autonomous maintenance checklists preparation   8. Industrial automation and robotic system autonomous maintenance checklists filling   9. Practice: maintain industrial automation and robotic system. | * Carry out industrial automation and robotic system autonomous maintenance |
| * + - 1. Carry out industrial automation and robotic system troubleshooting | * 1. Identification of industrial automation and robotic system alerts:      1. Warnings      2. Alarms   2. Industrial automation and robotic system alerts clearance      1. Identifying the type and source of the alert      2. Understanding the alert description and code      3. Performing initial troubleshooting      4. Clearing mechanical or electrical issues      5. Verifying software and control system configurations      6. Performing safety checks      7. Clearing the alert on the control Interface      8. Documenting the alert and corrective actions      9. Testing the system before full operation   3. Practice: troubleshoot industrial automation and robotics system | * Carry out industrial automation and robotic system troubleshooting |
| * + - 1. Replace industrial automation and robotic system parts | * 1. Consumable industrial automation and robotic system parts identification and usage      1. Bearings         1. Types of bearing         2. Causes of bearing wear         3. Symptoms of worn-out bearing      2. Seals and gaskets         1. Types of sealants and gaskets         2. Cause of worn-out seals and gaskets         3. Symptoms of worn-out seals and gaskets of      3. Filters         1. Types of filters         2. Maintenance of filters      4. Belts and chains         1. Types of belts and chains         2. Causes of worn-out belts and chains         3. Symptoms of worn-out belts and chains      5. Wear plates and liners         1. Types of plates and liners         2. Causes of worn-out plates and liners         3. Symptoms of worn-out plates and liners      6. Cutting tools         1. Types of cutting tools         2. Maintenance of cutting tools      7. Batteries and power sources         1. Types of batteries and power sources         2. Maintenance of batteries and power sources   2. Purpose of tools and equipment used in replacement of industrial automation and robotics system parts      1. Tools         1. Flashlights         2. Hand tools         3. Thermal imaging cameras         4. Grease guns         5. Oil guns         6. Oil dispensers         7. Tachometers         8. Vibration meters         9. Multimeters      2. Equipment         1. Air compressors         2. Solvent sprayers         3. Safety equipment   3. Industrial automation and robotic system consumable parts service      1. Replenish lubricants      2. Cleaning equipment      3. Replace worn out parts      4. Replenishing cooling fluids      5. Service record documentation      6. Housekeeping activities after service   4. Practice: repair and maintenance of industrial automation and robotics system. | * Replace industrial automation and robotic system parts |

**Recommended Resources for 25 trainees**

|  |  |  |  |  |
| --- | --- | --- | --- | --- |
| **S/No.** | **Category/Item** | **Description/Specifications** | **Quantity** | **Recommended Ratio (Item: Trainee)** |
| **A** | **Tools** | | | |
|  | Screwdriver Sets | Assorted screwdrivers for various applications | 2 sets | 2:25 |
|  | Wrench Sets | Assorted wrenches for mechanical work | 2 sets | 2:25 |
|  | Digital Flashlights | Portable flashlights for visibility during hands-on work | 2 | 2:25 |
|  | Grease Guns | For applying grease to machinery | 2 | 2:23 |
|  | Digital Multimeters | For voltage, current, and resistance measurements | 2 | 2:25 |
|  | Oil Guns | For applying oil to machinery | 2 | 2:25 |
|  | Oil Dispensers | For dispensing oil accurately | 2 | 2:25 |
|  | Tachometers | For measuring rotational speed | 2 | 2:25 |
|  | Vibration Meter | For measuring vibration levels in equipment | 1 | 1:25 |
|  | Cutting Tools | For cutting materials in practical applications | 2 | 2:25 |
| **B** | **Learning Facilities & Infrastructure** | | | |
|  | Lecture/Theory Room | Spacious, equipped with projectors and seating for 25 trainees, approximately 60 sqm | 1 | 1:25 |
|  | Workshop | Hands-on training area with workbenches, tools, and safety equipment, approximately 80 sqm | 1 | 1:25 |
|  | Laboratory | Equipped with robotics training kits for experiments, approximately 50 sqm | 1 | 1:25 |
| **C** | **Materials and Supplies** | | | |
|  | Sensors | For detecting various parameters in automation systems | 5 | 1:5 |
|  | Actuators | For controlling movement in mechanical systems | 5 | 1:5 |
|  | Bearings | For reducing friction in rotating components | 5 | 1:5 |
|  | Seals and Gaskets | For preventing leaks and maintaining pressure | 5 | 1:5 |
|  | Filters | For purifying fluids in systems | 3 | 1:8.3 |
|  | Belts and Chains | For power transmission in machinery | 2 | 1:12.5 |
|  | Wear Plates and Liners | For reducing wear in machinery components | 2 | 1:12.5 |
|  | Batteries and Power Sources | For powering equipment and sensors | 2 | 1:12.5 |
| **D** | **Equipment** | | | |
|  | Industrial Automation Kits | Complete training kits for automation and robotics | 2 | 1:12.5 |
|  | Hydraulic Training Kits | Kits for hydraulic systems training | 2 | 1:12.5 |
|  | Pneumatics Training Kits | Kits for pneumatic systems training | 2 | 1:12.5 |
|  | User Manuals | Manuals for each available training kit | 1 | 1:25 |
|  | Service Manuals | Manuals for servicing training equipment | 1 | 1:25 |
|  | PPE Sets | Personal protective equipment for all trainees | 25 sets | 1:1 |
|  | PLC Panels | Programmable logic controller panels for training | 2 | 1:12.5 |
|  | HMI Panels | Human-machine interface panels for training | 2 | 1:12.5 |
| **E** | **Reference Materials** | | | |
|  | OSHA Documentation | Occupational Safety and Health Act resources | 1 | 1:25 |
|  | Maintenance Books | Books on industrial automation and robotics systems maintenance | 1 | 1:25 |

MODULE THREE

## DIGITAL LITERACY

**ISCED UNIT CODE:** 0611 441 01A

**Relationship with occupational standards**

This unit addresses the unit of competency: Apply digital literacy

**Duration of unit: 40 Hours**

**Unit description**

This unit covers the competencies required to demonstrate digital literacy. It involves solving tasks using the Office suite, managing data and information, performing online communication and collaborations, applying cybersecurity skills, performing jobs online and applying job entry techniques.

**Summary of learning outcomes**

By the end of this unit of learning, the trainee will be able to:

|  |  |  |
| --- | --- | --- |
| **S/No** | **Learning Outcome** | **Duration (Hrs.)** |
|  | Operate computer devices | **6** |
|  | Solve Tasks Using Office Suite | **14** |
|  | Manage Data and Information | **6** |
|  | Perform Online Communication and Collaborations | **4** |
|  | Apply Cybersecurity Skills | **4** |
|  | Perform Online Jobs | **4** |
|  | Apply job entry techniques. | **2** |
|  |  | **TOTAL 40 HRS** |

**Learning outcomes, content, and suggested assessment methods**

| **Learning outcome** | **Content** | **Suggested**  **assessment methods** |
| --- | --- | --- |
| 1. Operate computer devices | * 1. Meaning and importance of digital literacy   2. Functions and Uses of Computers   3. Classification of computers   4. Components of a computer system   5. Computer Hardware   6. The System Unit E.g. Motherboard, CPU, casing   7. Input Devices e.g. Pointing, keying, scanning, voice/speech recognition, direct data capture devices.   8. Output Devices e.g. hardcopy output and softcopy output   9. Storage Devices e.g. main memory e.g. RAM, secondary storage (Solid state devices, Hard Drives, CDs & DVDs, Memory cards, Flash drives   10. Computer Ports e.g. HDMI, DVI, VGA, USB type C etc.   11. Classification of computer software   12. Operating system functions   13. Procedure for turning/off a computer   14. Mouse use techniques   15. Keyboard Parts and Use Techniques   16. Desktop Customization   17. File and Files Management using an operating system   18. Computer Internet Connection Options       1. Mobile Networks/Data Plans       2. Wireless Hotspots       3. Cabled (Ethernet/Fiber)       4. Dial-Up       5. Satellite       6. Computer external devices management   19. Device connections   20. Device controls (volume controls and display properties) | * Observation * Portfolio of Evidence * Project * Written assessment * Practical assessment * Oral assessment |
| 1. Solve tasks using office suite | * 1. Meaning and importance of word processing   2. Examples of word processors   3. Working with word documents      1. Open and close word processor      2. Create a new document      3. Save a document      4. Switch between open documents   4. Enhancing productivity      1. Set basic options/preferences      2. Help resources      3. Using magnification/zoom tools      4. Display, hide built-in tool bar      5. Using navigation tools   5. Typing text   6. Document editing (copy, cut, paste commands, spelling and grammar check)   7. Document formatting      1. Formatting text      2. Formatting paragraph      3. Formatting styles      4. Alignment      5. Creating tables      6. Formatting tables   8. Graphical objects      1. Insert object (picture, drawn object)      2. Select an object      3. Edit an object      4. Format an object   9. Document print setup      1. Page layout,      2. Margins set up      3. Orientation.   10. Word document printing   11. Meaning & importance of electronic spreadsheets   12. Components of spreadsheets   13. Application areas of spreadsheets   14. Using spreadsheet application       1. Parts of excel screen: ribbon, formula bar, active cell, name box, column letter, row number, quick access toolbar.       2. Cell data types       3. Block operations       4. Arithmetic operators (formula bar (-, +, \*, /).       5. Cell referencing   15. Data manipulation       1. Using functions (Sum, average, sum if, count, max, max, if, rank, product, mode etc)       2. Using formulae       3. Sorting data       4. Filtering data       5. Visual representation using charts   16. Worksheet printing   17. Electronic presentations   18. Meaning and importance of electronic presentations   19. Examples of presentation software   20. Using the electronic presentation application       1. Parts of the PowerPoint screen (slide navigation pane, slide pane, notes, the ribbon, quick access toolbar, and scroll bars).       2. Open and close presentations       3. Creating slides (insert new slides, duplicate, or reuse slides.)       4. Text management (insert, delete, copy, cut and paste, drag and drop, format, and use spell check).       5. Using magnification/zoom tools       6. Apply or change a theme.       7. Saving a presentation       8. Switching between open presentations   21. Developing a presentation       1. Presentation views       2. Slides       3. Master slide   22. Text       1. Editing text       2. Formatting       3. Tables   23. Charts       1. Using charts       2. Organization charts   24. Graphical objects       1. Insert, manipulate       2. Drawings   25. Prepare outputs       1. Applying slide effects and transitions       2. Check and deliver          1. Spell check a presentation          2. Slide orientation          3. Slide shows, navigation   26. Print presentations (slides and handouts) | * Observation * Portfolio of Evidence * Project * Written assessment * Practical assessment * Oral assessment |
| 1. Manage data and information | * 1. Meaning of data and information   2. Importance and uses of data and information   3. Types of internet services      1. Communication Services      2. Information retrieval services      3. File transfer      4. World wide web services      5. Web services      6. Automatic network address configuration      7. News group      8. Ecommerce   4. Types of internet access applications   5. Web browsing concepts      1. Key concepts      2. Security and safety   6. Web browsing      1. Using the web browser      2. Tools and settings      3. Clearing cache and cookies      4. URIs      5. Bookmarks      6. Web outputs   7. Web based information      1. Search      2. Critical evaluation of information      3. Copyright, data protection   8. Downloads management   9. Performing digital data backup (Online and offline)   10. Emerging issues in internet | * Observation * Portfolio of Evidence * Project * Written assessment * Practical assessment * Oral assessment |
| 1. Perform online communication and collaboration | * 1. Netiquette principles   2. Communication concepts      1. Online communities      2. Communication tools      3. Email concepts   3. Using email      1. Sending email      2. Receiving email      3. Tools and settings      4. Organizing email   4. Digital content copyright and licenses   5. Online collaboration tools      1. Online Storage (Google Drive)      2. Online productivity applications (google docs & forms)      3. Online meetings (google meet/zoom)      4. Online learning environments      5. Online calendars (google calendars)      6. Social networks (Facebook/twitter - settings & privacy)   6. Preparation for online collaboration      1. Common setup features      2. Setup   7. Mobile collaboration      1. Key concepts      2. Using mobile devices      3. Applications      4. Synchronization | * Observation * Portfolio of Evidence * Project * Written assessment * Practical assessment * Oral assessment |
| 1. Apply cybersecurity skills | * 1. Data protection and privacy      1. Confidentiality of data/information      2. Integrity of data/information      3. Availability of data/information   2. Internet security threats      1. Malware attacks      2. Social engineering attacks      3. Distributed denial of service (DDoS)      4. Man-in-the-middle attack (MitM)      5. Password attacks      6. IoT attacks      7. [Phishing attacks](https://onlinedegrees.sandiego.edu/top-cyber-security-threats/#phishing-attacks)      8. [Ransomware](https://onlinedegrees.sandiego.edu/top-cyber-security-threats/#ransomware)   3. Computer threats and crimes   4. Cybersecurity control measures      1. Physical controls      2. Technical/logical controls (passwords, Pins, biometrics)      3. Operational controls   5. Laws governing protection of ICT in Kenya      1. The Computer Misuse and Cybercrimes Act No. 5 of 2018      2. The data protection Act No. 24 Of 2019 | * Observation * Portfolio of Evidence * Project * Written assessment * Practical assessment * Oral assessment |
| 1. Perform online Jobs | * 1. Introduction to online working   2. Types of online jobs   3. Online job platforms      1. Remo task      2. Data annotation tech      3. Cloud worker      4. Upwork      5. Oneforma      6. Appen   4. Online account and profile management   5. Identifying online jobs/job bidding   6. Online digital identity   7. Executing online tasks   8. Management of online payment accounts. | * Observation * Portfolio of Evidence * Project * Written assessment * Practical assessment * Oral assessment |
| 1. Apply job entry techniques | * 1. Types of job opportunities      1. Self-employment      2. Service provision      3. product development      4. salaried employment         1. Sources of job opportunities   2. Resume/ curriculum vitae      1. What is a CV      2. How long should a CV be      3. What to include in a CV      4. Format of CV      5. How to write a good CV      6. Don’ts of writing a CV   3. Job application letter      1. What to include      2. Addressing a cover letter      3. Signing off a cover letter   4. Portfolio of evidence      1. Academic credentials      2. Letters of commendations      3. Certification of participations      4. Awards and decorations   5. Interview skills      1. Listening skills      2. Grooming      3. Language command      4. Articulation of issues      5. Body language      6. Time management      7. Honesty   6. Generally knowledgeable in current affairs and technical area | * + Observation   + Oral assessment   + Portfolio of evidence   + Third party report * Written assessment |

**Suggested Methods Instruction**

* + Instructor-led facilitation using active learning strategies
  + Demonstration by trainer
  + Viewing of related videos
  + Group discussions
  + Role play
  + Case study

**Recommended resources for 30 trainees**

|  |  |  |  |  |
| --- | --- | --- | --- | --- |
| **S/No.** | **Category/Item** | **Description/specifications** | **Quantity** | **Recommended ratio (Item: trainee)** |
| **A** | **Learning materials** | | | |
|  | Textbooks | Comprehensive texts books on digital literacy | 5 pcs | 1:6 |
|  | Installation manuals | Detailed guides for equipment and software installation and troubleshooting | 5 pcs | 1:6 |
|  | PowerPoint presentations | For trainer’s use, covering course content and practical applications | 1 | 1:30 |
|  | Projector | Functional projector for displaying content during presentations | 1 | 1:30 |
|  | White board | Quality whiteboard of approximately 6 ft by 3 ft for writing during theory instruction | 1 | 1:30 |
|  | Printer | An ink-jet, laser-jet or toner-cartridge printer for printing notes, instructions and working drawings | 1 | 1:30 |
|  | Templates | Templates for creating various documents e.g. CV, Cover Letter, etc. | 30 | 1:1 |
| **B** | **Learning Facilities & Infrastructure** | | | |
|  | Lecture/theory room  /Learning resource  Area | Spacious, equipped with projectors and Seats for 30 trainees, approximately 45 sqm (5 m x 9 m) | 1 | 1:30 |
|  | Computer laboratory | Equipped with at least 30 functional computers with internet connectivity and the following software:   * + - Windows/ Linux/ macintosh operating system     - Microsoft office software     - Google workspace account     - Antivirus software | 1 | 1:30 |
|  |  |  |  |  |
| **C** | **Consumable materials** | | | |
|  | Printing papers | A4 and A3 printing papers suitable for the task | adequate |  |
|  | Whiteboard marker pens | Dry-erase markers for trainer’s use. Assorted colors | adequate |  |
|  | Storage devices | Any of the following storage devices:   * USB flash drive * USB hard drive * Compact disks (CDs) * Digital versatile disks (DVDs) | adequate |  |

## APPLY ENGINEERING MATHEMATICS

**UNIT CODE:** 0541 441 05A

**Relationship with Occupational Standards**

This unit addresses the Unit of Competency: Apply Mathematics

**Unit Duration: 150 Hours**

**Unit Description**

This unit describes the competences required in order to apply algebra, trigonometric and hyperbolic functions, coordinate geometry, statistics, vector theorem, matrices and to carry out mensuration.

**Summary of Learning Outcomes**

By the end of this unit of learning, the trainee will be able to:

|  |  |  |
| --- | --- | --- |
| S/No | Learning Outcome | **Duration (Hrs.)** |
| 1 | Apply algebra | **20** |
| 2 | Apply trigonometric functions | **30** |
| 3 | Apply coordinate geometry | **20** |
| 4 | Carry out mensuration | **10** |
| 5 | Apply statistics | **30** |
| 6 | Apply vector theorem | **20** |
| 7 | Apply matrices | **20** |
|  | **TOTAL** | **150 HRS** |

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

|  |  |  |
| --- | --- | --- |
| **Learning Outcome** | **Content** | **Suggested Assessment Methods** |
| 1. Apply algebra | * 1. Indices      1. Power zero      2. Negative powers      3. Fractional powers      4. Laws of indices         1. Addition         2. Subtraction         3. Division         4. Multiplication   2. BODMAS   3. Roots      1. Square roots      2. Cube roots   4. Logarithms      1. Laws of logarithms         1. Product law         2. Quotient law         3. Power law   5. Use of scientific calculator      1. Power ON/OFF      2. Mode         1. Degree         2. Radian         3. Gradient         4. SD      3. Clear      4. Save   6. Simultaneous equations (2 equations)      1. Elimination      2. Substitution   7. Quadratic equations      1. Factorization      2. Quadratic formula | * Written tests |
| 1. Apply trigonometric functions | * 1. Angles      1. Acute      2. Obtuse      3. Reflex      4. Right angle   2. Triangles      1. Isosceles      2. Equilateral      3. Right angled      4. Scalene   3. Trigonometric ratios      1. Sine      2. Cosine      3. Tangent      4. Cosecant      5. Secant      6. Cotangent   4. Trigonometric identities      1. Proof of identities      2. Pythagorean identities   2.5 Solve trigonometric equations | * Written tests |
| 1. Apply coordinate geometry | * 1. Introduction to linear coordinates      1. Cartesian plane         1. x and y axes         2. Positive and negative coordinates      2. Gradient         1. Positive         2. Negative         3. Zero         4. Infinite         5. Gradients of parallel line         6. Gradients of perpendicular lines      3. y-intercept   2. Linear equations      1. Straight line      2. Parallel lines      3. Perpendicular lines   3. Graphs of linear equations      1. Straight line | * Written tests |
| 1. Carry out mensuration | * 1. Units and symbols of measurement      1. Mass      2. Distance      3. Speed      4. Temperature      5. Time   2. Imperial and metric units      1. Conversions   3. Perimeter      1. Regular shapes   4. Area      1. Regular shapes   5. Volume      1. Regular shapes | * Written tests |
| 1. Apply statistics and probability | * 1. Data presentation      1. Continuous variables         1. Histogram         2. Line      2. Discrete variable         1. Bar graph         2. Pie graph      3. Grouped data         1. Histogram         2. Bar         3. Cumulative frequency         4. ogive      4. Ungrouped data         1. Line         2. Cumulative frequency   2. Measures of central tendency      1. Mean         1. Grouped data         2. Ungrouped data      2. Mode         1. Grouped data         2. Ungrouped data      3. Medium         1. Grouped data         2. Ungrouped data   3. Measures of dispersion      1. Standard deviation         1. Grouped data         2. Ungrouped data      2. Variance         1. Grouped data         2. Ungrouped data   4. Probability      1. With replacement      2. Without replacement | * Written tests |
| 1. Apply vector theorem | * 1. Differentiate between vector and scalar quantities      1. Magnitude      2. Direction         1. Positive         2. Negative   2. Operation on vectors      1. Addition      2. Subtraction   3. Resolution of vectors      1. Analysis | * Written tests |
| 1. Apply matrices | * 1. Matrices      1. Types         1. Row         2. Column         3. Square         4. Zero         5. Identity         6. Diagonal   2. Matrices operations of a 2 x 2      1. Addition      2. Subtraction      3. Multiplication   3. Inverse of matrices of a 2 x 2      1. Determinant      2. Transpose      3. Adjoint      4. Inverse   4. Simultaneous equations of 2 equations      1. Inverse method | * Written tests |

**Suggested Delivery Methods**

* Demonstration
* Group discussions
* Online materials
* Direct instructions
* Simulation

**Recommended resources for 30 trainees**

|  |  |  |  |  |
| --- | --- | --- | --- | --- |
| **S/No.** | **Category/Item** | **Description/Specifications** | **Quantity** | **Recommended Ratio (Item: Trainee)** |
| **A** | **Learning materials** | | | |
|  | Textbooks | Comprehensive textbooks on Engineering Mathematics | 5 Pcs | 1:6 |
|  | Graph books | For graphical representation of solutions | 30 | 1:1 |
|  | Projector | Functional projector for displaying content during presentations | 1 | 1:30 |
|  | Computer | Functional desktop computer with online instructional content | 1 | 1:30 |
|  | White board | Quality whiteboard of approximately 6 ft by 3 ft for writing during theory instruction | 1 | 1:30 |
|  | Printer | An ink-jet, laser-jet or toner-cartridge printer for printing notes, instructions and working drawings | 1 | 1:30 |
| **B** | **Learning facilities & infrastructure** | | | |
|  | Lecture/theory room | Spacious room with seats for 25 trainees, approximately 60 sqm | 1 | 1:30 |
| **C** | **Materials and supplies** | | | |
|  | First Aid kit | Fully equipped First Aid kit for use in case of accidents | 1 | 1:30 |
| **D** | **Tools and equipment** | | | |
|  | Set of mathematical instruments | For constructions and measurements | 30 | 1:1 |
|  | Scientific Calculator | For Calculations | 30 | 1:1 |
|  | Firefighting extinguishers | Water, carbon dioxide and chemical powder fire extinguishers for fire fighting | 1 | 1:30 |
| **E** | **Reference materials** | | | |
|  | Training presentations/slides | Digital format for shared access among trainees | 1 | 1:30 |
|  | Standard mathematical tables | For reference on formulae, identities, laws and principles | 30 | 1:1 |

## INDUSTRIAL AUTOMATION ELECTRICAL SYSTEMS INSTALLATION AND MAINTAINANCE

**UNIT CODE:** 0714 451 12A

**Relationship to occupational standards**

This unit addresses the unit of competency: Install and Maintain Industrial Automation Electrical Systems

**Duration of unit: 170 hours**

**Unit description**

This unit covers the competencies required in installation of an industrial automation and robotics electrical systems according to the system design considerations. It involves conducting industrial automation electrical system site survey, planning industrial automation electrical system installation, installing industrial automation electrical system and maintaining industrial automation electrical system.

**Summary of learning outcomes**

By the end of this unit of learning, the trainee will be able to;

|  |  |  |
| --- | --- | --- |
| S/No | Learning Outcome | **Duration (Hrs.)** |
| 1 | Conduct industrial automation electrical system site survey. | **30** |
| 2 | Plan industrial automation electrical system installation | **50** |
| 3 | Install industrial automation electrical system | **50** |
| 4 | Maintain industrial automation electrical system | **40** |
|  | **TOTAL** | **170 HRS** |

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

| **Learning Outcome** | **Content** | **Suggested Assessment Methods** |
| --- | --- | --- |
| 1. Conduct industrial automation electrical system site survey | * 1. Site survey aspects      1. Phase requirement analysis, voltage and power factor needs, electrical protection.      2. Environmental considerations, cable routing, redundancy, and scalability.      3. Instrumentation systems and compatibility with existing systems.   2. Tools and equipment for site survey      1. Classification of tools      2. Uses of tools      3. Operations of tools.      4. Maintenance and care of tools.   3. Practice: site visit survey   4. Report writing      1. Structure of site survey report.      2. Procedures and standards for documentation. | * Project * Practical * Third party report * Portfolio of evidence * Written tests * Oral questioning |
| 1. Plan industrial automation electrical system installation | * 1. Introduction to industrial automation      1. Overview of industrial automation      2. Definition and significance      3. Key components and technologies   2. Types of automation systems      1. Fixed vs. flexible automation      2. Continuous vs. batch processes   3. Electrical fundamentals      1. Basic electrical concepts      2. Voltage, current, resistance, and power      3. Ohm’s law and electrical circuits   4. Electrical components      1. Resistors, capacitors, inductors      2. Switches, relays, and contactors   5. AC vs. DC Systems      1. Characteristics and applications   6. Control systems and components      1. Introduction to control systems      2. Types of control systems: open-loop vs. closed-loop      3. Programmable Logic Controllers (PLCs)   7. Sensors and actuators      1. Types of sensors (proximity, photoelectric)      2. Types of actuators (motors, valves)   8. Human-Machine Interface (HMI)      1. Basics of HMI design and implementation   9. Designing installation      1. Electrical design principles         1. Load balancing         2. Redundancy         3. Safety.      2. Equipment and System layout planning.   10. Work plan preparation       1. Scheduling       2. Resources estimation       3. Safety plans       4. Task assignments.   11. Electrical system supplies       1. Overview of electrical supplies          1. Motors          2. Drives          3. Generators          4. Switchgear          5. Distribution panel          6. Control panels       2. Working principles of electrical supplies.          1. Cables          2. Protection devices and switchgear          3. Distribution board          4. Lighting fixtures          5. Enclosures          6. Earthing rods, clamps          7. Electrical tools and equipment          8. Connectors and terminals          9. Conduits          10. Raceways          11. Fasteners   12. Practice: Plan industrial automation electrical system | * Project * Practical * Third party report * Portfolio of evidence * Written tests * Oral questioning |
| 1. Install industrial automation electrical system | * 1. Personal Protective Equipment (PPE)      1. Uses and importance of PPE         1. Helmets         2. gloves,         3. Safety goggles.   2. Structured Wiring      1. Techniques of wiring diagrams and structured cabling.      2. Laying cables, routing through conduits, raceways.   3. Operation and specifications of accessories and equipment      1. Accessories         1. Terminal blocks         2. Switches         3. Sockets         4. Push buttons         5. Safety interlocks         6. Relays      2. Equipment         1. Motors         2. Drives         3. Generators         4. Switchgear         5. Distribution panel         6. Control panels   4. Wire Termination      1. Techniques for wire Termination         1. Wire cutting         2. Stripping         3. Connecting.   5. Testing electrical systems      1. Continuity tests      2. Insulation resistance tests      3. Phase sequence      4. Functionality tests   6. Housekeeping and waste disposal      1. Procedures for maintaining a clean installation site and managing waste.   7. Practice: Install industrial automation electrical system | * Project * Practical * Third party report * Portfolio of evidence * Written tests * Oral questioning |
| 1. Maintain industrial automation electrical system | * 1. Maintenance scheduling      1. Development and implementation of regular maintenance schedules.      2. Tracking maintenance logs and reporting.   2. Maintenance tools and equipment usage:      1. Tools         1. Tape measure         2. Laser meter         3. Camera         4. Multimeters         5. Stationery         6. Infrared thermometer         7. Cable tracer         8. Ladder         9. Flashlight      2. Equipment         1. Power analyser         2. Megohmmeter         3. Oscilloscope   3. Carry out maintenance tasks      1. Inspection routines      2. Testing      3. Cleaning      4. Tightening      5. Lubrication.      6. Troubleshoot and replace defective components.   4. Practice: Maintain industrial automation electrical system | * Project * Practical * Third party report * Portfolio of evidence * Written tests * Oral questioning |

**Suggested Delivery Methods**

* Group discussions
* Demonstration by trainer
* Online videos
* Power point presentation

**Recommended Resources for 25 Trainees**

|  |  |  |  |  |
| --- | --- | --- | --- | --- |
| **S/No.** | **Category/Item** | **Description/Specifications** | **Quantity** | **Recommended Ratio (Item: Trainee)** |
| **A** | **Learning Materials** | | | |
|  | Textbooks | Comprehensive texts on electrical systems and automation | 10 pcs | 2:5 |
|  | Installation Manuals | Detailed guides for equipment installation and troubleshooting | 5 pcs | 1:5 |
|  | Charts | Visual aids covering electrical theories and safety protocols | 10 pcs | 2:5 |
|  | PowerPoint Presentations | For trainer’s use, covering course content and practical applications | Adequate |  |
|  |  |  |  |  |
| **B** | **Learning Facilities & Infrastructure** | | | |
|  | Lecture/Theory Room | Spacious, equipped with projectors and seating for 25 trainees, approximately 60 sqm | 1 | 1:25 |
|  | Workshop | Hands-on training area with workbenches, tools, and safety equipment, approximately 80 sqm | 1 | 1:25 |
|  | Laboratory | Equipped with testing setups for electrical experiments, approximately 50 sqm | 1 | 1:25 |
|  |  |  |  |  |
| **C** | **Consumable Materials** | | | |
|  | Electrical Wires | Assorted sizes and color-coded (e.g., 1.5mm², 2.5mm², 4mm²) | Adequate |  |
|  | Insulation Tapes | For securing connections and insulation, assorted colors | Adequate |  |
|  |  |  |  |  |
| **D** | **Tools and Equipment** | | | |
|  | Tape Measures | 5m tape measures for accurate measurement | 5pcs | 1:5 |
|  | Laser Meters | For precise distance measurements, shared among trainees | 5pcs | 1:5 |
|  | Multimeters | Digital multimeters for voltage, current, and resistance measurements | 5 pcs | 1:5 |
|  | Cable Tracers | For tracing cable paths and identifying faults | 5 pcs | 1:5 |
|  | Infrared Thermometers | For non-contact temperature measurements, shared among trainees | 5 pcs | 1:5 |
|  | Ladders (4-6 ft) | For reaching elevated areas during practical training | 5 pcs | 1:5 |
|  | Flashlights | Portable flashlights for visibility during hands-on work | 5 pcs | 1:5 |
|  | Megohmmeters | For insulation resistance testing, shared among trainees | 2 pcs | 2:25 |
|  | Power Analyzers | For analyzing power quality, shared among trainees | 5 pcs | 1:5 |
|  | Basic Hand Tools | Sets including screwdrivers, pliers, and cutters | 25 sets | 1:1 |
|  | Clamp Meters | For measuring current flow in circuits, shared among trainees | 5 pcs | 1:5 |
|  | Thermal Imaging Cameras | For detecting heat patterns in electrical systems, shared among trainees | 1 pc | 1:25 |
|  | Controllers | For controlling electrical systems | 5 | 1:5 |
|  |  |  |  |  |
| **E** | **PPE (Personal Protective Equipment)** | | | |
|  | PPE Sets | For personal protection | 25 sets | 1:1 |
|  | Safety Signs and Barriers | For simulating safety zones and hazards | Adequate |  |
|  | Earthing Test Kits | For ground testing and demonstrating earthing procedures | 5 pcs | 1:5 |
|  | Electrical Test Benches | For hands-on testing of functionality and circuit design | 5 pcs | 1:5 |
|  |  |  |  |  |
| **F** | **Reference Materials** | | | |
|  | Industrial Automation Manuals | Covering principles and practices in automation | 5 pcs | 1:5 |
|  | Electrical Standards | Reference on industry standards (e.g., IEEE Guidelines) | 5 pcs | 1:5 |
|  | Technical Handbooks On motors, drives, and wiring systems | Reference | 5 pcs | 1:5 |
|  | Multimedia Learning Modules | Digital licenses for videos and tutorials | 1 License | 1:1 |
|  | Practical Assessment Guides | Worksheets for practical assessments | 5 pcs | 1:5 |

MODULE FOUR

## STANDALONE CONTROL SYSTEMS INSTALLATION AND MAINTENANCE

**UNIT CODE:** 0714 451 13A

**Relationship to Occupational Standards**

This unit addresses the unit of competency: Install and Maintain Stand-Alone Controlled Systems

**Duration of Unit:** 200 hours.

**Unit Description**

This unit covers the competencies required in installation and maintenance of stand-alone control system. These competencies include; conducting stand-alone system control site survey, planning stand-alone control system installation, installing stand-alone control system and maintaining stand-alone control system.

**Summary of Learning Outcomes**

By the end of the Unit of Learning, the trainee will be able to:

|  |  |  |
| --- | --- | --- |
| S/No | Learning Outcome | **Duration (Hrs.)** |
| 1 | Conduct stand-alone control system site survey | **30** |
| 2 | Plan stand-alone control system installation | **50** |
| 3 | Install stand-alone control systems | **70** |
| 4 | Maintain stand-alone control systems | **50** |
|  | **TOTAL** | **200 HRS** |

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

| **Learning Outcome** | **Content** | **Suggested Assessment Methods** |
| --- | --- | --- |
| 1. Conduct stand-alone control system site survey | * 1. Standalone Controllers      1. Programmable Logic Controllers (PLCs)      2. Supervisory Control and Data Acquisition (SCADA)      3. Distributed Control System (DCS).      4. PIDs      5. Microcontroller      6. Digital signal processors      7. Motor controllers      8. Power inverters   2. Site Survey Aspects Considerations      1. Power requirements      2. User requirements      3. Environmental considerations      4. Cable routes      5. Instrumentation systems      6. Compatibility with existing systems      7. Scalability      8. Cost   3. Site Assessment      1. Structural integrity, and environmental factors (temperature, humidity).      2. Utilities (power, networking, ventilation).   4. Safety and Compliance      1. Safety regulations and standards (e.g., OSHA, ISO).      2. Hazard prevention (such as emergency stops and barriers).   5. Infrastructure Preparation      1. Power supply and cabling      2. Communication and data networks (wired/wireless).      3. Lighting, ventilation, and flooring.   6. Mounting and Support Structures      1. Mounting platforms, frames, or rails for SAC.   7. Environmental Controls      1. Temperature, humidity, and dust control needs.      2. Airflow and ventilation for robotic operation.   8. SAC Access and Space Management      1. Clearances and pathways for SAC, maintenance, and operator access.   9. Applications of tools and equipment.      1. Tools         1. Tape measure         2. Laser meter         3. Camera         4. Multimeter         5. Stationery         6. Infrared thermometer         7. Cable tracer         8. Ladder         9. Flashlight      2. Equipment         1. Power analyser         2. Megohmmeter         3. Personal computer   10. Site survey report documentation. | * Oral assessment * Portfolio of evidence * Interviews * Third party report * Written assessment * Practical assessment * Projects |
| 1. Plan stand-alone control system installation | 1. Definition and Applications    * 1. Overview of stand-alone controlled systems      2. Common applications in various industries (manufacturing, robotics, HVAC, etc.) 2. System Components    * 1. Sensors, actuators, controllers, and interfaces      2. Overview of system architecture 3. Precautions during installation of Stand- alone Control System. 4. Safety measurers undertaken during workplan.    * 1. specifications of Stand-alone control supplies      2. Cables      3. Protection devices and switchgear      4. Distribution board      5. Lighting fixtures      6. Enclosures      7. Earthing rods, clamps      8. Installation Tools and equipment      9. Connectors and terminals      10. Conduits      11. Raceways      12. Fasteners    1. Practice: Plan Stand- alone control system | * Oral assessment * Portfolio of evidence * Interviews * Third party report * Written assessment * Practical assessment * Projects |
| 1. Install Stand-alone control systems | * 1. Structured wiring      1. Cable routing      2. Cable laying      3. Cable labelling   2. Stand-alone control system accessories and equipment      1. Classifications of Tools and Accessories.      2. Uses of Tools and Accessories.      3. Operations of Tools and Accessories.   3. Ways of terminating Stand-alone Control System.   4. Tests carried out in Stand-alone control system.   5. Standalone controller Programming      1. Objective definition, (Task identification and performance criteria.)      2. System flow chart.      3. Control Algorithms      4. Coding.      5. Testing and Debugging program      6. System simulation      7. Field Testing      8. Code, algorithm documentation, and user manuals.   6. Housekeeping procedure carried out in a workplace.   7. Ways of disposing site waste in a workplace   8. Practice: Install Stand- alone control system | * Oral assessment * Portfolio of evidence * Interviews * Third party report * Written assessment * Practical assessment * Projects |
| 1. Maintain Stand-alone control systems | * 1. Standalone Controller Maintenance Schedule      1. Factors to consider while designing a Maintenance Schedule.   2. Importance of PPE in a workplace.   3. Ways of handling and maintaining Tools and Accessories.   4. Tasks carried out in Stand- alone control system maintenance.   5. Stand-alone report.   6. Practice: Maintain Stand- alone control system | * Oral assessment * Portfolio of evidence * Interviews * Third party report * Written assessment * Practical assessment * Projects |

**Suggested delivery methods**

* Group discussions
* Demonstration by trainer
* Online videos
* Power point presentation

**Recommended Resources**

|  |  |  |  |  |
| --- | --- | --- | --- | --- |
| **S/No.** | **Category/Item** | **Description/Specifications** | **Quantity** | **Recommended Ratio (Item: Trainee)** |
| **A** | **Tools** |  |  |  |
|  | Multimeters | Digital multimeters for measuring voltage, current, and resistance | 25 pcs | 1:1 |
|  | Clamp Meters | For measuring current flow in electrical systems | 5 pcs | 1:5 |
|  | Power Analyzers | For analyzing power quality and consumption | 5 pcs | 1:5 |
|  | Sensors | Assorted sensors | 5 pcs | 1:5 |
| **B** | **Learning Facilities & Infrastructure** | | | |
|  | Lecture/Theory Room | Approximately 60 sqm | 1 | 1:25 |
|  | Workshop | Approximately 80 sqm | 1 | 1:25 |
|  | Laboratory | Approximately 80 sqm | 1 | 1:25 |
| **C** | **Hand Tools** | | | |
|  | Wrenches | Adjustable wrenches for various sizes of nuts and bolts | 4 pcs | 4:25 |
|  | Screwdrivers | Phillips and flathead screwdrivers for assembly work | 5 pcs | 1:5 |
|  | Pliers | For gripping, twisting, and cutting wires | 5 pcs | 1:5 |
|  | Hex Keys | Allen wrenches for hexagonal screws and bolts | 5 pcs | 1:5 |
|  | Cutters | Wire cutters for precise cutting of electrical wires | 5 pcs | 1:5 |
| **D** | **Measuring Tools** | | | |
|  | Tape Measures | 5m tape measures for accurate measurements | 5 pcs | 1:5 |
|  | Calipers | For measuring internal and external dimensions precisely | 5 pcs | 1:5 |
|  | Alignment Tools | Assorted | 5 pcs | 1:5 |
|  |  |  |  |  |
| **E** | **Materials and Supplies** | | | |
|  | Manipulators | For robotic manipulation tasks | 2 pcs | 2:25 |
|  | Controller Units | For controlling robotic systems | 2 pcs | 2:25 |
|  | Sensors | Various sensors for feedback and measurement | 2 pcs | 2:25 |
|  | Actuators | For converting electrical signals into mechanical motion | 2 pcs | 2:25 |
|  | Encoders | For position sensing in robotic systems | 2 pcs | 2:25 |
|  | Gears | For mechanical transmission in robotics | 2 pcs | 2:25 |
|  | Motors | Includes servo motors, stepper motors, and linear motors | 2 pcs | 2:25 |
|  |  |  |  |  |
| **F** | **Equipment** | | | |
|  | *Safety Equipment* |  |  |  |
|  | Safety Glasses | For eye protection during practical activities | 25 pcs | 1:1 |
|  | Gloves | For hand protection while working with machinery | 25 pairs | 1:1 |
|  | Hearing Protection | Ear protection to prevent noise-related injuries | 25 pcs | 1:1 |
|  | Hard Hats | Head protection for safety during hands-on work | 25 pcs | 1:1 |
|  | *Testing Equipment* |  |  |  |
|  | Oscilloscopes | For visualizing electrical signals | 2 pcs | 2:25 |
|  | Megohmmeters | For insulation resistance testing | 2 pcs | 2:25 |
|  | *Miscellaneous* |  |  |  |
|  | Lubricating Equipment | For maintenance of mechanical systems | 1 set |  |
|  | Vacuum Pump | For testing and cooling applications | 1 unit |  |
|  | Megohmmeter | For additional insulation testing | 1 unit |  |
|  |  |  |  |  |
| **G** | **Reference Materials** | | | |
|  | Component and Equipment Manuals | Detailed manuals for operation and maintenance | Adequate |  |
|  | Robotic Installation Books | Texts covering the principles and practices of robotic systems | Adequate |  |
|  | Other Reference Materials | Journals, past papers, and online resources for further learning | Adequate |  |

## PNEUMATIC SYSTEM INSTALLATION AND MAINTENANCE

**UNIT CODE:** 0714 451 14A

**Relationship to occupational standards**

This unit addresses the unit of competency: Install and maintain pneumatic systems

**Duration of unit:** 220 hours.

**Unit description**

This unit covers the competencies required in installation and maintenance of pneumatic systems. These competencies include; applying knowledge of perfect gases, operating air compressors, conducting pneumatic system site survey, planning pneumatic system installation and installing pneumatic system and maintaining pneumatic systems.

**Summary of learning outcomes**

By the end of the unit of learning, the trainee will be able to;

|  |  |  |
| --- | --- | --- |
| S/No | Learning Outcome | **Duration (Hrs.)** |
| 1 | Apply knowledge of perfect gases | **10** |
| 2 | Operate air compressors | **10** |
| 3 | Conduct pneumatic system site survey | **30** |
| 4 | Plan pneumatic system installation | **50** |
| 5 | Install pneumatic systems | **70** |
| 6 | Maintain pneumatic systems | **50** |
|  | **TOTAL** | **220 HRS** |

**Learning outcomes, content and suggested assessment methods**

| **Learning outcome** | **Content** | **Suggested assessment methods** |
| --- | --- | --- |
| 1. Apply knowledge of perfect gases | * 1. Laws of perfect gases      1. Boyle's law      2. Charles' law      3. Gay-Lussac law      4. Joule's law      5. Avogadro's law   2. General gas equation      1. Derive and apply general gas equation PV=mRT   3. Characteristic equation of gas      1. Application in engineering calculations   4. Universal gas constant      1. Define universal gas constant      2. Apply universal gas constant equation in engineering calculation   5. Specific heat      1. Constant volume      2. Constant pressure | * Written tests |
| 1. Operate air compressors | * 1. Classification of air compressors      1. According to working      2. According to action      3. According to number of stages   2. Single stage reciprocating air compressor      1. Work done by a single stage reciprocating air compressor without clearance volume   3. Work done during      1. isothermal compression      2. polytropic compression (PVn = Constant)      3. isentropic compression   4. Power required to drive a single-stage reciprocating air compressor      1. Calculations   5. Work-done by reciprocating air compressor with clearance volume      1. Calculations      2. Determine multistage compression   6. Power required to drive a two-stage reciprocating air compressor   7. Minimum work required for a two-stage reciprocating air compressor | * Written tests |
| 1. Conduct pneumatic system site survey | * 1. Identifying site survey aspects.      1. User requirements      2. System requirements.      3. Space and layout considerations.      4. Environmental conditions      5. Safety regulations and standards.      6. Air quality assessment.      7. Compatibility with existing systems   2. Assembling site survey tools and equipment      1. Classification of tools and equipment      2. Uses of tools and equipment   3. Performing the site survey      1. Conducting measurements and evaluations.      2. Documenting site conditions   4. Generating the site survey report      1. Compiling findings.      2. Presenting data according to workplace procedures | * Project * Practical * Third party report * Portfolio of evidence * Written tests * Oral questioning |
| 1. Plan pneumatic system installation | * 1. Pneumatic system design      1. Pneumatic system components. * Compressors, valves, actuators, and filters * Types of pneumatic cylinders (single-acting, double-acting)   + 1. System design * Circuit design principles * Sizing and selecting components   + 1. Factors to consider while designing Pneumatic system layout.     2. Design of Pneumatic system layout.   1. Operation and Control      1. System Operation * Basics of pneumatic control * Flow control and pressure regulation   + 1. Automation in pneumatics * Introduction to electronic controls * Integration with PLCs and other control systems   1. Pneumatic system installation workplan      1. Pre-installation planning   (objectives, scope, timeline, and assign roles)   * + 1. Site preparation     2. Delivery & inspection     3. Mechanical installation     4. Electrical installation     5. Software installation & configuration     6. I/O and communication testing   1. Pneumatic system supplies      1. Types of pneumatic system supplies * Pressure gauges * Vacuum gauges * Pressure regulators * Pipes and tubes * Connectors * Air compressors * Control valves * Dryers * Pneumatic system reservoir * Enclosures * Fittings * Safety valves   + 1. Interpretation of pneumatic system design symbols.     2. Uses of pneumatic system supplies.     3. Safety precautions to undertake while handling pneumatic system supplies.   1. Practice: Plan pneumatic system installation | * Project * Practical * Third party report * Portfolio of evidence * Written tests * Oral questioning |
| 1. Install pneumatic system | * 1. PPE      1. Types of PPE.   • Helmet  • Hand gloves  • Safety shoes  • Harness  • Safety goggles   * + 1. Uses of PPE   1. Pneumatic system piping installation.      1. Types of joints.      2. Pneumatic system fittings      3. Tools and equipment.      4. Interpretation of installation layout.   2. Mounting pneumatic system accessories and equipment      1. Accessories         1. Couplers         2. Check valves         3. Flow meters         4. Pressure gauges         5. Installation valves      2. Equipment         1. Pneumatic valves         2. Pneumatic cylinders         3. Compressors         4. Pneumatic pumps         5. Positioners   3. Pneumatic system test      1. Functionality test      2. Leakage test      3. Pressure test      4. Air quality test      5. Flow rate test   4. Calibration of pneumatic control      1. System parameters      2. Pneumatic system accessories Calibration against system parameters.         1. Control valve         2. Pressure gauges         3. Flow metres   5. House Keeping and waste disposal   6. Practice: Install pneumatic system installation | * Project * Practical * Third party report * Portfolio of evidence * Written tests * Oral questioning |
| 1. Maintain pneumatic systems | * 1. Pneumatic system maintenance      1. maintaining pneumatic system.   2. PPE Usage      1. Helmet      2. Hand gloves      3. Safety shoes      4. Harness      5. Safety goggles   3. Uses of pneumatic system maintenance tools, equipment and spares      1. Tools         1. Tape measure         2. Laser distance meter         3. Camera         4. Flow meters         5. Pressure gauges         6. Stationery         7. Infrared thermometer         8. Ladder         9. Flashlight         10. Leakage testers         11. Hand tools      2. Equipment         1. Air analyzers         2. Ladder   4. Pneumatic system maintenance tasks * Inspection * Testing and measurements * Air quality check * Pressure check * Cleaning * Tightening * Replacing components * Replacing consumables   1. Maintenance report   2. Practice      1. Hands-on Installation and Maintenance      2. Practical exercises in installing pneumatic systems      3. Simulated troubleshooting scenarios   3. Project Work      1. Group projects on designing and implementing a pneumatic system      2. Presentation of project outcomes and experiences | * Project * Practical * Third party report * Portfolio of evidence * Written tests * Oral questioning |

**Suggested delivery methods**

* Group discussions
* Demonstration by trainer
* Online videos
* Power point presentation

**Recommended resources for 25 trainees**

|  |  |  |  |  |
| --- | --- | --- | --- | --- |
| **S/No.** | **Category/item** | **Description/specifications** | **Quantity** | **Recommended ratio (item: trainee)** |
| **A** | **Tools** | | | |
|  | Multimeters | For measuring voltage, current, and resistance | 25 pcs | 1:1 |
|  | Clamp meters | For measuring electrical current | 5 pcs | 1:5 |
|  | Power analyzers | For analyzing power quality and consumption | 5 pcs | 1:5 |
|  | Thermal imaging cameras | For visualizing heat patterns and identifying issues | 5 pcs | 1:5 |
|  | Wrenches | For tightening and loosening fasteners | 4 pcs | 4:25 |
|  | Screwdrivers | For driving screws; various types included | 5 pcs | 1:5 |
|  | Pliers | For gripping and bending wires | 5 pcs | 1:5 |
|  | Hex Keys | For hexagonal screws and bolts | 5 pcs | 1:5 |
|  | Cutters | For cutting wires and cables | 5 pcs | 1:5 |
|  | Tape measures | For measuring lengths and distances | 5 pcs | 1:5 |
|  | Calipers | For measuring internal and external dimensions | 5 pcs | 1:5 |
|  | Alignment lasers | For precise alignment of components | 2 pcs | 2:25 |
|  | Plumb bobs | For vertical alignment in installations | 5 pcs | 1:5 |
| **B** | **Learning facilities & infrastructure** | | | |
|  | Lecture/theory room | Approximately 60 sqm | 1 | 1:25 |
|  | Workshop | Approximately 80 sqm | 1 | 1:25 |
|  | Laboratory | Approximately 80 sqm | 1 | 1:25 |
|  |  |  |  |  |
| **C** | **Materials and supplies** | | | |
|  | Pressure gauges | For measuring pressure in pneumatic systems | 25 pcs | 1:1 |
|  | Vacuum gauges | For measuring vacuum levels in systems | 25 pcs | 1:1 |
|  | Pressure regulators | For controlling and regulating pressure | 25 pcs | 1:1 |
|  | Pipes and tubes | For various pneumatic and hydraulic applications | 100 pcs | 4:1 |
|  | Connectors | For connecting pipes and tubes | 100 pcs | 4:1 |
|  | Air compressors | For supplying compressed air for pneumatic tools | 25 pcs | 1:1 |
|  | Valves | For controlling the flow of fluids in systems | 25 pcs | 1:1 |
|  | Enclosures | For housing electrical and mechanical components | 25 pcs | 1:1 |
|  | Fittings | For connecting different sections of pipes and tubes | 25 pcs | 1:1 |
|  | Safety valves | For ensuring safety in pressure systems | 25 pcs | 1:1 |
|  | Pneumatic cylinders | Single/ double | 10 pcs | 2:25 |
|  | Sensors | Assorted | 10 pcs | 2:25 |
|  | Controllers | Controlling automatic pneumatics system | 5 pcs | 1:5 |
|  |  |  |  |  |
| **D** | **Equipment** | | | |
|  | Safety glasses | Eye protection for all trainees | 25 pcs | 1:1 |
|  | Gloves | Hand protection during training and operations | 25 pairs | 1:1 |
|  | Hearing protection | To safeguard against loud noises | 25 pcs | 1:1 |
|  | Hard hats | Head protection while working | 25 pcs | 1:1 |
|  | Oscilloscopes | For visualizing electrical signals | 2 units | 2:25 |
|  | Megohmmeters | For testing insulation resistance | 5 units | 1:5 |
|  |  |  |  |  |
| **E** | **Miscellaneous** | | | |
|  | Lubricating equipment | For maintaining smooth operation of mechanical components | 1 unit | 1:25 |
|  | Vacuum pump | For creating a vacuum for testing and operations | 1 unit | 1:25 |
|  |  |  |  |  |
| **F** | **Reference materials** | | | |
|  | Component and equipment manuals | Comprehensive guides on all tools and equipment | Adequate |  |
|  | Pneumatic system installation manuals | For proper setup and maintenance of pneumatic systems | Adequate |  |
|  | Other reference materials | Journals, past papers, and online resources for further study | Adequate |  |

MODULE FIVE

## COMMUNICATION SKILLS

**UNIT CODE:** 0031 441 02A

**Relationship with occupational standards**

This unit addresses the unit of competency: apply communication skills

**Duration of unit:** **40 Hours**

**Unit description**

This unit covers the competencies required to apply communication skills. It involves applying communication channels, written, non-verbal, oral, and group communication skills.

**Summary of learning outcomes**

|  |  |  |
| --- | --- | --- |
| S/No | Learning Outcome | **Duration (Hrs.)** |
| 1 | Apply communication channels. | **10** |
| 2 | Apply written communication skills. | **12** |
| 3 | Apply non-verbal skills. | **4** |
| 4 | Apply oral communication skills. | **4** |
| 5 | Apply group communication skills. | **10** |
|  |  | **TOTAL 40 HRS** |

**Learning outcomes, content, and suggested assessment methods**

| **Learning outcome** | **Content** | **Suggested assessment methods** |
| --- | --- | --- |
| 1. Apply communication channels | * 1. Communication process   2. Principles of effective communication   3. Channels/medium/modes of communication   4. Factors to consider when selecting a channel of communication   5. Barriers to effective communication   6. Flow/patterns of communication   7. Sources of information   8. Organizational policies | * Oral questions * Written assessment * Observation * Portfolio of evidence * Practical assessment * Third party report |
| 1. Apply written communication skills | * 1. Types of written communication   2. Elements of communication   3. Organization requirements for written communication | * Oral assessment * Written assessment * Observation * Portfolio of evidence * Practical assessment * Third party report |
| 1. Apply non-verbal communication skills | * 1. Utilize body language and gestures   2. Apply body posture   3. Apply workplace dressing code | * Oral assessment * Written assessment * Observation * Portfolio of evidence * Practical assessment * Third party report |
| 1. Apply oral communication skills | * 1. Types of oral communication pathways   2. Effective questioning techniques   3. Workplace etiquette   4. Active listening | * Oral assessment * Written assessment * Observation * Portfolio of evidence * Practical assessment * Third party report |
| 1. Apply group discussion skills | * 1. Establishing rapport      1. Facilitating resolution of issues      2. Developing action plans      3. Group organization techniques      4. Turn-taking techniques      5. Conflict resolution techniques      6. Team-work | * Oral assessment * Written assessment * Observation * Portfolio of evidence * Practical assessment |

**Suggested methods of instruction**

* Discussion
* Roleplaying
* Simulation
* Direct instruction
* Demonstration
* Field trips

**Recommended resources for 30 trainees**

|  |  |  |  |  |
| --- | --- | --- | --- | --- |
| **S/No.** | **Category/item** | **Description/specifications** | **Quantity** | **Recommended ratio (item: trainee)** |
| **A** | **Learning materials** | | | |
|  | Textbooks | Comprehensive texts books on communication skills | 30 pcs | 1:1 |
|  | Mobile phones | Smartphone for use by trainees | 30 pcs | 1:1 |
|  | Internet connection | Internet connection to aid communication between trainees |  |  |
|  | PowerPoint presentations | For trainer’s use, covering course content and practical applications | 1 | 1:30 |
|  | Projector | Functional projector for displaying content during presentations | 1 | 1:30 |
|  | White board | Quality whiteboard of approximately 6 ft by 3 ft for writing during theory instruction | 1 | 1:30 |
|  | Printer | An ink-jet, laser-jet or toner-cartridge printer for printing notes, instructions and working drawings | 1 | 1:30 |
|  | Templates | Templates for creating various documents e.g. CV, Cover Letter, minutes, reports etc. | 30 | 1:1 |
| **B** | **Learning facilities & infrastructure** | | | |
|  | Lecture/theory room  /Learning resource  Area | Spacious, equipped with projectors and seats for 30 trainees, approximately 45 sqm (5 m x 9 m) | 1 | 1:30 |
|  | Computer laboratory | Equipped with at least 30 functional computers with internet connectivity and the following software:   * + - Windows/ Linux/ macintosh operating system     - Microsoft office software     - Google workspace account     - Antivirus software | 30 | 1:1 |
|  |  |  |  |  |
| **C** | **Consumable Materials** | | | |
|  | Printing papers | A4 and A3 printing papers suitable for the task | Adequate |  |
|  | Flashcards | For carrying out various activities by trainees | Adequate |  |
|  | Flipcharts | Sufficient for group work activities and displaying | Adequate |  |
|  | Whiteboard marker pens | Dry-erase markers for trainer’s use. Assorted colors | Adequate |  |

## WORK ETHICS AND PRACTICES

**UNIT CODE:** 0417 441 03A

**Relationship with Occupational Standards**

This unit addresses the Unit of Competency: Apply work ethics and practices.

**Duration of Unit: 40 Hours**

**Unit Description**

This unit covers competencies required to demonstrate employability skills. It involves the ability to: conduct self-management, promote ethical work practices and values, promote teamwork, manage workplace conflicts, maintain professional and personal development, apply problem-solving, and promote customer care.

**Summary of Learning Outcomes**

By the end of this unit of learning, the trainee will be able to:

|  |  |  |
| --- | --- | --- |
| **S/No** | **Learning Outcome** | **Duration (Hrs.)** |
| 1 | Apply self-management skills | **10** |
| 2 | Promote ethical practices and values | **4** |
| 3 | Promote teamwork | **10** |
| 4 | Maintain professional and personal development | **10** |
| 5 | Apply problem-solving skills | **4** |
| 6 | Promote customer care. | **2** |
|  | **TOTAL HOURS** | **40** |

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

| **Learning Outcome** | **Content** | **Suggested Assessment Methods** |
| --- | --- | --- |
| 1. Apply self-management skills | * 1. Self-awareness   2. Formulating personal vision, mission, and goals   3. Healthy lifestyle practices   4. Strategies for overcoming work challenges   5. Emotional intelligence   6. Coping with Work Stress.   7. Assertiveness versus aggressiveness and passiveness      1. Developing and maintaining high self-esteem      2. Developing and maintaining positive self-image      3. Time management      4. Setting performance targets      5. Monitoring and evaluating performance targets | * Observation * Written assessment * Oral assessment * Third party reports * Portfolio of evidence * Project * Practical |
| 1. Promote ethical work practices and values | * 1. Integrity   2. Core Values, ethics and beliefs   3. Patriotism   4. Professionalism   5. Organizational codes of conduct   6. Industry policies and procedures | * Observation * Written assessment * Oral assessment * Third party reports * Portfolio of evidence * Project * Practical |
| 1. Promote Teamwork | * 1. Types of teams   2. Team building      1. Individual responsibilities in a team      2. Determination of team roles and objectives      3. Team parameters and relationships      4. Benefits of teamwork      5. Qualities of a team player      6. Leading a team      7. Team performance and evaluation   3. Conflicts and conflict resolution   4. Gender and diversity mainstreaming   5. Developing Healthy workplace relationships   6. Adaptability and flexibility   7. Coaching and mentoring skills | * Observation * Written assessment * Oral assessment * Third party reports * Portfolio of evidence * Project * Practical |
| 1. Maintain professional and personal development | * 1. Personal vs professional development and growth   2. Avenues for professional growth   3. Recognizing career advancement   4. Training and career opportunities      1. Assessing training needs      2. Mobilizing training resources   5. Licenses and certifications for professional growth and development   6. Pursuing personal and organizational goals   7. Managing work priorities and commitments   8. Dynamism and on-the-job learning | * Observation * Written assessment * Oral assessment * Third party reports * Portfolio of evidence * Project * Practical |
| 1. Apply Problem-solving skills | * 1. Causes of problems   2. Methods of solving problems   3. Problem-solving process   4. Decision making   5. Creative thinking and critical thinking process in development of innovative and practical solutions | * Observation * Written assessment * Oral assessment * Third party reports * Portfolio of evidence * Project * Practical |
| 1. Promote Customer Care | * 1. Identifying customer needs   2. Qualities of good customer service   3. Customer feedback methods   4. Resolving customer concerns   5. Customer outreach programs   6. Customer retention | * Observation * Written assessment * Oral assessment * Third party reports * Portfolio of evidence * Project * Practical |

**Suggested Methods of Instruction**

* Instructor lead facilitation of theory using active learning strategies.
* Demonstrations
* Simulation/Role play
* Group Discussion
* Presentations
* Projects
* Case studies
* Assignments

**Recommended Resources for 30 Trainees**

|  |  |  |  |  |
| --- | --- | --- | --- | --- |
| **S/No.** | **Category/Item** | **Description/Specifications** | **Quantity** | **Recommended Ratio (Item: Trainee)** |
| **A** | **Learning Materials** |  |  |  |
|  | Textbooks | Comprehensive texts books on Work Ethics and Practices | 30 pcs | 1:1 |
|  | PowerPoint Presentations | For trainer’s use, covering course content and practical applications | 1 | 1:30 |
|  | Projector | Functional projector for displaying content during presentations | 1 | 1:30 |
|  | Media Resources | This include but are not limited to:   * Video Clips * Audio Clips * TV Sets * Radio Sets |  |  |
|  | White board | Quality whiteboard of approximately 6 ft by 3 ft for writing during theory instruction | 1 | 1:30 |
| **B** | **Learning Facilities & Infrastructure** |  |  |  |
|  | Lecture/Theory Room  /Learning Resource  Area\* | Spacious, equipped with projectors and Seats for 30 trainees, approximately 45 sqm (5 m x 9 m) | 1 | 1:30 |
|  | Computer Laboratory | Equipped with at least 30 functional computers with internet connectivity and the following software:   * + - Windows/ Linux/ Macintosh Operating System     - Microsoft Office Software     - Google Workspace Account     - Antivirus Software | 30 | 1:1 |
|  |  |  |  |  |
| **C** | **Consumable Materials** |  |  |  |
|  | Printing Papers | A4 and A3 Printing papers suitable for the task | Enough |  |
|  | Flashcards | For carrying out various activities by trainees | Enough |  |
|  | Charts | Sufficient for group work activities and displaying | Enough |  |
|  | Whiteboard Marker Pens | Dry-erase markers for trainer’s use. Assorted colors | Enough |  |

## ENTREPRENEURIAL SKILLS

**UNIT CODE:0413 441 04A**

**Relationship with occupational standards**

This unit addresses the unit of competency: Apply Entrepreneurial skills.

**Duration of unit: 40 Hours**

**Unit Description:**

This unit covers the competencies required to demonstrate an understanding of entrepreneurship. It involves demonstrating an understanding of financial literacy, applying entrepreneurial concepts identifying entrepreneurship opportunities, applying business legal aspects, and developing business innovative strategies and business plans.

**Summary of Learning Outcomes**

By the end of this unit of learning, the trainee will be able to:

|  |  |  |
| --- | --- | --- |
| **S/No** | **Learning Outcome** | **Duration (Hrs.)** |
| 1 | Apply financial literacy | **6** |
| 2 | Apply the entrepreneurial concept | **4** |
| 3 | Identify entrepreneurship opportunities | **6** |
| 4 | Apply business legal aspects | **6** |
| 5 | Innovate Business Strategies | **6** |
| 6 | Develop business plan | **12** |
|  | **TOTAL HOURS** | **40** |

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

| **Learning Outcome** | **Content** | **Suggested Assessment Methods** |
| --- | --- | --- |
| 1. Apply financial literacy | * 1. Personal finance management   2. Balancing between needs and wants   3. Budget Preparation   4. Saving management   5. Factors to consider when deciding where to save   6. Debt management   7. Factors to consider before taking a loan   8. Investment decisions   9. Types of investments   10. Factors to consider when investing money   11. Insurance services   12. insurance products available in the market   13. Insurable risks | * Observation * Project * Written assessment * Oral assessment * Third party report * Interviews |
| 1. Apply entrepreneurial concept | * 1. Difference between Entrepreneurs and Business persons   2. Types of entrepreneurs   3. Ways of becoming an entrepreneur   4. Characteristics of Entrepreneurs   5. salaried employment and self-employment   6. Requirements for entry into self-employment   7. Roles of an Entrepreneur in an enterprise   8. Contributions of Entrepreneurship | * Observation * Project * Written assessment * Oral assessment * Third party report |
| 1. Identify entrepreneurship opportunities | * 1. Sources of business ideas   2. Factors to consider when evaluating business opportunity   3. Business life cycle | * Observation * Project * Written assessment * Oral assessment * Third party report |
| 1. Apply business legal aspects | * 1. Forms of business ownership   2. Business registration and licensing processing   3. Types of contracts and agreements   4. Employment laws   5. Taxation laws | * Observation * Project * Written assessment * Oral assessment * Third party report |
| 1. Innovate business Strategies | * 1. Creativity in business   2. Innovative business strategies   3. Entrepreneurial Linkages   4. ICT in business growth and development | * Observation * Project * Written assessment * Oral assessment * Third party report |
| 1. Develop Business Plan | * 1. Business description   2. Marketing plan   3. Organizational/Management   4. plan   5. Production/operation plan   6. Financial plan   7. Executive summary   8. Business plan presentation   9. Business idea incubation | * Observation * Written assessment * Project * Oral assessment * Third party report |

**Suggested Methods of Instruction**

* Direct instruction with active learning strategies
* Project (Business plan)
* Case studies
* Field trips
* Group Discussions
* Demonstration
* Question and answer
* Problem solving
* Experiential
* Team training
* Guest speakers

**Recommended Resources for 30 Trainees**

|  |  |  |  |  |
| --- | --- | --- | --- | --- |
| **S/No.** | **Category/Item** | **Description/Specifications** | **Quantity** | **Recommended Ratio (Item: Trainee)** |
| **A** | **Learning Materials** |  |  |  |
|  | Textbooks | Comprehensive texts books on Entrepreneurial Skills | 30 pcs | 1:1 |
|  | PowerPoint Presentations | For trainer’s use, covering course content and practical applications | 1 | 1:30 |
|  | Projector | Functional projector for displaying content during presentations | 1 | 1:30 |
|  | Media Resources | These include but are not limited to:   * Video Clips * Audio Clips * TV Sets * Radio Sets * Newspapers * Business Journals * Case studies |  |  |
|  | Templates | Templates for creating various documents e.g. business plan, invoices etc. | 30 | 1:1 |
|  | White board | Quality whiteboard of approximately 6 ft by 3 ft for writing during theory instruction | 1 | 1:30 |
| **B** | **Learning Facilities & Infrastructure** |  |  |  |
|  | Lecture/Theory Room  /Learning Resource  Area\* | Spacious, equipped with projectors and Seats for 30 trainees, approximately 45 sqm (5 m x 9 m) | 1 | 1:30 |
|  | Computer Laboratory | Equipped with at least 15 functional computers with internet connectivity and the following software:   * + - Windows/ Linux/ Macintosh Operating System     - Microsoft Office Software     - Google Workspace Account     - Antivirus Software | 1 | 1:1 |
|  |  |  |  |  |
| **C** | **Consumable Materials** |  |  |  |
|  | Writing Materials | Writing materials for note taking | Enough |  |
|  | Flashcards | For carrying out various activities by trainees | Enough |  |
|  | Charts | Sufficient for group work activities and displaying | Enough |  |
|  | Whiteboard Marker Pens | Dry-erase markers for trainer’s use. Assorted colors | Enough |  |

## HYDRAULIC SYSTEMS INSTALLATION AND MAINTAINANCE

**UNIT CODE:** 0714 451 15A

**Relationship to occupational standards**

This unit addresses the unit of competency: Install and maintain hydraulic system

**Duration of unit:** 220 hours.

**Unit description**

This unit covers the competencies required in installation and maintenance of hydraulic systems according to the design considerations and installation standards. These competencies include; conducting hydraulic system site survey, planning hydraulic system installation, installing hydraulic system and maintaining hydraulic systems.

**Summary of Learning outcomes**

By the end of the unit of learning, the trainee will be able to;

|  |  |  |
| --- | --- | --- |
| S/No | Learning Outcome | **Duration (Hrs.)** |
| 1 | Apply heat transfer and heat exchangers in fluid | **10** |
| 2 | Apply knowledge of flow of fluids | **10** |
| 3 | Apply knowledge of viscous flow of fluids | **10** |
| 4 | Operate fluid pumps | **10** |
| 5 | Conduct hydraulic system site survey | **30** |
| 6 | Plan hydraulic system installation | **30** |
| 7 | Install hydraulic system | **70** |
| 8 | Maintain hydraulic system | **50** |
|  | **TOTAL** | **220 HRS** |

**Learning outcomes, content and suggested assessment methods**

| **Learning outcome** | **Content** | **Suggested assessment methods** |
| --- | --- | --- |
| * 1. Apply heat transfer and heat exchangers in fluid | * 1. Heat transfer media      1. Heat transfer methods:         1. Conduction         2. Convection         3. Radiation      2. Newton's law of Cooling      3. Derivation and application of Fourier's\* law of heat conduction equation   2. Heat transfer by conduction   through   * + 1. Slab        1. Thermal conductivity        2. Temperature gradient     2. Composite wall     3. Thick cylinder     4. Thick sphere   1. Overall coefficient of heat transfer      1. Heat exchangers | * Written tests |
| * 1. Apply knowledge of flow of fluids | * 1. Types of fluid flow      1. Steady and unsteady flows      2. Uniform and non-uniform flows      3. Rotational and irrotational flows      4. Laminar and turbulent flows      5. Compressible and incompressible flows   2. Loss of energy (or Head) in Pipes      1. Darcy-weisbach formula      2. Chezy’s formula for loss of head due to friction      3. Loss of head due to sudden enlargement      4. Loss of head due to sudden contraction      5. Loss of head due to obstruction in pipe      6. Loss of head at the entrance to pipe      7. Loss of head at the exit of a pipe      8. Loss of head due to bend in the pipe   3. Hydraulic gradient and total energy lines      1. Pipes in series or compound pipes      2. Pipes in parallel      3. Power transmission through Pipes | * Written tests |
| * 1. Apply knowledge of viscous flow of fluids | * 1. Flow of viscous flow      1. Flow of viscous fluid in circular pipes      2. Flow of viscous fluid through an annulus      3. Flow of viscous fluid between two parallel plates         1. One plate moving and other at rest         2. Both plates at rest         3. Both plates moving in opposite directions      4. Kinetic energy correction and momentum      5. Power absorbed in viscous flow      6. Viscous resistance of journal bearings      7. Viscous resistance of foot-step      8. Viscous resistance of collar bearing | * Written tests |
| * 1. Operate fluid pumps | * 1. Principles of operation of:      1. Reciprocating pumps      2. Centrifugal pumps   2. Derivation of equations for a reciprocating pump      1. Coefficient of discharge      2. percentage slip      3. Work done      4. Acceleration head      5. Friction head      6. Pressure head in the cylinder   3. Application of reciprocating pumps equations to solve problems   4. Derivation of equations for a centrifugal pump      1. Effective head      2. Manometric head      3. efficiency      4. Mechanical efficiency      5. Discharge      6. Torque      7. Work done unit weight      8. Specific speed   5. Application of centrifugal pumps equations to solve problems | • Written tests |
| 1. Conduct hydraulic system site survey | * 1. Site survey aspects      1. User requirements      2. System requirements      3. Space and layout      4. Environmental considerations      5. Power sources      6. Safety regulations and standards      7. Instrumentation systems      8. Status of existing systems      9. Scalability      10. Reliability      11. Cost   2. Survey Tools and Equipment      1. Required tools         1. Tape measure         2. Laser distance meter         3. Camera         4. Flow meters         5. Pressure gauges         6. Stationery         7. Thermometer         8. Ladder         9. Flashlight         10. Leakage testers         11. Hand tools      2. Required equipment         1. Leakage testers         2. Hydraulic fluid analysis kit         3. Hydraulic pressure testing kit         4. Ladder   3. Conduct the Site Survey      1. Execute site survey as per work requirements      2. Document findings   4. Generate Survey Report      1. Prepare a comprehensive site survey report      2. Follow workplace procedures for documentation | * Project * Practical * Third party report * Portfolio of evidence * Written tests * Oral questioning |
| 1. Plan hydraulic system installation | * 1. Introduction to Hydraulic Systems      1. Fundamentals of Hydraulics         1. Definition and principles of hydraulics         2. Applications in various industries         3. Advantages of hydraulic systems over other systems      2. Types of hydraulic system components and their operations.         1. Hydraulic fluids,         2. pumps,         3. valves         4. actuators,         5. filters      3. Types of hydraulic cylinders (single-acting, double-acting)   2. Operation and control      1. System operation      2. Basics of hydraulic control systems      3. Flow control and pressure regulation   3. Automation in hydraulics      1. Introduction to electronic controls      2. Integration with PLCs and other control systems   4. System design      1. Hydraulic circuit design principles      2. Sizing and selecting hydraulic components   5. Installation workplan preparation      1. Outline tasks and timeline      2. Identify resources and personnel   6. Hydraulic system supplies specifications      1. Pressure gauges      2. Vacuum gauges      3. Pressure regulators      4. Pipes      5. Connectors      6. Air compressors      7. Hydraulic Valves      8. Enclosures      9. Hydraulic cylinders and pumps      10. Fluid reservoirs      11. Hydraulic fluid      12. Sealing and fasteners      13. Mounting hardware      14. Installation tools and equipment      15. Electrical supplies      16. Safety equipment   7. Practice:      1. Design automatic hydraulic systems      2. Prepare a workplan for automatic hydraulic system | * Project * Practical * Third party report * Portfolio of evidence * Written tests * Oral questioning |
| 1. Install hydraulic system | * 1. Types of PPE      1. Helmets,      2. Gloves,      3. Goggles   2. Hydraulic piping      1. Hydraulic tubing      2. Hydraulic hoses      3. Hydraulic fittings      4. Flanges      5. Couplers      6. Manifolds      7. Filters      8. Check valves      9. Pressure relief valves      10. Supports and brackets      11. Flow control valves   3. Mounting accessories:      1. Breathers and filters      2. Pressure gauges      3. Temperature gauges      4. Level gauges      5. Sight glasses      6. Pressure switches      7. Coolers and heat exchangers      8. Accumulators      9. Valves   4. System testing:      1. Functionality test      2. Leakage test      3. Pressure test      4. Temperature test      5. Flow rate test      6. Noise and vibration test   5. Calibration of hydraulic controls   6. Site Housekeeping and waste disposal      1. Packaging material      2. Faulty components and equipment   7. Practice: Install automatic hydraulic systems | * Project * Practical * Third party report * Portfolio of evidence * Written tests * Oral questioning |
| 1. Maintain hydraulic system | * 1. Maintenance Schedule Creation   2. Tools and Spares:      1. Tools      + Hand tools      + Pressure gauge      1. Equipment      + Lifting gear      + Hydraulic press      + Hydraulic flushing unit      + Hydraulic test bench      + Hydraulic hose crimping machine      1. Spares      + Hydraulic hoses      + Hydraulic fittings      + Hydraulic fluid      + Hydraulic filters      + Hydraulic valves      + Hydraulic cylinders      + Hydraulic pump seals   3. Maintenance tasks:      1. Inspection      2. Testing and measurements      3. Fluid level check      4. Fluid condition check      5. Cleaning      6. Tightening      7. Lubrication      8. Pressure check      9. Replacing components      10. Replacing consumables   4. Technical reporting and documentation   5. Practice: Maintain installed hydraulic systems | * Project * Practical * Third party report * Portfolio of evidence * Written tests * Oral questioning |

**Suggested delivery methods**

* Group discussions
* Demonstration by trainer
* Online videos
* Power point presentation

**Recommended resources for 25 trainees**

|  |  |  |  |  |
| --- | --- | --- | --- | --- |
| **S/No.** | **Category/item** | **Description/specifications** | **Quantity** | **Recommended ratio (item: trainee)** |
| **A** | **Tools** | | | |
|  | Hand Tools | Complete set including wrenches, screwdrivers, and pliers | 5 pcs | 1:5 |
|  | Pressure gauges | For measuring hydraulic pressure | 5 pcs | 1:5 |
|  | Multimeters | For measuring voltage, current, and resistance | 5 pcs | 1:5 |
|  | Hydraulic hose crimping tool | For crimping hydraulic hoses | 5 pcs | 1:5 |
|  | Flow meters | For measuring the flow rate of hydraulic fluids | 5 pcs | 1:5 |
|  | Laser distance meters | For measuring distances accurately, shared between two trainees | 5 pcs | 1:5 |
| **B** | **Learning facilities & infrastructure** | | | |
|  | Lecture/theory room | Approximately 60 sqm | 1 | 1:25 |
|  | Workshop | Approximately 80 sqm | 1 | 1:25 |
|  | Laboratory | Approximately 80 sqm | 1 | 1:25 |
|  |  |  |  |  |
| **C** | **Materials and supplies** | | | |
|  | Hydraulic fluid | 20 liters per trainee for operations | 500 liters | 20L:1 |
|  | Hydraulic hoses | 10 meters per trainee for various applications | 250 meters | 10m:1 |
|  | Connectors, fittings, seals | Sets for hydraulic connections | 500 sets | 20 sets:1 |
|  | Pipes (Various Sizes) | For plumbing and installation in hydraulic systems | 125 meters | 5m:1 |
|  | Mounting brackets and fasteners | For securing hydraulic components | 250 pcs | 10:1 |
|  | Safety gear (ppe) | Complete sets including helmet, gloves, goggles, safety shoes, and harness | 25 sets | 1:1 |
|  |  |  |  |  |
| **D** | **Equipment** | | | |
|  | Hydraulic test benches | For conducting pressure tests on hydraulic systems | 2 units | 2:25 |
|  | Hydraulic pumps | For generating hydraulic pressure | 2 units | 2:25 |
|  | Hydraulic motors | For driving hydraulic systems | 2 units | 2:25 |
|  | Hydraulic cylinders | For providing force in hydraulic systems | 2 units | 2:25 |
|  | Hydraulic power units | For powering hydraulic systems | 2 units | 2:25 |
|  | Hydraulic pressure testing kits | For testing pressure levels in systems | 2 units | 2:25 |
|  | Sensors | Assorted | 10 | 2:5 |
|  | Controllers | For controlling automatic hydraulic system | 5 | 1:5 |
|  |  |  |  |  |
| **E** | **Equipment** | | | |
|  | Hydraulic fluid analysis kits | For analyzing the quality of hydraulic fluid | 2 units | 2:25 |
|  | Leakage testers | For detecting leaks in hydraulic systems | 2 units | 2:25 |
|  | Vacuum pumps | For creating vacuum conditions | 2 units | 2:25 |
|  | hydraulic training kit | For training | 2 units | 2:25 |
|  |  |  |  |  |
| **F** | **Reference materials** | | | |
|  | Hydraulic system manuals | Comprehensive guides for understanding hydraulic systems | 5 copies | 1:5 |
|  | Hydraulic system design blueprints | For understanding layout and design of hydraulic systems | 5 copies | 1:5 |
|  | Occupational health and safety (OHS) guidelines | For ensuring safety practices are followed | 1 copy | 1:25 |
|  | Technical documentation for hydraulic components | Detailed information for components | 5 sets | 1:5 |
|  | System Troubleshooting Guides | For diagnosing and solving system issues | 25 copies | 1:1 |

MODULE SIX

## ENGINEERING MECHANICS

**ISCED UNIT CODE:** 0715 541 06A

**Relationship to occupational standards**: apply engineering mechanics

**Duration of unit**: 150 Hours

**Unit description**

This unit of competency describes the competences required in order to apply engineering mechanics principles. This includes: applying forces and moments, friction principles, kinematics of motion, mechanical work-energy theorem, kinetics of motion, law of machines, determining loading conditions, applying simple mechanisms, designing belts, ropes and chain drives, designing toothed gears and gear trains, designing mechanical rotor dynamic machines, applying stress and strain concepts, applying simple bending theory, and torsion theory in mechanical systems.

**Summary of learning outcomes**

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

|  |  |  |
| --- | --- | --- |
| S/No | Learning Outcome | **Duration (Hrs.)** |
| 1 | Apply forces and moments in a mechanical system | **10** |
| 2 | Apply friction principles in mechanical systems | **10** |
| 3 | Apply kinematics of motion in mechanical systems | **10** |
| 4 | Apply mechanical work-energy theorem | **10** |
| 5 | Apply kinetics of motion in mechanical systems | **10** |
| 6 | Apply law of machines | **10** |
| 7 | Determine loading conditions in mechanical systems | **10** |
| 8 | Apply simple mechanisms | **10** |
| 9 | Design belts, ropes and chain drives | **15** |
| 10 | Design toothed gears and gear trains | **15** |
| 11 | Design mechanical rotor dynamic machines | **10** |
| 12 | Apply stress and strain concepts in mechanical systems | **10** |
| 13 | Apply simple bending theory in mechanical systems | **10** |
| 14 | Apply torsion theory in mechanical systems | **10** |
|  | **TOTAL HOURS** | **150** |

**Learning outcomes, content and suggested assessment methods**

|  |  |  |
| --- | --- | --- |
| **Learning outcome** | **Content** | **Suggested assessment methods** |
| 1. Apply forces and moments in a mechanical system | * 1. Force      1. Definition      2. Types         1. Tensional         2. Compressional         3. Shear      3. Applications   2. Moments      1. Definition      2. Types         1. Bending moments      3. Applications | * Written Tests |
| 1. Apply friction principles in mechanical systems | * 1. Friction      1. Static      2. Dynamic         1. Rolling friction         2. Sliding friction   2. Coefficient of friction   3. Limiting friction   4. Laws of friction   5. Factors affecting friction   6. Advantages and disadvantages of friction   7. Applications of friction   8. Lubrication      1. Types of lubricants      2. Advantages of lubricants   9. Analysis of Friction      1. Friction on a horizontal plane      2. Friction on an inclined plane   10. Applications of friction in engineering       1. Tire traction       2. Braking systems       3. Bearing and bushings       4. Grinding of tools       5. Transmission systems   11. Coolants and cutting fluids       1. Categories and types       2. Functions       3. Properties of an ideal cutting fluid | * Written tests |
| 1. Apply kinematics of motion in mechanical systems | * 1. Introduction to kinematics of motion      1. Definition of kinematics      2. Linear and angular motion         1. Linear and angular displacement         2. Linear and angular velocity         3. Linear and angular acceleration         4. Relative velocity      3. Applications of kinematics of motion in mechanical systems         1. Cam and follower systems         2. Piston and engine mechanisms         3. Elevators and escalators   2. Structural supports      1. Load analysis      2. Material selection for structural supports      3. Structural support components      4. Deflection and stiffness requirements for structural supports   3. Displacement/time graphs      1. Body moving with uniform velocity      2. Body moving with varied velocity | * Written Tests |
| 1. Apply mechanical work-energy theorem | * 1. Work      1. Definition      2. Calculations of work done   2. Energy      1. Definition      2. Calculations of energy requirements and efficiency   3. Power      1. Definition      2. Calculations of power | * Written tests |
| 1. Apply kinetics of motion in mechanical systems | * 1. Definition of KINETICS   2. Newtons laws of motion      1. First law      2. Second law      3. Third law   3. Applications of kinetics in mechanical systems   4. Structural Supports      1. Definition and types of structural supports      2. Forces acting on structural supports      3. Loads and reactions in structural supports      4. Stress and strain in structural supports      5. Designing structural supports for motion   5. Kinetic linkages      1. Definition and types      2. Factors in selecting kinematic linkages | * Written tests |
| 1. Apply law of machines | * 1. Simple machines      1. Definition      2. Working principles and applications         1. Lever         2. Wedge         3. Inclined plane         4. Pulley         5. Wheel and axle         6. Screw jack      3. Simple machine analysis         1. Load and load distance         2. Effort and effort distance         3. Ideal load and effort         4. Mechanical advantage         5. Velocity ratio         6. Efficiency         7. Law of machine      4. Factors affecting the efficiency of simple machines   2. Selection of simple machines      1. Advantages and disadvantages of each type of simple machine      2. Factors to consider when selecting a simple machine   3. Simple machines speed adjustment      1. Relationship between speed and mechanical advantage      2. Adjusting speed with different simple machines      3. Combining simple machines for speed and efficiency | * Written Tests |
| 1. Determine loading conditions in mechanical systems | * 1. Define structure   2. Types of loading      1. Point load      2. Uniformly distributed load      3. Varying load   3. Types of beams      1. Simply supported beams      2. Cantilever beam      3. Overhanging beam | Written tests |
| 1. Apply simple mechanisms | * 1. Define simple mechanism   2. Components of simple mechanism      1. Link      2. Element   3. Types of mechanisms      1. Single slider mechanism      2. Double slider mechanism | * Written tests |
| 1. Design belts, ropes and chain drives | * 1. Definition      1. Belt      2. Rope      3. Chain   2. Belts      1. Material used for belt         1. Rubber         2. Cotton         3. Leather      2. Types of belts         1. Flat         2. V belt         3. Circular      3. Configuration of belt drive         1. Open         2. Crossed      4. Design analysis of flat and V-Belts         1. Velocity ratio         2. Length of belt         3. Angle of contact         4. Power transmitted   3. Rope drives      1. Types of rope drives   4. Chain drives      1. Types of chain drives | * Written tests |
| 1. Design toothed gears and gear trains | * 1. Types of gears      1. Spur      2. Helical      3. Double helical   2. Types of gear trains      1. Simple gear train         1. Design calculations      2. Compound gear train         1. Design calculations      3. Reverted gear train         1. Design calculations      4. Epicyclic gear train   3. Lubrication of gears | * Written tests |
| 1. Design mechanical rotor dynamic machines | * 1. Types of pumps and operation principle      1. Reciprocating pump      2. Centrifugal pump   2. Derivation of equations for      1. Reciprocating pumps      2. Centrifugal pumps   3. Analysis of pumps      1. Discharge      2. Efficiency      3. Power      4. Head      5. Weight per unit   4. Types and operation principle of rotary compressors      1. Rotary screw compressors      2. Rotary vane compressors      3. Scroll compressor      4. Rotary lobe   5. Analysis of compressors      1. Inlet and outlet flow      2. Work done      3. Mass flow rate      4. Power requirement      5. Efficiency   6. Compressor fans and vanes      1. Structure and functions of compressor fans and vanes      2. Operation principles of fans and vanes in rotary compressors      3. Maintenance of fans and vanes   7. Design analysis      1. Vane efficiency      2. Fan efficiency      3. Power consumption | * Written tests |
| 1. Apply stress and strain concepts in mechanical systems | * 1. Define stress and strain   2. Types of simple stresses      1. Direct      2. Shear      3. Ultimate tensile stress      4. Yield stress      5. Breaking stress      6. True stress   3. Analysing stress on      1. Beams      2. Thin cylinders      3. Thin shells   4. Applications of stress and strain concepts      1. Bolts and nuts      2. Shafts | * Written tests |
| 1. Apply simple bending theory in mechanical systems | * 1. Engineers bending equation   2. Types of Beams      1. Simply supported beams      2. Cantilever beam      3. Overhanging beam   3. Analysis of beams      1. T-section      2. L-section      3. I-section   4. Types of shafts      1. Solid      2. Tubular      3. stepped   5. Analysis of shafts      1. Solid      2. Tubular      3. Stepped | * Written tests |
| 1. Apply torsion theory in mechanical systems | * 1. Define torsion   2. Torque analysis   3. Analysis of shafts      1. Series arranged shafts      2. Parallel arranged shafts   4. Determine angle of twist      1. Engineers’ torsion equation | * Written tests |

**Suggested delivery methods**

* Group discussions
* Demonstration by the trainer
* Online video clips
* Power point presentation

**Recommended resources for 30 trainees**

|  |  |  |  |  |
| --- | --- | --- | --- | --- |
| **S/No.** | **Category/item** | **Description/specifications** | **Quantity** | **Recommended ratio (item: trainee)** |
| **A** | **Learning materials** | | | |
|  | Textbooks | Comprehensive textbooks on Engineering mechanics principles | 30 | 1:1 |
|  | Graph books | For graphical representation of solutions | 30 | 1:1 |
|  | Projector | Functional projector for displaying content during presentations | 1 | 1:30 |
|  | Computer | Functional desktop computer with online instructional content | 1 | 1:30 |
|  | White board | Quality whiteboard of approximately 6 ft by 3 ft for writing during theory instruction | 1 | 1:30 |
|  | Printer | An ink-jet, laser-jet or toner-cartridge printer for printing notes, instructions and working drawings | 1 | 1:30 |
| **B** | **Learning facilities & infrastructure** | | | |
|  | Lecture/theory room | Spacious room with seats for 25 trainees, approximately 60 sqm | 1 | 1:30 |
| **C** | **Materials and supplies** | | | |
|  | First aid kit | Fully equipped first aid kit for use in case of accidents | 1 | 1:30 |
| **D** | **Tools and equipment** | | | |
|  | Calculators | For calculations | 30 | 1:1 |
|  | Firefighting extinguishers | Water, carbon dioxide and chemical powder fire extinguishers for fire fighting | 1 | 1:30 |
| **F** | **Reference materials** | | | |
|  | Training Presentations/Slides | Digital format for shared access among trainees | 1 | 1:30 |

## ELECTRICAL AND ELECTRONICS PRINCIPLES

**UNIT CODE:** 0713 541 07A

**UNIT DURATION: 150 HOURS**

**Relationship to Occupational Standards**

This unit addresses the unit of competency: Apply Electrical and Electronic principles.

**Unit description**

This unit describes the competences required in order to apply electrical and electronics principles. It involves applying basic concepts of electrical quantities, magnetism and electromagnetism, basic electrical machines and electronics principles and cells and batteries

**Summary of Learning Outcomes**

By the end of the Unit of Learning, the trainee will be able to;

|  |  |  |
| --- | --- | --- |
| S/No | Learning Outcome | **Duration (Hrs.)** |
| 1 | Use the concept of basic Electrical quantities | **10** |
| 2 | Apply DC and AC circuits | **20** |
| 3 | Apply Safety requirements for electricity | **20** |
| 4 | Apply understanding of electronics | **20** |
| 5 | Apply Magnetism and electromagnetism | **20** |
| 6 | Perform Single and three phase power supply | **20** |
| 7 | Apply Sensors and transducers principles | **20** |
| 8 | Apply Concept of cells and batteries | **20** |
|  | **TOTAL HOURS** | **150** |

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

|  |  |  |
| --- | --- | --- |
| **Learning Outcome** | **Content** | **Suggested Assessment Methods** |
| 1. Use the concept of basic Electrical quantities | 1. Basic SI Units    * 1. Overview of SI Units  * Power (Watts, W) * Current (Amperes, A) * Resistance (Ohms, Ω) * Voltage (Volts, V)  1. Conductors and Insulators    * 1. Identification and Characteristics  * Metals vs. non-metals * Applications in electrical circuits  1. Electrical Quantities    * 1. Charge, Force, Work, and Power      2. Definitions and units      3. Calculations involving Electrical quantities 2. Ohm’s Law    * 1. Understanding Ohm's Law      2. Practical applications and calculations 3. Basic Electrical and Electronic Measurements    * 1. Measurement Techniques      2. Use of multimeter, oscilloscopes, and ammeters      3. Measurement accuracy and calibration | 1. Written tests 2. Oral Questioning 3. Portfolio of evidence |
| 1. Apply DC and AC circuits | * 1. Introduction to Electrical Circuits      1. Introduction to electricity:      2. Voltage, current, and power.      3. Overview of DC and AC circuits.      4. Basic circuit elements: Resistors, capacitors, and inductors.   2. DC Circuit Analysis      1. Series and parallel circuits.      2. Voltage and current division principles.      3. Kirchhoff's Voltage Law (KVL) and Kirchhoff's Current Law (KCL).      4. Analysis of complex circuits using KVL and KCL.      5. Introduction to circuit simulation software (e.g., SPICE).      6. Thevenin's and Norton's Theorems.      7. Superposition Theorem.      8. Practical applications of DC circuit analysis.      9. Circuit design and testing using breadboards.      10. Hands-on lab: Building and testing DC circuits.   3. AC circuits analysis      1. Introduction to AC: Sinusoidal waveforms, frequency, and period.      2. RMS values, peak values, and average values.      3. AC voltage and current sources.      4. Phasor representation of AC quantities.      5. Impedance and admittance.      6. Series and parallel AC circuits.      7. Resonance in RLC circuits.      8. Practical analysis of AC circuits using phasors.      9. Power in AC Circuits * Power factor and power factor correction. * Real, reactive, and apparent power. * AC power calculations for single-phase and three-phase circuits. * Energy consumption and efficiency. * Applications of AC power in household and industrial settings.   1. Practical Activity:      1. Connection in series and Parallel      2. Simulation | 1. Project 2. Practical 3. Written tests 4. Oral Questioning 5. Portfolio of evidence |
| 1. Apply safety requirements for electricity | * 1. Personal Protective Equipment (PPE)      1. Types of PPE * Head protection, insulating gloves, eye protection * Usage guidelines and importance   1. Control of Electrical Hazards      1. Identification of Hazards * Shocks, explosions, electrocution, burns, fires, electric arcs * Risk assessment and management   1. Electric Hazard Prevention      1. Preventative Measures * Lockout/Tagout (LOTO) procedures * Safe work practices | * Project * Practical * Written tests * Oral Questioning * Portfolio of evidence |
| 1. Apply understanding of electronics | * 1. Introduction to Electronic Components      1. Overview of electronics: What are electronic components?      2. Classification of components: Passive, active, and electromechanical.      3. Introduction to circuit symbols and schematic diagrams.      4. Basic electrical quantities and units (voltage, current, resistance).      5. Understanding datasheets and component specifications.      6. Overview of testing and measurement tools (multimeters, oscilloscopes).   2. Passive Components      1. Resistors: Types, color codes, power ratings, and applications.      2. Capacitors: Types (ceramic, electrolytic, film), capacitance value, and working voltage.      3. Charging and discharging of capacitors in DC circuits.      4. Applications of capacitors in filtering, timing, and energy storage.      5. Inductors: Types, inductance value, and applications.      6. Inductor behavior in DC and AC circuits.      7. Introduction to filters: RC, RL, and RLC circuits.   3. Semiconductor Devices      1. Diodes: Introduction to PN junctions, characteristics, and types (LEDs, Zener diodes, Schottky diodes).      2. Applications of diodes in rectification, voltage regulation, and signal clipping.      3. Transistors: Types (BJT and MOSFET), characteristics, and configurations.      4. Basic transistor circuits: Switches and amplifiers.      5. Hands-on lab: Building and testing simple diode and transistor circuits.      6. Special semiconductor devices: Thyristors, TRIACs, and optoelectronic devices.      7. Characteristics and applications in switching and control.   4. Integrated Circuits (ICs)      1. Overview of integrated circuits: Analog vs. digital ICs.      2. Operational amplifiers (Op-Amps): Characteristics and basic configurations.      3. Applications of Op-Amps in signal processing.      4. Timers and oscillators: 555 timer IC and its applications.      5. Voltage regulators: Linear and switching regulators.      6. Introduction to data converters (ADC and DAC).      7. Digital ICs: Logic gates and flip-flops.      8. Applications of digital ICs in basic logic circuits.      9. Hands-on lab: Building circuits using Op-Amps, timers, and logic gates.   5. Electromechanical and Specialized Components      1. Relays: Types, operation, and applications in switching.      2. Switches and connectors: Types and usage in electronic circuits.      3. Transformers: Basic operation, step-up/step-down functions, and isolation.      4. Displays: LED, LCD, and seven-segment displays.      5. Circuit Design and Practical Applications      6. Basic circuit design principles: Bread boarding, PCB layout, and soldering.      7. Introduction to circuit simulation tools (e.g., Multisim, LTSpice).      8. Testing and troubleshooting techniques.      9. Real-world applications of electronic components.      10. Building practical projects: Power supplies, audio amplifiers, and sensor-based circuits.      11. Hands-on lab: Final project assembly and testing. | * Project * Practical * Written tests * Oral Questioning * Portfolio of evidence |
| 1. Apply magnetism and electromagnetism | * 1. Magnetic Circuits and Devices      1. Introduction to magnetic circuits.      2. Magnetic flux, magnetic field density, magnetic field strength, Reluctance, magnetomotive force (MMF), and magnetic flux.      3. Calculations involving magnetic circuits      4. Analogies between electric and magnetic circuits.      5. Magnetic materials in electrical devices (soft and hard magnetic materials).   2. Electromagnetic Induction      1. Faraday’s Law of electromagnetic induction.      2. Lenz's Law: Direction of induced EMF.      3. Practical applications: Electric generators and transformers.      4. Induced EMF in different configurations (moving conductors, changing magnetic fields).      5. Self-induction and mutual induction.      6. Transformers: Working principles, construction, and applications.      7. Step up and step-down transformers      8. Power losses in transformers.      9. Calculations involving transformers      10. Energy stored in magnetic fields. | * Project * Practical * Written tests * Oral Questioning * Portfolio of evidence |
| 1. Perform single and three phase power supply principles | * 1. Overview of Electrical Power Systems      1. Definition and importance of power supply systems      2. Types of power systems: Single-phase vs. three-phase      3. Basic Electrical Concepts         1. Voltage, current, power, and frequency         2. Phase relationships and power factor   2. Single-Phase Power Supply      1. Characteristics of Single-Phase Systems         1. Voltage and current waveforms         2. Applications and limitations of single-phase power      2. Circuit Design and Implementation   3. Basic circuit configurations: Series and parallel   4. Wiring techniques and component selection      1. Measurement Techniques   5. Measuring voltage, current, and power in single-phase circuits   6. Tools and instruments for measurements   7. Three-Phase Power Supply      1. Fundamentals of Three-Phase Systems   8. Characteristics of three-phase power: Star (Y) and Delta (Δ) configurations   9. Advantages of three-phase systems over single-phase      1. Circuit Design and Implementation   10. Wiring and connection techniques for three-phase systems   11. Component selection and configuration       1. Measurement Techniques   12. Measuring line and phase voltages, currents, and power in three-phase circuits   13. Use of power analyzers and other measurement tools   14. Power Calculations and Analysis       1. Power Calculations   15. Active, reactive, and apparent power calculations   16. Understanding the power triangle in both single and three-phase systems       1. Power Factor Correction   17. Importance of power factor in electrical systems   18. Techniques for improving power factor in both types of systems   19. Troubleshooting and Maintenance       1. Common Issues in Power Supply Systems   20. Identifying and diagnosing faults in single and three-phase systems   21. Troubleshooting techniques and best practices | * Project * Practical * Written tests * Oral Questioning * Portfolio of evidence |
| 1. Apply sensors and transducers principles | * + 1. Introduction to Sensors and Transducers     2. Definitions and Concepts     3. Differences between sensors and transducers     4. Overview of their roles in measurement and control systems     5. Basic Principles of Operation     6. How sensors and transducers convert physical phenomena into electrical signals     7. Common physical quantities measured (e.g., temperature, pressure, moisture, position, oxygen, light)     8. Types of Sensors     9. Temperature Sensors     10. Thermocouples, thermistors, and infrared sensors     11. Principles of operations     12. Applications and selection criteria     13. Pressure Sensors     14. Strain gauge, piezoelectric, and capacitive pressure sensors     15. Principles of operations     16. Measurement techniques and applications     17. Proximity and Displacement Sensors     18. Inductive, capacitive, and photoelectric sensors     19. Principles of operations     20. Use cases and installation considerations     21. Other Sensor Types     22. Humidity, moisture, oxygen, flow, level, and gas sensors     23. Overview of their principles and applications     24. Types of Transducers     25. Definition and Functionality     26. Types of transducers (active vs. passive)     27. Examples and applications     28. Electrical Transducers     29. Strain gauges, load cells, and piezoelectric transducers     30. Principles of operation and usage     31. Mechanical Transducers     32. Overview of mechanical types and their applications     33. Integration into automated systems     34. Hands-on experiments on testing sensors and actuators. | * Project * Practical * Written tests * Oral Questioning * Portfolio of evidence |
| 1. Apply the concept of cells and batteries | * 1. Introduction to Cells and Batteries   2. Overview of energy storage and electrochemical cells.   3. Basic concepts: Voltage, current, capacity, and energy density.   4. e.m.f and internal resistance of cells   5. Electrochemical principles: Redox reactions and electrode potentials.   6. Components of a cell: Anode, cathode, electrolyte, and separator.   7. Types of cells: Primary vs. secondary cells (non-rechargeable vs. rechargeable).   8. Primary Cells (Non-Rechargeable)      1. Zinc-Carbon Cells: Construction, chemistry, and applications.      2. Alkaline Cells: Advantages over zinc-carbon, usage, and performance characteristics.      3. Comparison of common primary cells (e.g., lithium primary cells).      4. Performance limitations and efficiency of primary cells.      5. Environmental impact and disposal considerations for non-rechargeable batteries.      6. Hands-on lab: Testing the performance of different primary cells.   9. Secondary Cells (Rechargeable)      1. Lead-Acid Batteries: Chemistry, construction, and applications (e.g., automotive).      2. Nickel-Cadmium (NiCd) and Nickel-Metal Hydride (NiMH): Differences, pros, and cons.      3. Charging and discharging cycles of rechargeable cells.      4. Lithium-Ion Batteries: Working principles, construction, and applications.      5. Advantages of lithium-ion technology over older battery types.      6. Safety considerations: Overcharging, thermal runaway, and battery management systems.      7. Emerging Technologies: Solid-state batteries, lithium-sulphur, and other advancements.      8. Energy density and power density considerations in modern applications.      9. Batteries maintenance      10. Hands-on lab: Disassembling and examining a rechargeable battery.   10. Battery Performance and Characteristics       1. Battery capacity: Ampere-hour (Ah) ratings and energy content.       2. Factors affecting battery life: Temperature, charge/discharge rates, and cycling.       3. Internal resistance and its effect on performance.       4. Battery efficiency and energy losses.       5. State of charge (SOC) and depth of discharge (DOD).       6. Battery degradation and aging mechanisms.       7. Measuring battery parameters (voltage, current, capacity).       8. Testing techniques for battery health and performance.       9. Hands-on lab: Performance testing of different battery types.   11. Applications of Batteries       1. Batteries in consumer electronics (e.g., smartphones, laptops).       2. Automotive applications: Starting, lighting, and ignition (SLI) batteries.       3. Electric vehicles (EVs) and hybrid electric vehicles (HEVs): Battery requirements and challenges.       4. Industrial and grid storage applications.       5. Renewable energy integration: Solar and wind energy storage solutions.       6. Specialized applications: Medical devices, aerospace, and military.       7. Case studies on battery failure and safety incidents.       8. Discussion on regulations and standards for battery use.   12. Environmental Impact and Recycling       1. Environmental impact of battery production and disposal.       2. Strategies for reducing the ecological footprint of battery technologies.       3. Recycling processes for different types of batteries.       4. Government policies and regulations regarding battery disposal.       5. Advances in battery recycling technologies.   Hands-on lab: Exploring the recycling process and evaluating eco-friendly battery alternatives. |  |

**Suggested Methods of Instruction**

* Demonstration by trainer
* Practice by the trainee
* Field trips
* Discussions

**Recommended Resources for 25 Trainees**

|  |  |  |  |  |
| --- | --- | --- | --- | --- |
| **S/No.** | **Category/Item** | **Description/Specifications** | **Quantity** | **Recommended Ratio (Item: Trainee)** |
| **A** | **Learning Materials** |  |  |  |
| 1 | Textbooks | Comprehensive texts on electrical and control principle. | 5 pcs | 1:5 |
| 2 | Charts | Visual aids covering electrical theories and safety protocols | 10 pcs | 1:2.5 |
| 3 | PowerPoint Presentations | For trainer’s use, covering course content and practical applications | 1 | 1:25 |
| **B** | **Learning Facilities & Infrastructure** |  |  |  |
| 1 | Lecture/Theory Room | Equipped with projectors and seating for 25 trainees, ~60 sqm | 1 | 1:25 |
| 2 | Workshop | Hands-on training area with workbenches, tools, and safety equipment, ~80 sqm | 1 | 1:25 |
| 3 | Computer Laboratory | Equipped with testing setups for electrical experiments, ~50 sqm.  Equipped with computers installed with Circuit simulation software. | 25 | 1:1 |
|  |  |  |  |  |
| **C** | **Consumable Materials** |  |  |  |
| 1 | Electrical Wires | Assorted sizes and color-coded (e.g., 1.5mm², 2.5mm², 4mm²) | 5 rolls | 1:5 |
| 2 | Insulation Tapes | For securing connections and insulation, assorted colors | 25 pcs | 1:1 |
| 3 | Breadboard | For prototyping and testing circuits | 5 pcs | 1:5 |
| 4 | Sensors | Assorted types (temperature, pressure, proximity) | 10 pcs | 1:2.5 |
| 5 | Signal generators | For generating AC signals | 5pcs | 1:5 |
| 6 | Transducers | Assorted | 10 pcs | 1:3 |
| 7 | Electronic components | Resistors, transistors, capacitors, relays, transformers. Integrated IC, OPAM. | 100pcs | 4:25 |
|  |  |  |  |  |
| **D** | **Tools and Equipment** |  |  |  |
| 1 | Screwdrivers | Assorted sets for various applications | 2 sets | 1:12.5 |
| 2 | Side Cutters | For cutting wires and cables | 4 pcs | 1:6.25 |
| 3 | Pliers | For gripping and bending wires | 3 pcs | 1:8.33 |
| 4 | Stripping Knives | For stripping insulation from wires | 4 pcs | 1:6.25 |
| 5 | Computers | Equipped with electrical and electronics simulation software | 5 pcs | 1:5 |
| 6 | Multimeters | For measuring voltage, current, and resistance | 5 pcs | 1:5 |
| 7 | Clamp Meters | For measuring current flow in circuits | 5 pcs | 1:5 |
| 8 | Oscilloscope | For observing waveforms and signals | 1 | 1:25 |
| 9 | Voltmeter | For measuring voltage | 1 | 1:25 |
| 10 | Ammeter | For measuring current | 1 | 1:25 |
| 11 | Signal Generator | For generating electrical signals for testing | 1 | 1:25 |
| 12 | Soldering gun | For soldering | 10 | 1:3 |
| 13 | Soldering wire | For making joints in electrical circuits | 10 | 1:3 |
| 14 | PLC | For program practice | 5 | 1:5 |
| 15 | Cells and batteries | For learning | 5 | 1:5 |
|  |  |  |  |  |
| **E** | **PPE (Personal Protective Equipment)** |  |  |  |
| 1 | PPE Sets | Includes helmets, gloves, safety goggles, shoes, and harnesses | 25 sets | 1:1 |
| 2 | Safety Signs and Barriers | For simulating safety zones and hazards | 10 sets | 1:2.5 |
| 3 | Earthing Test Kits | For ground testing and demonstrating earthing procedures | 5 pcs | 1:5 |
| 4 | Electrical Test Benches | For hands-on testing of functionality and circuit design | 5 pcs | 1:5 |
|  |  |  |  |  |
| **F** | **Reference Materials** |  |  |  |
| 1 | Industrial Automation Manuals | Covering principles and practices in automation | 25 pcs | 1:1 |
| 2 | Electrical Standards | Reference on industry standards (e.g., IEEE Guidelines) | 5 pcs | 1:5 |
| 3 | Technical Handbooks | On motors, drives, and wiring systems | 25 pcs | 1:1 |
| 4 | Training Presentations/Slides | Digital format for shared access among trainees | 1 | 1:25 |
| 5 | Multimedia Learning Modules | Digital licenses for videos and tutorials | 25 pcs | 1:1 |
| 6 | Practical Assessment Guides | Worksheets for practical assessments | 25 pcs | 1:1 |

**Suggested Methods of Instruction**

* Group discussions
* Demonstration by trainer
* Exercises by trainee

**Recommended Resources**

* Scientific Calculators
* Relevant reference materials
* Stationeries
* Electrical workshop
* Relevant practical materials

## ELECTRICAL DRIVES INSTALLATION AND MAINTAINANCE

**UNIT CODE: 0714 551 16A**

**Relationship to Occupational Standards**

This unit addresses the unit of competency: Install and Maintain Electrical Drives

**Duration of Unit:** 180 hours.

**Unit Description**

This unit covers the competencies required in installation and maintenance electrical drives. It equips the trainee with skills and knowledge necessary to conduct electrical drives systems site survey, plan electrical drives system installation, install electrical drives and maintain electrical drives.

**Summary of Learning Outcomes**

By the end of the Unit of Learning, the trainee will be able to;

|  |  |  |
| --- | --- | --- |
| S/No | Learning Outcome | **Duration (Hrs.)** |
| 1 | Conduct electrical drives site survey | **40** |
| 2 | Plan electrical drives installation | **40** |
| 3 | Install electrical drives | **50** |
| 4 | Maintain electrical drives | **50** |
|  | **TOTAL HOURS** | **180** |

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

| **Learning Outcome** | **Content** | **Suggested Assessment Methods** |
| --- | --- | --- |
| 1. Conduct electrical drives site survey | * 1. Assessing site survey aspects      1. Cable Power requirements      2. User requirements      3. Environmental considerations      4. Cable routes      5. Instrumentation systems      6. Compatibility with existing systems      7. Scalability      8. Cost   2. Site Survey Tools and Equipment      1. Tape measures,      2. Infrared thermometers,      3. Multimeters      4. Data collection with cameras and report generation   3. Site survey   4. Site survey report. | * Project * Practical * Third party report * Portfolio of evidence * Written tests * Oral questioning |
| 1. Plan electrical drives installation | * 1. Introduction to electrical drives      1. Basics of electrical drives      2. Definition and types of electrical drives      3. Applications in industry      4. Overview of drive components (motors, controllers, sensors)   2. Electrical Motors      1. AC and DC drives      2. Servo motor drives      3. Stepper motors      4. Types of AC motors (synchronous, induction)      5. Types of DC motors (series, shunt, compound)      6. Motor selection criteria   3. Motor characteristics      1. Speed-torque characteristics      2. Efficiency and performance parameters   4. Power electronics for drives      1. Power electronic devices      2. Introduction to semiconductors (solid state devices)      3. Inverters and converters in drive applications   5. Control techniques      1. Pulse Width Modulation (PWM)      2. Vector control and direct torque control      3. Variable speed control      4. Variable frequency control   6. Types of electrical drives system designs.   7. Designing electrical drive systems      1. Configuration of drive ratings to match motor specifications (HP, voltage)   8. Installation layout      1. Interpretation of circuit diagrams and panel layouts.      2. Components placement. (drives, control panels, sensors)   9. Workplan preparation      1. Tasks in workplan preparations         1. Mounting         2. Wiring         3. Testing      2. Resource allocation: manpower, tools, materials   10. Assembling supplies       1. Identification of required materials          1. Electrical drives          2. Cables          3. Protection devices and switchgear          4. Distribution board          5. Enclosures          6. Earthing rods, clamps          7. Installation tools and equipment          8. Connectors and terminals          9. Conduits          10. Raceways          11. Fasteners       2. Compatibility of components   11. Practice: Plan electrical drives installation | * Project * Practical * Third party report * Portfolio of evidence * Written tests * Oral questioning |
| 1. Install electrical drives | * 1. PPE, health and safety      1. Helmet      2. Hand gloves      3. Safety shoes      4. Harness      5. Safety goggles   2. Structured wiring      1. Cable routing      2. Cable laying      3. Cable labelling   3. Importance of structured wiring.   4. Types of structured wiring   5. Mounting equipment and accessories      1. Accessories         1. Terminal blocks         2. Switches         3. Sockets         4. Push buttons         5. Safety interlocks         6. Relays         7. Contactors         8. Sensors      2. Equipment         1. Enclosures         2. Switchgear         3. Distribution panel         4. Control panels         5. Electrical drives      3. Safety precautions while handling accessories and equipment.      4. Tools used in installation of electrical drives.   6. Cable termination      1. Stripping      2. Crimping      3. Safe wire connections   7. System testing      1. Electrical continuity test      2. Insulation resistance tests      3. Phase sequence and polarity checks for three-phase systems   8. Calibration process   9. Housekeeping measures undertaken in electrical drive installation.   10. Waste disposal in electrical drive installation.       1. Packaging materials       2. Stripped cable insulation       3. Faulty components and equipment   11. Practice: Install electrical drives | * Project * Practical * Third party report * Portfolio of evidence * Written tests * Oral questioning |
| 1. Maintain electrical drives | * 1. Maintenance scheduling      1. Preventive maintenance calendars.      2. Frequent checks   2. Tools, equipment, and spares      1. Diagnostic tools (Multimeters, clamp meters) for troubleshooting      2. Spare parts;         1. Controllers,         2. Circuit breakers   3. Maintenance tasks      1. Inspection for wear and tear         1. bearings         2. wiring         3. connectors      2. Testing drives for abnormal noise, vibrations, and overheating      3. Cleaning dust and debris from cooling fans and heat sinks      4. Lubrication of moving parts (bearings, motors)   4. Maintenance report      1. Documentation of maintenance activities and results.      2. Logs for equipment performance and issues   5. Practical: Maintain installed electrical drives | * Project * Practical * Third party report * Portfolio of evidence * Written tests * Oral questioning |

**Suggested Delivery Methods**

* Group discussions
* Demonstration by trainer
* Online videos
* Power point presentation

**Recommended Resources for 25 Trainees**

|  |  |  |  |  |
| --- | --- | --- | --- | --- |
| **S/No.** | **Category/Item** | **Description/Specifications** | **Quantity** | **Recommended Ratio (Item: Trainee)** |
| **A** | **Tools** | | | |
|  | Multimeters | Digital multimeters for measuring voltage, current, and resistance | 5 pcs | 1:5 |
|  | Clamp Meters | For measuring electrical current, shared between trainees | 5 pcs | 1:5 |
|  | Cable Strippers | For removing insulation from wires | 25 pcs | 1:1 |
|  | Crimping Tools | For terminating electrical connectors | 5 pcs | 1:5 |
|  | Insulated Screwdriver Sets | Comprehensive set for safe handling of electrical components | 5 sets | 1:5 |
|  | Torque Wrenches | For tightening terminals accurately, shared among trainees | 2 sets | 2:25 |
|  | Tape Measures | 5m tape measures for measuring cable routes and components | 5 pcs | 1:5 |
|  | Laser Distance Meters | For precise distance measurements, shared between trainees | 5 pcs | 1:5 |
|  | Flashlights/Headlamps | For working in dark or tight spaces | 5 pcs | 1:5 |
|  | Ladders | For elevated installations, shared among trainees | 5 pcs | 1:5 |
|  | Cable Pulling Equipment | For drawing cables | 5 pcs | 1:5 |
| **B** | **Learning Facilities & Infrastructure** | | | |
|  | Lecture/Theory Room | Approximately 60 sqm | 1 | 1:25 |
|  | Workshop | Approximately 80 sqm | 1 | 1:25 |
|  | Laboratory | Approximately 80 sqm | 1 | 1:25 |
|  |  |  |  |  |
| **C** | **Materials and Supplies** | | | |
|  | Electrical Cables (Various Gauges) | For wiring practice | Adequate |  |
|  | Cable Ties | For bundling and organizing wires | Adequate |  |
|  | Electrical Tape (Insulating) | For insulating and securing wires | Adequate |  |
|  | Wire Connectors (Various Types) | For connecting wires during practice | Adequate |  |
|  | Earthing Rods and Clamps | For grounding practice, one set per trainee | 5 sets | 1:5 |
|  | Conduits (PVC or Metal) | For structured wiring exercises | Adequate |  |
|  | Fasteners (Nuts, Bolts, Washers) | For assembling electrical drives and panels | Adequate |  |
|  | Distribution Boards | One per trainee for installation practice | 5 pcs | 1:5 |
|  | Terminal Blocks | For wire terminations in control panels | Adequate |  |
|  |  |  |  |  |
| **C** | **Equipment** | | |  |
|  | Variable Frequency Drives (VFDs) | For hands-on installation, shared among trainees | 2 units | 2:25 |
|  | Servo Motor Drives | For practical exercises, shared among trainees | 5 pcs | 1:5 |
|  | Control Panels | For practical exercises, shared among trainees | 5 pcs | 1:5 |
|  | Power Analyzers | For power analysis during site surveys, shared among trainees | 2 units | 2:25 |
|  | Personal Computers (PCs) | Shared for drive configuration and software use | 5 pcs | 1:5 |
|  | Megohmmeters | For testing insulation resistance, shared among trainees | 5 units | 1:5 |
|  | Personal Protective Equipment (PPE) | For personal protection | 25 sets | 1:1 |
|  | DC motors | 24v | 5 pcs | 1:5 |
|  | Induction motors | 240/415v | 5 pcs | 1:5 |
|  | Motor rewinding kit | For rewinding motor’s field coils. | 1pc | 1:25 |
|  |  |  |  |  |
| **D** | **Informed Equipment** | | | |
|  | Oscilloscopes | For troubleshooting and testing electrical drives, shared | 2 units | 2:25 |
|  | Drive Configuration Software | Installed on PCs, shared among groups for configuring drives | 1license |  |
|  | Lifting Gear | For handling heavy equipment, shared among all trainees | 2 units | 2:25 |
|  | Vibration Analyzers | For drive diagnostics, shared among trainees | 5 units | 1:5 |
|  |  |  |  |  |
| **E** | **Reference Materials** | | | |
|  | Electrical Drive Manuals | For drives parameters reference | 25 copies | 1:1 |
|  | IEEE Electrical Standards Handbooks | For reference | 1 copy | 1:25 |
|  | Occupational Health and Safety Guides | For reference | 5 copies | 1:5 |
|  | Wiring Diagram Posters | For illustrating wiring standards | 4 posters | 4:25 |

MODULE SEVEN

## COMPUTER AIDED DRAWING

**UNIT CODE:** 0732 551 08A

**UNIT DURATION: 150 HOURS**

**Relationship to occupational standards**

This unit addresses the unit of competency: perform computer aided drawing.

**Unit description**

This unit covers the competences required to perform computer aided drawing. It involves: navigating CAD software, producing geometric, pictorial, orthographic and assembly drawings, and designing mechanical components.

**Summary of learning outcomes**

By the end of the unit of learning, the trainee will be able to;

|  |  |  |
| --- | --- | --- |
| S/No | Learning Outcome | **Duration (Hrs.)** |
| 1 | Navigate CAD software | **25** |
| 2 | Produce geometric drawings | **25** |
| 3 | Produce pictorial drawings | **25** |
| 4 | Produce orthographic drawings. | **25** |
| 5 | Produce assembly drawings | **25** |
| 6 | Design mechanical components | **25** |
|  | **TOTAL HOURS** | **150** |

**Learning outcomes, content and suggested assessment methods**

|  |  |  |
| --- | --- | --- |
| **Learning outcome** | **Content** | **Suggested assessment methods** |
| 1. Navigate CAD software | * 1. Overview of CAD      1. Definition and significance of CAD in engineering and design.      2. Historical development of CAD technologies.   2. Computing equipment and Software      1. Identify hardware requirements for CAD operations.      2. List popular CAD software options (e.g., AutoCAD, SolidWorks, Inventor).   3. Drawing CAD Software      1. Overview of the software interface.      2. Functions and capabilities of CAD tools.   4. CAD software templates      1. Explore various templates available for different drawing requirements.   5. Importing CAD Files      1. Process of importing files (DWG, STL, DXF, STEP) into the working space.   6. User interface navigation      1. Familiarization with the CAD software interface.      2. Understanding toolbars, menus, and command lines.   7. Setting up the drawing environment      1. Units and measurement settings.      2. Creating a new drawing and saving files.   8. Symbols, codes, and standards      1. Identify relevant symbols and codes according to software functionality.   9. Understand and utilize drawing elements      1. Points      2. Line angles      3. Circles and arcs      4. Planes (horizontal, vertical)      5. Figures and solids      6. Shapes      7. Objects snapping settings      8. Polar tracking settings.      9. Orthomode utilization   10. Use editing commands editing tools       1. Delete, undo and redo commands       2. Fillet and chamfer commands       3. Trim, extend and break commands       4. Zoom and pan commands       5. Move, copy, and paste commands       6. Rotate and mirror commands       7. Object snapping and grouping commands       8. Dimension and scaling commands | 1. Written tests 2. Oral Questioning 3. Portfolio of evidence |
| 1. Produce geometric drawings | * 1. Setting drawing lines      1. Recognize standard drawing line conventions      2. Dimension lines      3. Hidden detail lines      4. Extension lines      5. Section lines      6. Break lines      7. Chain   2. Using drawing lines   3. Constructing types of angles      1. Use trigonometry principles to construct acute, obtuse, and right angles.   4. Constructing geometrical forms      1. Create circles, rectangles, triangles, and polygons according to standards.   5. Developing geometric drawings      1. 2-Dimensional      2. Orthographic      3. Isometric |  |
| 1. Produce pictorial drawings | * 1. Drawing symbols and abbreviations      1. Apply standard drawing symbols and abbreviations in pictorial drawings.   2. Producing pictorial drawings      1. Techniques for creating isometric, oblique, cabinet, and cavalier drawings.   3. Saving pictorial drawings      1. Procedures for saving drawings in appropriate formats. |  |
| 1. Produce orthographic drawings. | * 1. Fundamentals of orthographic projection      1. Definition and importance of orthographic drawing.      2. Differences between orthographic and other drawing types (isometric, perspective).   2. Types of orthographic projections      1. First-angle projection.      2. Third-angle projection.   3. Understanding views      1. Front, top, and side views.      2. Additional views (sectional, auxiliary).   4. First angle orthographic drawings      1. Develop first-angle drawings adhering to standard conventions.   5. Third angle orthographic drawings      1. Create third-angle drawings based on standard practices.   6. Saving orthographic drawings      1. Techniques for properly saving orthographic drawings.   7. Dimensioning orthographic views   8. Printing orthographic views   9. Creating isometric drawing      1. Choosing isometric cursor      2. Dimensioning isometric drawing      3. Printing isometric drawing   10. Creating 3D model       1. Choosing 3D workspace       2. 3D workspace modifying tool (3D orbit, 3D mirrors, union, extrude, press pull, etc.)       3. Rendering       4. Printing 3D models |  |
| 1. Produce assembly drawings | * 1. Overview of assembly drawings      1. Definition and purpose of assembly drawings.      2. Importance in manufacturing and engineering.   2. Types of assembly drawings      1. General assembly drawings vs. detailed assembly drawings.      2. Exploded view vs. isometric assembly drawings.   3. Exploding orthographic views      1. Techniques for exploding views in accordance with standard conventions.   4. Exploding pictorial views      1. Create exploded pictorial views based on drawing specifications.   5. Assembling views      1. Assemble orthographic and pictorial views accurately.   6. Producing sectional views      1. Generate sectional views according to drawing standards.   7. Developing parts list      1. Creating a parts list based on the drawing schematic. |  |
| 1. Design mechanical components | * 1. Designing mechanical components      1. Apply CAD principles to design mechanical components per work requirements.   2. Applying CAE in simulation      1. Use computer-aided engineering tools for simulating mechanical designs.   3. Determining improvements      1. Analyze design results to identify efficiency improvements.   4. Creating a manufacturing database      1. Develop a database to support the manufacturing process.   5. Improving design documents      1. Make enhancements to design documents based on manufacturing feedback. |  |

**Suggested Delivery Methods**

* Demonstration
* Group discussions
* Online training
* Direct instructions
* Simulation

**Recommended resources for 30 trainees**

|  |  |  |  |  |
| --- | --- | --- | --- | --- |
| **S/No.** | **Category/item** | **Description/specifications** | **Quantity** | **Recommended ratio (item**  **)** |
| **A** | **Learning materials** | | | |
|  | Textbooks | Comprehensive texts on CAD basics, history, and hardware requirements. | 5 pcs | 1:5 |
|  | Charts | Visual aids covering CAD software evolution and industry applications. | 10 pcs | 1:2.5 |
|  | PowerPoint Presentations | For trainer’s use, covering CAD definitions, history, and hardware requirements. | 1 | 1:25 |
| **B** | **Learning Facilities & Infrastructure** | | | |
|  | Lecture/Theory Room | Equipped with projector, seating for 25 trainees, ~60 sqm. | 1 | 1:25 |
|  | Computer Laboratory | Equipped with 25 computers installed with CAD software, ~80 sqm. | 25 | 1:1 |
|  | Printer/plotter | For printing CAD drawings | 2 | 1:13 |
|  | 3D printer | For printing 3D models | 2 | 1:13 |
|  | 3D printer filament | 3D printing material | 2 rolls | 1:13 |
| **C** | **Consumable Materials** | | | |
|  | USB Drives | For storing and transferring CAD project files. | 25 pcs | 1:1 |
|  | Notebooks | For trainees to take notes during CAD sessions. | 25 pcs | 1:1 |
| **D** | **Tools and Equipment** | | | |
|  | Computers | Equipped with CAD software and compatible hardware (e.g., high RAM, graphics support). | 25 pcs | 1:1 |
|  | Projector | For displaying CAD software demonstrations and presentations in lecture room. | 1 | 1:25 |
|  | External Hard Drives | For backing up CAD files and course materials. | 5 pcs | 1:5 |
|  | Drawing Tablets | For CAD software use, supporting stylus input for design precision. | 5 pcs | 1:5 |
| **E** | **Reference Materials** |  |  |  |
|  | CAD Software Manuals | Documentation detailing CAD software functionalities and hardware requirements. | 25 pcs | 1:1 |
|  | CAD Industry Case Studies | Case studies showcasing CAD applications in engineering and design. | 5 pcs | 1:5 |
|  | Practical Assessment Guides | Worksheets for practical assessments on CAD navigation and hardware requirements. | 25 pcs | 1:1 |
|  | Training Presentations/Slides | Digital format for shared access among trainees covering CAD course content. | 1 | 1:25 |

## PROGRAMMABLE LOGIC CONTROLLERS’ INSTALLATION AND MAINTANANCE

**UNIT CODE:** **0714 551 17A**

**Relationship to Occupational Standards**

This unit addresses the unit of competency: Install and Maintain Programmable Logic Controllers

**Duration of Unit: 220 hours**

**Unit Description**

This unit covers the competencies required in installation and maintenance of programmable logic controller according to design and installation considerations for Programmable Logic Controller systems (PLC) based control systems. It puts into consideration conducting site survey, developing PLC programs, planning programmable logic controllers’ installation, installing planning programmable logic controllers and maintaining programmable logic controllers

**Summary of Learning Outcomes**

By the end of the Unit of Learning, the trainee will be able to;

|  |  |  |
| --- | --- | --- |
| S/No | Learning Outcome | **Duration (Hrs.)** |
| 1 | Conduct programmable logic controller site survey | **40** |
| 2 | Develop PLC Program | **50** |
| 3 | Plan Programmable Logic Controllers installation | **40** |
| 4 | Maintain PLC system | **45** |
| 5 | Maintain Programmable Logic Controllers | **45** |
|  | **TOTAL HOURS** | **220** |

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

| **Learning Outcome** | **Content** | **Suggested Assessment Methods** |
| --- | --- | --- |
| 1. Conduct programmable logic controller site survey | * 1. Programmable Logic Controllers sitesurvey aspects      1. Power requirement analysis      2. User requirements      3. Electrical protection requirements      4. Environmental considerations      5. Cable routes      6. Instrumentation systems      7. Compatibility with existing systems      8. Scalability      9. Cost   2. Uses of Site survey tools and equipment      1. Tools         1. Tape measure         2. Laser meter         3. Camera         4. Multimeters         5. Stationery         6. Infrared thermometer         7. Cable tracer         8. Ladder         9. Flashlight      2. Equipment         1. Power analyser         2. Megohmmeter      3. Maintenance tools and equipment   3. Practical on-site survey.   4. Site survey report. | * Oral assessment * Portfolio of evidence * Interviews * Third party report * Written assessment * Oral assessment * Portfolio of evidence * Interviews * Third party report * Written assessment * Practical assessment * Projects |
| * 1. Develop PLC Program | * 1. Process requirements      1. PLC architecture      2. Definition of objectives:      3. Identification of Inputs and Outputs (I/O)      4. Sequence of operations      5. Safety requirements:   2. Programming language      1. Ladder Logic (LD)      2. Function Block Diagram (FBD)      3. Structured Text (ST)      4. Sequential Function Chart (SFC)      5. Instruction List (IL)   3. Development of control program   4. Testing and debugging      1. Testing PLC code      2. Debugging PLC code.   2.5 Practice: Developing PLC program | * Oral assessment * Portfolio of evidence * Interviews * Third party report * Written assessment * Practical assessment * Projects |
| * 1. Plan programmable Logic Controllers installation | * 1. PLC system design   2. PLC installation work plan   3. Specifications of PLC system supplies      1. Cables      2. Protection devices and switchgear      3. Distribution board      4. Enclosures      5. Rails      6. Programmable logic controllers      7. Electrical tools and equipment      8. Connectors and terminals      9. Trunking      10. Raceways      11. Fasteners   4. Practice: Hands-on tasks for PLC installation planning | * Oral assessment * Portfolio of evidence * Interviews * Third party report * Written assessment * Practical assessment * Projects |
| 4. Install Programmable Logic Controllers | * 1. PLC network cables      1. Types of Cables         1. Ethernet cable         2. USB Cable         3. Serial Cable         4. Profinet cables         5. Profibus cables         6. Coaxial cables         7. Fibre optic cables   2. Wiring and cable management      1. Power wiring      2. I/O wiring      3. Communication wiring   3. Mounting PLC accessories and equipment      1. Accessories         1. Memory modules         2. Expansion modules         3. Communication adapters         4. Input and output modules         5. Human machine interfaces         6. Sensors and transducers         7. Programmable logic controllers         8. Power supplies         9. Mounting hardware         10. Enclosures         11. Surge protectors         12. Terminal blocks         13. Interlocks         14. Safety relays      2. Equipment’s         1. Field devices         2. Power supplies         3. Enclosures and racks         4. Signal conditioners         5. Human machine interface panels         6. Safety devices   4. PLC system wires termination.      1. Wire labelling      2. Termination of PLC I/O cables      3. Grounding and shielding   5. Testing and verification of PLC      1. Power-On test      2. Signal testing:      3. Communication test:      4. Functionality test      5. Electrical continuity test      6. Electrical resistance test   6. PLC calibration   7. PLC site wastes disposal      1. Packaging material      2. Stripped cable insulation      3. Faulty components and equipment   8. Practice: Hands-on tasks for PLC installation. | * Oral assessment * Portfolio of evidence * Interviews * Third party report * Written assessment * Practical assessment * Projects |
| 1. Maintain Programmable Logic Controllers | * 1. PLC maintenance tools, equipment, and spares.      1. Tools         1. Multimeters         2. Clamp meters         3. Hand tools         4. Thermometer      2. Equipment         1. Personal computer         2. Signal generators         3. Blower      3. Spares         1. Circuit breakers         2. Programmable logic controllers         3. HMI         4. Switches         5. Relays         6. Power supplies         7. Interface cards   2. PLC maintenance      1. Troubleshooting the PLC      2. PLC maintenance tools      3. Cleaning PLC modules      4. Testing PLC modules   3. Monitoring system performance.   4. Periodic program review.   5. program back up   6. Practice: Hands-on tasks for PLC maintenance | * Oral assessment * Portfolio of evidence * Interviews * Third party report * Written assessment * Practical assessment * Projects |

**Suggested Delivery Methods**

* Group discussions
* Demonstration by trainer
* Online videos
* Power point presentation

**Recommended Resources for 25 trainees**

|  |  |  |  |  |
| --- | --- | --- | --- | --- |
| **S/No.** | **Category/Item** | **Description/Specifications** | **Quantity** | **Recommended Ratio (Item: Trainee)** |
| **A** | **Tools** |  |  |  |
|  | Ethernet Crimping Tools | For terminating Ethernet cables, ensuring reliable connections | 5 pcs | 1:5 |
|  | Assorted Screwdriver Sets | For driving screws | Adequate |  |
|  | Wrench Sets | Adjustable wrenches for various sizes of nuts and bolts | 2 sets | 2:25 |
|  | Clamp Meters | For measuring current flow, essential for troubleshooting | 5 pcs | 1:5 |
|  | PLC Programming Software | For programming and simulating PLC applications | 1 license |  |
|  | Professional Testers | For testing electrical and electronic parameters | 5 pcs | 1:5 |
|  | Continuity Testers | To check electrical continuity in circuits | 5 pcs | 1:5 |
|  | LAN Cable Testers | For testing Ethernet cable integrity and connection | 5 pcs | 1:5 |
|  | Phone Line Testers | For testing telephone line connectivity | 5 pcs | 1:5 |
| **B** | **Learning Facilities & Infrastructure** | | | |
|  | Lecture/Theory Room | Approximately 60 sqm | 1 | 1:25 |
|  | Workshop | Approximately 80 sqm | 1 | 1:25 |
|  | Laboratory | Approximately 80 sqm | 1 | 1:25 |
|  |  |  |  |  |
| **C** | **Materials and Supplies** | | | |
|  | PLC Cables and Wires | 5 meters of various PLC cables and wires for installation | Adequate |  |
|  | Electrical Wires and Cables | 5 meters of assorted wires for general projects | Adequate |  |
|  | Bolts and Nuts | Sufficient quantity for various assembly tasks | Adequate |  |
|  | Insulation Tape | For securing electrical connections and insulation | Adequate |  |
|  | Fasteners | For mounting and securing equipment | Adequate |  |
|  | Component Manuals | Detailed manuals for various PLC components | 2 pcs | 2:25 |
|  | PPE | For personal protection | 25 pcs | 1:1 |
| **D** | **Equipment** | | | |
|  | PLC Controllers | PLC controllers for practical programming and testing | 2 pcs | 2:25 |
|  |  |  |  |  |
|  | Multi-meters | For measuring voltage, current, and resistance | 5 pcs | 1:5 |
|  | Multi-purpose Network Cable Testers | For testing various network cable types | 2 pcs | 2:25 |
|  | Laptops | Equipped with PLC programming software | 1 pc | 1:25 |
|  | Racks for Mounting PLC Modules | For organizing and securely mounting PLC components | 8 pcs | 8:25 |
|  | Computers with PLC Programming Software | Each computer equipped with programming software | 25 pcs | 1:1 |
|  |  |  |  |  |
| **F** | **Reference Materials** | | | |
|  | PLC Programming Books | Comprehensive texts covering PLC programming concepts | 5 pcs | 1:5 |
|  | Installation, Maintenance, and Operational Manuals | Essential guides for equipment operation and maintenance | Adequate |  |
|  | Online Learning Materials | Access to journals, websites, and whitepapers for further study |  |  |

MODULE EIGHT

## DISTRIBUTED CONTROL SYSTEMS INSTALLATION AND MAINTAINANCE

**UNIT CODE: 0714 551 18A**

**Relationship to occupational standards**

This unit addresses the unit of competency: Install and maintain distributed control systems

**Duration of unit: 240 hours**

**Unit description**

This unit equips an individual with the competencies required in installation and maintenance of distributed control systems (DCS). These competencies include conducting DCS system site survey, planning DCS installation, installing DCS and maintaining DCS.

**Summary of learning outcomes**

By the end of the unit of learning, the trainee will be able to;

|  |  |  |
| --- | --- | --- |
| S/No | Learning Outcome | **Duration (Hrs.)** |
| 1 | Conduct distributed control system site survey | **60** |
| 2 | Plan distributed control system installation | **60** |
| 3 | Install distributed control system | **60** |
| 4 | Maintain distributed control system | **60** |
|  | **TOTAL HOURS** | **240** |

**Learning outcomes, content and suggested assessment methods**

| **Learning outcome** | **Content** | **Suggested assessment methods** |
| --- | --- | --- |
| 1. Conduct distributed control system site survey | * 1. Site survey aspects      1. Power requirements      2. User requirements      3. Communication infrastructure      4. Environmental considerations      5. Cable routes      6. Instrumentation systems      7. Compatibility with existing systems      8. Scalability      9. Reliability      10. Cost   2. Assembling survey tools and   equipment   * + 1. Tools        1. Tape measure        2. Laser distance meter        3. Camera        4. Multimeter        5. Stationery        6. Infrared thermometer        7. Cable tracer        8. Ladder        9. Flashlight     2. Equipment        1. Power analyser        2. Megohmmeter     3. Personal computer Classifications of tools used.     4. Importance of tools and Equipment     5. Safety precautions of tools and equipment.   1. Performing the site survey      1. Conducting measurements      2. Evaluating site conditions   2. Generating the site survey report      1. Documenting findings      2. Presenting data per workplace procedures | * Oral assessment * Portfolio of evidence * Interviews * Third party report * Written assessment * Oral assessment * Portfolio of evidence * Interviews * Third party report * Written assessment * Practical assessment * Projects |
| 1. Plan distributed control system installation | * 1. Introduction to distributed control systems      1. Overview of DCS      2. Definition and key components      3. DCS vs. PLC vs. SCADA      4. Applications in various industries   2. DCS Architecture      1. System components      2. Control processors, I/O modules, and field devices      3. Human-machine interface (HMI)      4. Communication networks   3. Control strategies      1. Feedback and feedforward control      2. Distributed vs. centralized control   4. Installation design.      1. Project specifications      2. Integrating user requirements   5. Preparing the installation work plan      1. Timelines for workplan      2. Allocating resources   6. Installation Supplies      1. Identifying necessary equipment      2. Safety precautions to consider.      3. Uses and operations of Installation supplies.   7. Practice: Plan distributed control system installation | * Oral assessment * Portfolio of evidence * Interviews * Third party report * Written assessment * Practical assessment * Projects |
| 1. Install distributed control system | * 1. Usage of personal protective equipment (PPE)      1. Helmet      2. Hand gloves      3. Safety shoes      4. Harness      5. Safety goggles   2. Structured wiring      1. Cable routing and laying      2. Cable labelling practices   3. Accessories and equipment mounting      1. Accessories         1. Terminal blocks         2. Switches         3. Sockets         4. PLCs         5. Displays         6. Safety interlocks         7. Relays         8. Contactors         9. Sensors.      2. Equipment         1. Enclosures         2. Switchgear         3. Distribution panel         4. Control panels         5. PLCs         6. Electrical drives   4. Terminating wires      1. Connecting cables as per layout.   5. Conducting system tests      1. Functionality tests      2. Electrical continuity and safety   6. Site Housekeeping and waste disposal      1. Packaging material      2. Stripped cable insulation      3. Faulty components and equipment   7. Practical installation of a DCS in a controlled environment | * Oral assessment * Portfolio of evidence * Interviews * Third party report * Written assessment * Practical assessment * Projects |
| 1. maintain distributed control system | * 1. Maintenance schedule      1. Maintenance frequency      2. Maintenance tasks   2. Usage of maintenance tools and equipment.   Types of tools used.   * + 1. Spares tools     2. Multimeters     3. Clamp meters     4. Power analysers     5. Hand tools   equipment   * + 1. Lifting gear     2. Cable pulling equipment     3. Blower     4. Megohmmeter   Spares   * + 1. PLCs     2. Electrical drives     3. Interface cards     4. Stand-alone controllers     5. Switches     6. Sockets     7. Luminaires     8. Power electronic components     9. Indicator lights   1. Carrying out maintenance tasks      1. Performing inspections and tests      2. Conducting cleaning and tightening      3. Replacing faulty components   2. Preparing maintenance reports      1. Documenting maintenance activities.      2. Communicating findings to stakeholders   3. Hands-on installation and maintenance      1. Practical installation of a DCS in a controlled environment      2. Simulated troubleshooting and maintenance scenarios   4. Practice: maintenance of a DCS in a controlled environment | * Oral assessment * Portfolio of evidence * Interviews * Third party report * Written assessment * Practical assessment * Projects |

**Suggested delivery methods**

* Direct instruction method
* Group discussions

**Recommended resources for 25 trainees**

|  |  |  |  |  |
| --- | --- | --- | --- | --- |
| **S/No.** | **Category/item** | **Description/specifications** | **Quantity** | **Recommended ratio (item: trainee)** |
| **A** | **Tools** | | | |
|  | Multimeters | Digital multimeters for measuring voltage, current, and resistance | 5 pcs | 1:5 |
|  | Clamp meters | For measuring electrical current | 5 pcs | 1:5 |
|  | Power analyzers | For analyzing power quality and consumption | 5 pcs | 1:5 |
| **B** | **Learning facilities & infrastructure** | | | |
|  | Lecture/theory room | Approximately 60 sqm | 1 | 1:25 |
|  | Workshop | Approximately 80 sqm | 1 | 1:25 |
|  | Laboratory | Approximately 80 sqm | 1 | 1:25 |
|  |  |  |  |  |
| **B** | **Materials and supplies** | | | |
|  | Indicator lights | For visual feedback in control systems | 10 pcs | 2:5 |
|  | Field devices | Various devices used in field applications | 10 pcs | 2:5 |
|  | Overalls | Protective clothing for trainees | 25 pcs | 1:1 |
|  | Safety boots | Protective footwear for safety during training | 25 pairs | 1:1 |
|  | Safety glasses | Eye protection during practical activities | 25 pcs | 1:1 |
|  | Helmets | Head protection for safety | 25 pcs | 1:1 |
|  |  |  |  |  |
| **C** | **Equipment** | | | |
|  | PLC controllers | For hands-on programming and control exercises | 4 unit | 4:25 |
|  | DCS training kits | Complete training setups for distributed control systems | 1 unit | 1:25 |
|  | Demo hardware panels | For practical demonstrations and hands-on training | 1 unit | 1:25 |
|  | DCS controllers | For controlling distributed systems in training | 5 units | 1:5 |
|  | DCS Simulation Software | Software for simulating DCS operations | 1 license | N/A |
|  | Computer workstations | Complete workstation setup for each trainee with DCS software | 25 pcs | 1:1 |
|  | Sensors | Assorted | 10 | 2:5 |
|  | Actuator | Assorted | 10 | 2:5 |
|  |  |  |  |  |
| **D** | **Equipment** |  |  |  |
|  | Network equipment | For networking and communication in training setups | 4 units | 4:25 |
|  | Cable pulling equipment | To assist with installation and cable management | 2 units |  |
|  | Blowers | For cooling and ventilation during training | 4 units | 4:25 |
|  | Megohmmeters | For insulation resistance testing | 5 units | 1:5 |
|  | Computers/workstations | 25 computers with DCS simulation software installed for hands-on training | 25 pcs | 1:1 |
|  |  |  |  |  |
| **E** | **Reference materials** | | | |
|  | DCS textbooks | Comprehensive textbooks covering DCS theory and applications | Adequate |  |
|  | DCS vendor documentation | Manuals and guides from DCS equipment manufacturers | Adequate |  |
|  | Installation, maintenance, and operational manuals | For practical guidelines on equipment use and maintenance | Adequate |  |
|  | Online learning materials | Journals, websites, and whitepapers for additional resources | Adequate |  |

## INDUSTRIAL ROBOTIC SYSTEM INSTALLATION AND MAINTENANCE

**UNIT CODE:** 0714 551 19A

**Relationship to occupational standards**

This unit addresses the unit of competency: Install and maintain industrial robotic systems

**Duration of unit:** 220 hours.

**Unit description**

This unit covers the competencies required in installation and maintenance of industrial robotic systems according to the design considerations and installation standards. These competencies include; conducting industrial robotic system site survey, developing robot programs, planning industrial robotic system installation, installing industrial robotic system, and maintaining industrial robotic systems.

**Summary of learning outcomes**

By the end of the unit of learning, the trainee will be able to;

|  |  |  |
| --- | --- | --- |
| S/No | Learning Outcome | **Duration (Hrs.)** |
| 1 | Conduct industrial robotic systems site survey | **40** |
| 2 | Develop robot programs | **50** |
| 3 | Plan industrial robotic systems installation | **40** |
| 4 | Install industrial robotic system | **50** |
| 5 | Maintain industrial robotic systems | **40** |
|  | **TOTAL HOURS** | **220** |

**Learning outcomes, content and suggested assessment methods**

| **Learning outcome** | **Content** | **Suggested assessment methods** |
| --- | --- | --- |
| 1. Conduct industrial robotic systems site survey | * 1. Site survey aspects      1. Power requirements      2. User requirements      3. Space and layout considerations      4. Characteristics of materials (size, weight, shape, fragility)      5. Environmental considerations      6. Workflow and process integration      7. Compatibility with existing systems      8. Scalability and cost analysis   2. Tools and equipment for site survey      1. Tools         1. Tape measure         2. Laser distance meter         3. Camera         4. Multimeter         5. Hand tools         6. Stationery         7. Infrared thermometer         8. Cable tracer         9. Ladder         10. Flashlight      2. Equipment         1. Safety equipment         2. Walkie talkies         3. GPS receiver   3. Conducting the Survey      1. Step-by-step survey process      2. Data collection techniques      3. Generating survey reports | * Oral assessment * Portfolio of evidence * Interviews * Third party report * Written assessment * Practical assessment * Projects |
| 1. Develop robot programs | * 1. Introduction to robot programming      1. Overview of robotics and automation      2. Importance of programming in robotics      3. Types of robotic systems   2. Programming languages for robotics      1. Overview of popular robot programming languages      2. C      3. Python      4. Comparison of languages and their applications      5. Setting up programming environments      6. Selection criteria based on project requirements   3. Robot programming basics      1. Basic programming constructs (variables, loops, conditionals)      2. Writing simple programs for robot movements      3. Introduction to libraries and frameworks   4. Identifying robot system requirements      1. Robot programming software      2. Robot programming hardware      3. Input and output interface      4. Communication interface      5. Functional requirements      6. Performance requirements      7. Integration requirements   5. Development Process      1. Writing and structuring robot code      2. Testing and debugging methods         1. Functionality test         2. Electrical continuity test         3. Mechanical tests         4. Performance test         5. Endurance test         6. Safety test         7. Software test         8. User acceptance test      3. Version control and backup procedures   6. Practice: develop and back up robot programs | * Oral assessment * Portfolio of evidence * Interviews * Third party report * Written assessment * Practical assessment * Projects |
| 1. Plan industrial robotic systems installation | * 1. Introduction to industrial robotics      1. Overview of industrial robotics and applications      2. Types of robotic systems      3. Components of robotic system      4. Importance of planning in robotic installations   2. Designing the industrial robot      1. Design considerations based on the site survey      2. Selection of components and materials      3. Factors influencing robotic design (size, payload, mobility)      4. Compatibility with existing systems      5. Scalability and future-proofing designs   3. Preparing Installation workplan      1. Project timelines and resource allocation      2. Safety and compliance checks      3. Components of an effective installation work plan      4. Scheduling and resource allocation      5. Safety and compliance considerations   4. Assembling Supplies      1. Overview of required materials and components      2. Inventory management and procurement processes         1. Identifying required materials and components         2. Procurement processes and vendor selection         3. Inventory management for installation supplies   5. Practice: Plan installation of an industrial robotic system | * Oral assessment * Portfolio of evidence * Interviews * Third party report * Written assessment * Practical assessment * Projects |
| 1. Install industrial robotic system | * 1. Safety Protocols and PPE      1. Importance of PPE and safety checks before installation      2. Importance of proper installation      3. Safety protocols in robotic installation   2. Wiring and piping      1. Structured wiring techniques for robotic systems         1. creating wire route         2. laying wires         3. labelling wires      2. Mechanical assembly of robotic components      3. Connection of sensors and actuators      4. Safety considerations for fluid systems      5. Fluid power piping: Hydraulic and pneumatic tubing         1. Hydraulic and pneumatic hose pipes         2. Hydraulic and pneumatic fittings         3. Flanges         4. Couplers         5. Manifolds         6. Filters         7. Check valves         8. Pressure relief valves         9. Supports and brackets         10. Flow control valves   3. Mounting and Calibration      1. Accessories         1. Memory modules         2. Expansion modules         3. Communication adapters         4. Input and output modules         5. Human machine interfaces         6. Sensors and transducers         7. Manipulators and grippers         8. Programmable logic controllers         9. Computing units         10. Mobility systems         11. Actuators         12. Power supplies         13. Mounting hardware         14. Enclosures         15. Terminal blocks         16. Interlock         17. Navigation systems      2. Equipment         1. end effectors         2. actuators         3. Mobility arms         4. Programmable logic controllers         5. Power source         6. Structural supports         7. Human machine interface panels         8. Safety devices      3. Steps for wire termination and connection      4. Testing and calibrating the system post-installation         1. Functionality test         2. Electrical continuity test         3. Mechanical tests         4. Performance test         5. Endurance test         6. Safety test         7. Software test         8. User acceptance test   4. Site management      1. Housekeeping and waste disposal protocols      2. Packaging material      3. Stripped cable insulation      4. Faulty components and equipment   5. Documentation of installation procedures   6. Practice: Hands-on tasks related to planning and installation | * Oral assessment * Portfolio of evidence * Interviews * Third party report * Written assessment * Practical assessment * Projects |
| 1. Maintain robotic system | * 1. Introduction to robotic system maintenance      1. Importance of maintenance in robotic systems      2. Overview of robotic components and their functions      3. Types of maintenance: preventive, predictive, and corrective   2. Safety and risk management      1. Safety protocols for maintenance activities      2. Risk assessment procedures      3. Importance of personal protective equipment (PPE)   3. Maintenance planning      1. Developing a maintenance schedule      2. Documentation of maintenance activities   4. Maintenance Tasks      1. Inspection      2. Calibration      3. Lubrication      4. Testing and measurements      5. Cleaning      6. Tightening      7. Replacing faulty component      8. Robot program backup Record keeping for maintenance activities   5. Troubleshooting techniques      1. Common issues in robotic systems and their causes      2. Diagnostic tools and methods for identifying problems      3. Step-by-step troubleshooting processes   6. Identifying and managing tools, equipment and spares.      1. Tools         1. Multimeters         2. Hand tools         3. Cleaning tools         4. Diagnostic software      2. Equipment         1. Lifting gear         2. Personal computer         3. Signal generators         4. Blower         5. Diagnostic equipment         6. PPE      3. Spares         1. Sensors         2. Motors         3. Mechanical parts         4. Batteries         5. Power supplies         6. Belts         7. Pneumatic and hydraulic fittings         8. Fasteners         9. Circuit breakers         10. Programmable logic controllers         11. HMI         12. Switches         13. Relays         14. Interface cards      4. Practice: Hands-on maintenance tasks to demonstrate competency in routine procedures. | * Oral assessment * Portfolio of evidence * Interviews * Third party report * Written assessment * Practical assessment * Projects |

**Suggested delivery methods**

* Group discussions
* Demonstration by trainer
* Online videos
* Power point presentation

**Recommended resources for 25 trainees**

|  |  |  |  |  |
| --- | --- | --- | --- | --- |
| **S/No.** | **Category/item** | **Description/specifications** | **Quantity** | **Recommended ratio (item: trainee)** |
| **A** | **Learning materials** | | | |
|  | Textbooks | Relevant to robotic systems | 5 pcs | 1:5 |
|  | Installation Manuals | Guides for setup and troubleshooting | 1 set | 1:25 |
|  | Charts | Visual aids for training | 1 set | 1:25 |
|  | PowerPoint Presentations | For trainer’s use | 1 set | 1:25 |
|  |  |  |  |  |
| **B** | **Learning Facilities & infrastructure** | | | |
|  | Lecture/theory room | Approximately 60 sqm | 1 | 1:25 |
|  | Workshop | Approximately 80 sqm | 1 | 1:25 |
|  | Laboratory | Approximately 80 sqm | 1 | 1:25 |
|  |  |  |  |  |
| **C** | **Consumable materials** | | | |
|  | Electrical wires | Various sizes, color-coded | Adequate |  |
|  | Insulation tapes | Standard size | Adequate |  |
|  |  |  |  |  |
| **D** | **Tools and equipment** | | | |
|  | **Hand tools** |  |  |  |
|  | Wrenches | Set of various sizes | 4 pcs | 1:6.25 |
|  | Screwdrivers | Flat and Phillips heads | 5 pcs | 1:5 |
|  | Pliers | Variety of types | 5 pcs | 1:5 |
|  | Hex keys | Set for various sizes | 5 pcs | 1:5 |
|  | Cutters | Precision cutting tools | 5 pcs | 1:5 |
|  | **Measuring tools** |  |  |  |
|  | Tape measures | Standard size | 5 pcs | 1:5 |
|  | Calipers | For precision measurement | 5 pcs | 1:5 |
|  | Alignment tools | For precision alignment |  |  |
|  | Alignment lasers | For precision alignment | 2 pcs | 1:12.5 |
|  | Plumb bobs | For vertical alignment | 5 pcs | 1:5 |
|  | Computing tools |  |  |  |
|  | Laptops/PCs | Configured for robotic programming | 25 pcs | 1:1 |
|  | Safety equipment |  |  |  |
|  | Safety glasses | ANSI certified | 25 pcs | 1:1 |
|  | Gloves | Cut-resistant | 25 pcs | 1:1 |
|  | Hearing protection | Noise-cancelling | 25 pcs | 1:1 |
|  | Hard hats | Safety compliance | 25 pcs | 1:1 |
|  | Testing equipment |  |  |  |
|  | Multimeters | For electrical measurements | 5 pcs | 1:5 |
|  | Oscilloscopes | For analyzing waveforms | 5 pcs | 1:5 |
|  | Robot simulation software | For virtual testing and programming | 1 pcs | 1:25 |
|  | Robotics training kit | For training | 2 | 1:13 |
|  |  |  |  |  |
| **E** | **Miscellaneous** | | | |
|  | Service manuals | For equipment and systems | 1 set | 1:25 |
|  | Assembly jigs | For efficient assembly | 1 set | 1:25 |
| **F** | **Reference materials** | | | |
|  | Component manuals | For detailed specifications | 1 set | 1:25 |
|  | Robotic Installation books | For theoretical knowledge | 1 set | 1:25 |
|  | Journals & past papers | For additional research | 1 set | 1:25 |