REPUBLIC OF KENYA

COMPETENCY BASED MODULARISED CURRICULUM

FOR

INSTRUMENTATION AND CONTROL TECHNOLOGY

KNQF LEVEL 6

CYCLE 3

ISCED PROGRAMME CODE: 0714 554A

TVET CDACC
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FOREWORD

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

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

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

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

PRINCIPAL SECRETARY
STATE DEPARTMENT FOR TVET
MINISTRY OF EDUCATION

PREFACE

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

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

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

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

CHAIRMAN
TVET CDACC

ACKNOWLEDGMENT

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

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

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

COUNCIL SECRETARY/CEO

TVET CDACC

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ACRONYMS AND ABBREVIATION

ADCs – Analogue to digital converters

ISCED – International Standard Classification of Education

CEO – Chief Executive Officer

TVET – Technical and Vocational Education and Training

CBET – Competency-Based Education and Training

CBETA – Competency-Based Education and Training Authority

CDACC – Curriculum Development, Assessment, and Certification Council

AC – Alternating Current

CAD – Computer-Aided Design

CPU – Central Processing Unit

CV – Curriculum Vitae

DACs – Digital to analogue converters

DC – Direct Current

DOL – Direct-On-Line

DVI – Digital Visual Interface

HDMI – High-Definition Multimedia Interface

IEE Institution of Engineering and Technology

IET – Institution of Engineering and Technology

KCL – Kirchhoff's Current Law

KCSE – Kenya Certificate of Secondary Education

KNQF – Kenya National Qualifications Framework

KVL – Kirchhoff's Voltage Law

NEMA – National Environment Management Authority

NP – Net Power

OSHA – Occupational Safety and Health Administration

PPE – Personal Protective Equipment

RAM – Random Access Memory

RPL – Recognition of Prior Learning

SI – International System of Units

SMP – Symmetric Multiprocessing

SMS – Short Message Service

TV – Television

TVET – Technical and Vocational Education and Training

TVETA – Technical and Vocational Education and Training Authority

USB – Universal Serial Bus

UV – Ultraviolet

VGA – Video Graphics Array

PVC – Polyvinyl Chloride

VFD – Variable Frequency Drive

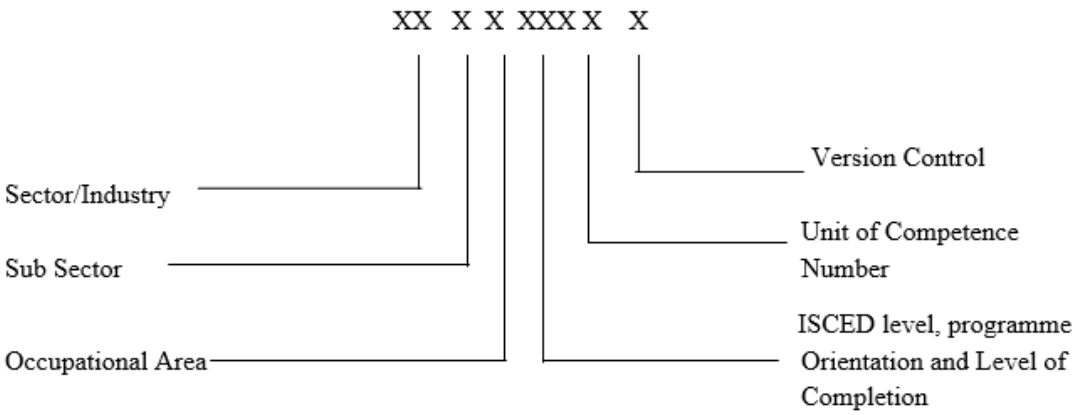
VGA – Video Graphics Array

VSD – Variable Speed Drive

PWM – Pulse Width Modulation

PCB – Printed Circuit Board

KEY TO ISCED UNIT CODE



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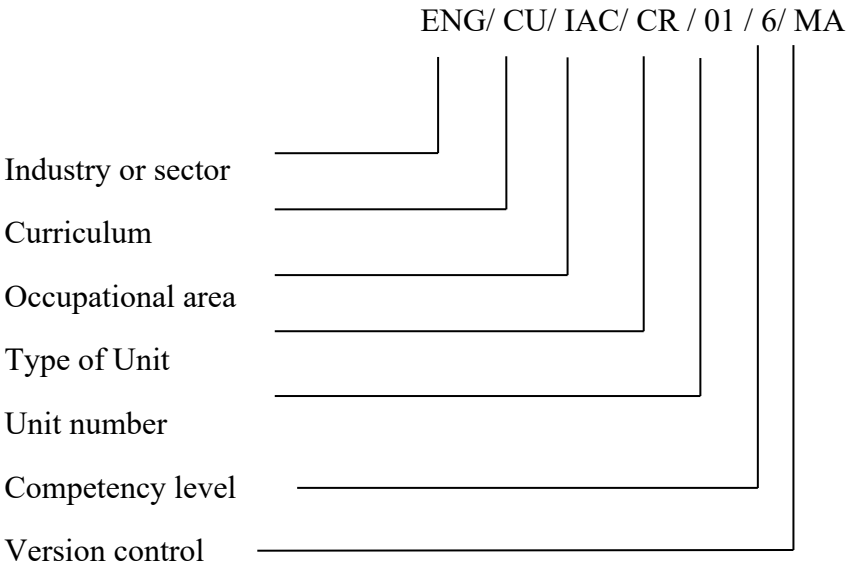

COURSE OVERVIEW

Instrumentation and control technology Level 6 curriculum consists of competencies that an individual must achieve to perform instrumentation and control activities. It involves installing electrical systems, installing instrumentation and control system operations, maintaining instrumentation and control system ,installing instrumentation and control system components, installing logic controllers, fabricate electronics circuits, installing electrical machines, installing hydraulic and pneumatic system and Control, instrumentation systems monitoring, industrial measurement instruments calibration and instrumentation and control system supervision.

Units of Learning

CORE UNITS OF LEARNING				
ISCED Unit code	**TVETCDACC UMIT CODE**	**Unit title**	**Duration in Hours**	**Credit factor**
Module 1				
0713 551 13A	ENG/CU/IC/CR/01/4/MA	Electrical Installation	80	8
0714 551 14A	ENG/CU/IC/CR/02/4/MA	Instrumentation And Control System Components installation	160	16
		TOTAL	**240**	**24**
Module 2				
0714 551 15A	ENG/CU/IC/CR/03/4/MA	Instrumentation And Control System Operations	160	16
0714 551 16A	ENG/CU/IC/CR/04/4/MA	Instrumentation And Control System Maintenance	160	16
		TOTAL	**320**	**32**

Module 3				
0611 451 01A	ENG/CU/IC/BC/01/5/MA	Digital Literacy	60	6
0732 451 06A	ENG/CU/IC/CC/01/5/MA	Engineering Drawing	60	6
0713 451 07A	ENG/CU/IC/CC/02/5/MA	Electrical Principles	120	12
0714 451 08A	ENG/CU/IC/CR/01/5/MA	Electronic Circuit Fabrication	100	10
0715 451 19A	ENG/CU/IC/CR/02/5/MA	Hydraulic and Pneumatic System Installation	120	12
		TOTAL	**460**	**46**
Module 4				
0031 451 02B	ENG/CU/IC/BC/02/5/MA	Communication Skills	40	4
0417 451 03B	ENG/CU/IC/BC/03/5/MA	Work Ethics and Practices	40	4
0413 451 04B	ENG/CU/IC/BC/04/5/MA	Entrepreneurial Skills	40	4
0541 451 05A	ENG/CU/IC/CC/03/5/MA	Basic Mathematics	80	8
0714 451 17A	ENG/CU/IC/CR/03/5/MA	Logic Controllers Installation	120	12
0713 451 20A	ENG/CU/IC/CR/04/5/MA	Electrical Machines Installation	120	12
		TOTAL	**440**	**44**
Module 5				
0541 551 10A	ENG/CU/IC/CC/01/6/MA	Engineering mathematics	100	10
0714 551 08A	ENG/CU/IC/CC/02/6/MA	Advanced electronic circuit Fabrication	120	12
0713 551 09A	ENG/CU/IC/CC/03/6/MA	Electrical Measurement and Fault Diagnosis	60	6
0714 551 21A	ENG/CU/IC/CR/01/6/MA	Control and Instrumentation Systems Monitoring	120	12

		TOTAL	**400**	40
Module 6				
0714 551 12A	ENG/CU/IC/CC/04/6/MA	Control Systems	100	10
0111 551 11A	ENG/CU/IC/CC/05/6/MA	Research Methods	60	6
0714 551 22A	ENG/CU/IC/CR/02/6/MA	Industrial Measurement Instruments Calibration	120	12
0714 551 23A	ENG/CU/IC/CR/03/6/MA	Instrumentation and Control System Supervision	120	12
		TOTAL	**400**	**40**
	Industry Training		**480**	**48**
	GRAND TOTAL		**2740**	**274**

Entry Requirements

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

a) Kenya Certificate of Secondary Education (KCSE) mean Grade C- (minus).

Or

b) Certificate in Instrumentation and Control Technology KNQF level 5 or related course

Or

c) Equivalent qualification as determined by TVETA

Trainer Qualification

Qualifications of a trainer for this course include:

a) Have a minimum of Instrumentation and Control KNQF Level 7 qualification or its equivalent in the related area of specialization.
b) Be registered by TVETA.

Industry Training

A n individual enrolled in this course will be required to undergo Industry training for a minimum period of 480 hours in Instrumentation and control sector. The industrial training may be taken after completion of all units for those pursuing the full qualification or be distributed equally in each unit for those pursuing part qualification. In the case of dual training model, industrial training shall be as guided by the dual training policy.

Assessment

The course shall be assessed formatively and summatively:

a) During formative assessment all performance criteria shall be assessed based on performance criteria weighting.
b) Number of formative assessments shall minimally be equal to the number of elements in a unit of competency.
c) During summative assessment basic and common units may be integrated in the core units or assessed as discrete units.
d) Theoretical and practical weight for each unit of learning shall be as follows:
    i) 10:90 for units in modules I and II;
    ii) 30:70 for units in modules III and IV;
    iii) 40:60 for units in modules V and VI.
e) Formative and summative assessments shall be weighted at 60% and 40% respectively in the overall unit of learning score
f) For a candidate to be declared competent in a unit of competency, the candidate must meet the following conditions:
    i) Obtained at least 40% in theory assessment in formative and summative assessments.
    ii) Obtained at least 60% in practical assessment in formative and summative assessment where applicable.
    iii) 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.
g) 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

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

Certification

A candidate will be issued with a Certificate of Competency upon demonstration of competence in a core Unit of Competency. To be issued with Kenya National TVET Certificate in Instrumentation and Control Technology KNQF Level 6 the candidate must demonstrate competence in all the Units of Competency as given in the qualification pack. Statement of Attainment certificate may be issued upon demonstration of competence in a certifiable element within a unit.

The certificates will be issued by the TVETCDACC

MODULE I

ELECTRICAL INSTALLATION

UNIT CODE: 0713 351 13A

TVETCDACC UNIT CODE: ENG/CU/IC/CR/01/4/MA

Relationship to Occupational Standards

This unit addresses the unit of competency: Perform Electrical Installation

Duration of Unit: 80 Hours

Unit Description

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

Summary of Learning Outcomes

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

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

Learning Outcomes, Content and Suggested Assessment Methods

Learning Outcome	Content	Suggested Assessment Methods
1. Prepare a list of tools, equipment and materials	1.1 Health and safety procedures 1.1.1 PPEs	• Oral questioning • Written tests

Learning Outcome	Content	Suggested Assessment Methods
	1.1.2 Safety, Rules and, regulations 1.1.3 Hazards 1.1 Electrical installation tools and materials 1.2.1 Cutting tools 1.2.2 Measuring tools 1.2.3 Measuring equipment 1.2.4 Cables and conductors 1.2.5 Crimping tools 1.2.6 Conduits 1.2.7 Trunking 1.2.8 Consumables 1.2 Types, application, care, maintenance and storage of: 1.2.1 Tools 1.2.1.1 Cable strippers 1.2.1.2 Pliers 1.2.1.3 Screw drivers 1.2.1.4 Hammers 1.2.1.5 Chisels 1.2.1.6 Allen keys 1.2.1.7 Electrician knives 1.2.1.8 Crimping tools 1.2.1.9 Bending springs 1.2.1.10 Steel tapes 1.2.1.11 Draw wires 1.2.1.12 Hack saws	• Observation • Practical

Learning Outcome	Content	Suggested Assessment Methods
	1.2.1.13 Drills 1.2.2 Equipment 1.2.2.1 Stock and die 1.2.2.2 Vice 1.2.3 Materials 1.2.3.1 Cables 1.2.3.2 Fittings 1.2.3.3 Accessories 1.3 Assemble electrical installation tools, equipment and materials	
2. Perform piping and laying of cables	2.1 Meaning of terms 2.2 Procedures for piping 2.3 Cables and cable joints 2.4 Wiring systems and accessories 2.4.1 Types and applications 2.4.1.1 Conduits 2.4.1.2 Cable trays 2.4.1.3 Cable ducts 2.4.1.4 Trunking 2.4.2 Preparation of wiring systems 2.4.2.1 Marking out 2.4.2.2 Cutting 2.4.2.3 Bending 2.4.2.4 Threading 2.4.2.5 Chiseling 2.4.2.6 Trenching 2.5 Draw –in/Lay of cables routes	• Written tests • Observation • Oral questioning • Practical test

Learning Outcome	Content	Suggested Assessment Methods
	2.5.1 Cable Identification 2.6 IEE regulations	
3 Install electrical components	3.1 Meaning of terms 3.2 Electrical symbols and abbreviations 3.3 Meaning of electrical drawings 3.4 Drawing of electrical diagrams 3.4.1 block 3.4.2 schematic 3.4.3 circuit 3.4.4 line 3.4.5 wiring 3.5 Electrical components 3.5.1 Junction boxes 3.5.2 Ceiling rose 3.5.3 Switches 3.5.4 Socket outlets 3.5.5 Bulb holders 3.5.6 IEE regulations	• Written tests • Oral questioning • Practical tests • Observation
4 Terminate electrical installation	4.1 Meaning of Terms 4.2 Importance of termination 4.3 Cable labelling 4.4 Cable lugging 4.5 Tools used in cable termination e.g. 4.5.1 Crimping tool 4.5.2 Strip Knife 4.6 IEE regulations 4.7 Disposal of waste materials	• • Written tests • Oral questioning • Practical tests • Observation

Learning Outcome	Content	Suggested Assessment Methods
5 Inspect and test installation	5.1 Types of tests on an electrical installation system 5.2 IEE regulations in regard to electrical installation testing and inspection 5.3 Electrical testing instruments	• Written tests • Oral questioning • Practical tests • Observation
6 Document an Electrical installation	6.1 Report preparation 6.2 Sharing of the installation report 6.3 Report filing	• Written tests • Oral questioning • Practical tests • Observation

Suggested Methods of Instruction

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

Recommended Resources for 25 trainees

S/No.	Category/Item	Description/ Specifications	Quantity	Recommended Ratio (Item: Trainee)
A	**Learning Materials**			
1.	Textbooks	1. B. Scaddan Electrical installation work 2. J. Hyde Electrical Installation Principles and Practices	5 pcs	1:5

		3. Electrical Theory for the Electrician" by Mike Holt 4. Electrical installation work by Brian Scaddan		
2.	Installation manuals	IEEE regulation BS3939 NEMA regulations OSHA	5 pcs	1:5
3.	Charts	Single line diagram Circuit diagrams Colour codes	1 pcs for each	1:25
4.	Power point presentations	For trainer's use	1	1:25
B	**Learning Facilities & infrastructure**			
1.	Lecture/theory room	$60m^2$	1	1:25
2.	Workshop	$150m^2$	1	1:25
3.	Site			
C	**Consumable materials**			
1.	Electrical wires	$1.5mm^2$(red, black green)	5 rolls	1:5
		$2.5mm^2$(red, black green)	5 rolls	1:5
		4.0 mm^2(red, black green)	3 rolls	1:10
		6.0 mm^2(red, black green)	2 rolls	1:12
		10 mm^2(red, black green)	2 rolls	1:12
2.	Insulation tapes		25 pcs	1:1
3.	Accessories	Switches, sockets, Junction boxes, Consumer units, Lamp holders,	25 pcs	1:1

		Patrice boxes, Circuit breakers, energy meter, cut out, cooker unit, instant water heater switch,		
4.	Conduits and trunkings	PVC conduits, Steel conduits, Mini trunking	25 pcs	1:1
	Tools and Equipment			
1.	Hacksaws		25 pcs	1:1
2.	Striping knives		25 pcs	1:1
3.	Side cutters		25 pcs	1:1
4.	Pliers		25 pcs	1:1
5.	Tape measure		25 pcs	1:1
6.	Try Square		25 pcs	1:1
7.	Spirit level		25 pcs	1:1
8.	Assorted Screw driver		25 pcs	1:1
9.	Assorted hammers		25 pcs	1:1
10.	PPEs		25 pcs	1:1
11.	Multimeters		5 pcs	1:5
12.	Clamp meters		5 pcs	1:5
13.	Earth resistance meter		5 pcs	1:5
14.	Stocks & Dies		5 pcs	1:5
15.	Vices		5 pcs	1:5
16.	Pipe bending Machine		5 pcs	1:5
17.	Bending spring		5 pcs	1:5
18.	Drilling machines		5 pcs	1:5
19.	Work stations		25	1:1
20.	Installation boards		13 pcs	1:2

INSTRUMENTATION AND CONTROL SYSTEM COMPONENTS INSTALLATION

UNIT CODE: 0714 351 14A

TVETCDACC UNIT CODE: ENG/CU/IC/CR/02/4/MA

Relationship to Occupational Standards

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

Duration of Unit: 160 Hours

Unit Description

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

Summary of Learning Outcomes

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

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

Learning Outcomes, Content and Suggested Assessment Methods

Learning Outcome	Content	Suggested Assessment Methods
1. Prepare for installation of instrumentation and control system component.	1.1.Site survey consideration 1.2.1 Temperature 1.2.2 Humidity 1.2.3 Distance 1.2.4 Dust 1.2.5 Light intensity 1.2.6 Pressure 1.2.Meaning of workshop tools, instruments and equipment 1.3.Uses of workshop tools, Instruments and equipment 1.3.1. Cutting tools 1.3.2. Fastening tools 1.3.3. Marking tools 1.3.4. Drilling tools 1.3.5. Crimping tools 1.3.6. Alignment tools 1.3.7. Measuring equipment 1.3.8. Testing equipment 1.4.Handling, care and maintenance of workshop tools and Instruments 1.5.Instrumentation and control system components 1.5.1 Type of instrumentation and control components and their specifications 1.3.1.1 Sensors 1.3.1.2 Controllers	1. Written Assessment 2. Oral Questioning 3. Practical Assessment 4. Project 5. Third party report 6. Portfolio of evidence

	1.3.1.3 Communication devices 1.3.1.4 Actuators 1.5.2 Types of electric motors 1.5.2.1 DC motors 1.5.2.2 AC motors 1.5.3 Transmitters 1.5.4 Motor control 1.5.4.1 DOL 1.5.4.2 Forward/Reverse 1.5.4.3 Star/Delta 1.5.4.4 Soft Starters 1.5.4.5 VFD/VSD 1.5.5 Signal processing 1.5.6 Signal conditioning 1.5.7 Display 1.6.Instrumentation transmission system components 1.6.1 Pressure system components 1.6.2 Flow rate measurement components 1.6.3 Level measurement components 1.6.4 Temperature measurement components	
2. Assemble instrumentation and control system components	2.1 System components mounting. 2.1.1 Factors to consider when mounting. 2.2 Interpretation of installation documents 2.2.1 Line diagrams 2.2.2 Wiring diagrams 2.2.3 Layouts 2.2.4 Installation manuals	1. Written Assessment 2. Oral Questioning 3. Practical Assessment 4. Project 5. Third party report 6. Portfolio of evidence

	2.3 Mounting instrumentation devices and components 2.3.1 Environmental conditions 2.3.2 Vibration and shock 2.3.3 Weight and size of component 2.3.4 Electrical safety 2.3.5 Accessibility 2.4 Cable lugging and tagging 2.4.1 Types of cable lugs and tags 2.4.2 Cable lugging and tagging standards 2.5 Cable laying 2.6 Terminations and joints 2.7 Housekeeping activities 2.6.1 Cleaning 2.6.2 Tools and equipment storage 2.6.3 Waste disposal 2.6.4 Documentation	
3. Test instrumentation and control system components	3.1 Importance of instrumentation system testing 3.2 Meaning of terms 3.2.1 Inspection 3.2.2 Testing 3.3 Types of tests e.g. 3.3.1 Electrical tests 3.3.2 Functionality tests 1. Test Signal Conditioning Elements 2. Test Signal Processing elements	1. Written Assessment 2. Oral Questioning 3. Practical Assessment 4. Project 5. Third party report 6. Portfolio of evidence

	3. Test Data presentation elements 3.4 Testing tools and equipment 3.4.1 Multimeter 3.4.2 Insulation resistance tester 3.4.3 Signal generators 3.5 Troubleshooting techniques 3.6 Performance characteristics 3.6.1 Statics and dynamics 3.6.2 Error and loading effects 3.6.3 Accuracy 3.6.4 Precision 3.6.5 Linearity 3.6.6 Sensitivity 3.6.7 Resolution 3.6.8 Response time 3.6.9 Drift 3.6.10 Calibration 3.6.11 Functional integration 3.7 Instrumentation system test report	

Suggested Methods of Instruction

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

Recommended Resources for 25 trainees

S/No.	Category/Item	Description/ Specifications	Quantity	Recommended Ratio (Item: Trainee)

A	**Learning Materials**			
1.	Reference books	A.K Sawhney Electrical and Electronic Measurement and Instrumentation. Arun. K Ghoshi Introduction to Measurements and Instrumentation 2nd edition R.K Rajput Electrical Measurements and Instrumentation 2nd edition	5 pcs	1:5
2.	Installation manuals	Assorted Systems component Manufacturer's manuals and data sheets Instrumentation Handbooks	5 pcs	1:5
3.	Maintenance manuals	Assorted Systems component Manufacturer's manuals and data sheets Maintenance Handbooks	5 pcs	1:5
4.	Checklists	Assorted Systems checklists	5 pcs	1:5
5.	Audio visual presentations	Projector	1	1:25
B	**Learning Facilities & infrastructure**			
6.	Lecture/theory room	$60m^2$	1	1:25

7.	Workshop	150m^2	1	1:25
8.	Computer laboratory	100m^2	1	1:25
C	**Consumable materials**			
9.	Installation materials	Insulation tapes and tubes, cleaning agents, Lubrication oil, assorted electrical cable rolls, cable tags and lags, soldering wire	25 pcs each	1:1
D	**Tools and Equipment**			
10.	Assorted tools and equipment	Side cutters, Side cutters, Pliers, Screwdriver, Crimping tools, multi-meter, torque wrench, Oscilloscope, clamp meters, drilling tools	25 pcs	1:1
11.	PPEs	Safety boots, overall, helmets	25 pcs	1:1
12.	Work stations	Electrical works station with mounting boards, 3θ power source.	25 pcs	1:1
13.	Process control training	With simulations faults	25 pcs	1:1

MODULE II

INSTRUMENTATION AND CONTROL SYSTEM OPERATIONS

UNIT CODE: 0714 351 15A

TVETCDACC UNIT CODE: ENG/CU/IC/CR/03/4/MA

Relationship to Occupational Standards

This unit addresses the unit of competency: Operate instrumentation and control system

Duration of Unit: 160 Hours

Unit Description

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

Summary of Learning Outcomes

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

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

Learning Outcomes, Content and Suggested Assessment Methods

Learning Outcome	Content	Suggested Assessment Methods
1. Perform instrumentation	1.1 Instrumentation and control system inspection 1.2.1 Visual inspection	1. Written Assessment 2. Oral Questioning 3. Practical Assessment

	and control system start up	1.2.2 Functional inspection 1.2 Procedure of Instrumentation and control system start up 1.3 Types of instrumentation control alarms 1.3.1 Indicators 1.4.1 sirens 1.4.2 codes 1.4 Instrumentation and control system dry run	4. Project 5. Third party report 6. Portfolio of evidence
2	Perform instrumentation and control system changeover dies	2.1 Instrumentation and control system dies 2.1.1 Moulds 2.1.2 Star wheels 2.1.3 Guide ways 2.1.4 Worm wheels 2.2 Tools and equipment 2.2.1 Cutting tools 2.2.2 Forming tools 2.2.3 Shaping tool 2.2.4 Fastening tools 2.2.5 Calibration equipment 2.3 System dies change over 2.4 System dies testing 2.4.1 Visual inspection 2.4.2 Functional test	1. Written Assessment 2. Oral Questioning 3. Practical Assessment 4. Project 5. Third party report 6. Portfolio of evidence
3	Run instrumentation and control system	3.1 Factor to consider when selecting the recipe 3.1.1 Sequence of events 3.1.2 Process type 3.2 Factors to consider when loading raw materials 3.2.1 Safety	1. Written Assessment 2. Oral Questioning 3. Practical Assessment 4. Project 5. Third party report 6. Portfolio of evidence

	3.2.2 Environmental 3.3 System parameters 3.3.1 Temperature 3.3.2 Pressure 3.3.3 Flow rate 3.3.4 Level sensing 3.4 System parameter adjustment 3.4.1 Adjustment techniques 3.4.2 Parameter testing 3.5 System monitoring 3.5.1 Monitoring tools and indicators 3.5.2 Interpreting alarms and indicators 3.5.3 Data logging techniques 3.6 Documentation and record-keeping 3.6.1 Types of documentation 3.6.1.1 Installation manuals 3.6.1.2 Maintenance manuals 3.6.1.3 Checklists 3.6.1.4 Maintenance schedules	

Suggested Methods of Instruction34I

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

Recommended Resources for 25 trainees

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9.	Checklists	Assorted Systems checklists	5 pcs	1:5
10.	Audio visual presentations	Projector	1	1:25
B	**Learning Facilities & infrastructure**			
14.	Lecture/theory room	$60m^2$	1	1:25

15.	Workshop	150m^2	1	1:25
16.	Computer laboratory	100m^2	1	1:25
C	**Consumable materials**			
17.	Installation materials	Indicators, sirens, insulation tape, cables	25 pcs	1:1
18.	Assorted dies	Moulds, star wheels, guide ways, worm wheels	5 for each category	1:5
D	**Tools and Equipment**			
19.	Assorted tools and equipment	Side cutters, Side cutters, Pliers, Screw driver, Crimping tools, Mult-meter, torque wrench	25 pcs	1:1
20.	PPEs	Safety boots, overall	25 pcs	1:1
21.	Work stations		25	1:1

INSTRUMENTATION AND CONTROL SYSTEMS MAINTENANCE

UNIT CODE: 0714 351 16A

TVETCDACC UNIT CODE: ENG/CU/IC/CR/04/4/MA

Relationship to Occupational Standards

This unit addresses the unit of competency: Maintain instrumentation and control systems.

Duration of Unit: 160 Hours

Unit Description

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

Summary of Learning Outcomes

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

S/NO	LEARNING OUTCOMES	DURATION (HOURS)
1.	Prepare instrumentation and control systems maintenance schedule	35
2.	Conduct instrumentation and control systems preventive maintenance	35
3.	Conduct instrumentation and control systems corrective maintenance	45
4.	Test and commission instrumentation and control system	45
	TOTAL HOURS	**160**

Learning Outcomes, Content and Suggested Assessment Methods

Learning Outcome	Content	Suggested Assessment Methods
1. Prepare instrumentation and control systems maintenance schedule	1.1 Maintenance scheduling 1.2 Types of maintenance and procedures 1.2.1 Preventive maintenance 1.2.2 Predictive maintenance 1.2.3 Corrective maintenance 1.2.4 Condition based maintenance 1.2.5 Predetermined maintenance 1.2.6 Reactive maintenance 1.3 Maintenance Work plan 1.2.1 Risk Assessment and Job Safety Analysis 1.2.2 Permit-to-Work System 1.2.3 Lockout/Tagout Procedures 1.2.4 Maintenance Tasks 1.2.5 Documentation 1.4.1.1 Date and time of maintenance 1.4.1.2 Equipment identification 1.4.1.3 Maintenance tasks performed 1.4.1.4 Spare parts used 1.4.1.5 Calibration results 1.4.1.6 Non-conformances and corrective actions	1. Written tests 2. Oral Questioning 3. Practical assessment 4. Project 5. Third party report 6. Portfolio of evidence

	1.2.6 Spare Parts Management 1.2.7 Training and Competency 1.2.8 Continuous Improvement 1.4 Maintenance documents 1.4.1 Maintenance manual 1.4.2 Maintenance report 1.4.3 Maintenance logs 1.4.4 Maintenance checklist	
2. Conduct instrumentation and control systems preventive maintenance	2.1 Critical instrumentation and control system components for maintenance 2.1.1 Audio sensitive gauges 2.1.2 Optical gauges 2.1.3 Pressure gauges 2.1.4 Temperature gauges 2.1.5 Vibration analysers 2.2 Preventive maintenance activities 2.2.1 Regular inspections 2.2.2 Cleaning 2.2.3 Adjustments e.g. alignment, balancing 2.2.4 Wear components check 2.2.5 lubrication 2.2.6 Calibrations	1. Written tests 2. Oral Questioning 3. Practical assessment 4. Project 5. Third party report 6. Portfolio of evidence
3 Conduct instrumentation and control systems corrective maintenance	3.1 Troubleshooting procedure in systems 3.2 Identification of maintenance activities 3.3 Types of faults 3.3.1 Sensor Faults:	1. Written tests 2. Oral Questioning 3. Practical assessment 4. Project 5. Third party report

	3.3.1.1 Calibration drift 3.3.1.2 Sensor failure 3.3.1.3 Noise and interference 3.3.2 Signal Transmission Faults: 3.3.2.1 Signal attenuation 3.3.2.2 Signal distortion 3.3.2.3 Signal loss 3.3.3 Signal Conditioning Faults: 3.3.3.1 Gain error 3.3.3.2 Offset error 3.3.3.3 Nonlinearity 3.3.4 Data Acquisition Faults: 3.3.4.1 Sampling rate errors 3.3.4.2 Quantization errors 3.3.4.3 Data corruption 3.3.5 Processing Faults: 3.3.5.1 Algorithm errors 3.3.5.2 Computational errors 3.3.5.3 Software bugs 3.3.6 Human Error: 3.3.6.1 Incorrect calibration 3.3.6.2 Improper maintenance 3.3.6.3 Misinterpretation of data 3.4 Corrective maintenance activities 3.4.1 Replacement 3.4.2 Repair 3.4.3 Overhaul 3.4.4 Alignment 3.4.5 Reset 3.4.6 Readjustment	6. Portfolio of evidence

	3.4.7 Software updates 3.4.8 Recalibration 3.5 System isolation points 3.3.1 Circuit breakers 3.3.2 Fuses 3.3.3 Isolators 3.3.4 Couplers 3.3.5 Fittings 3.6 Fault rectification	
4 Test and Commission instrumentation and control system	4.1 SI unit of various types of Electrical parameters 4.4.1 Power – Watts (W) 4.4.2 Current – Amperes (A) 4.4.3 Resistance – Ohms(Ω) 4.4.4 Voltage – Volts (V) 4.2 Electrical tests 4.3 Polarity test 4.4 Earth loop impedance test 4.5 Insulation resistance test 4.6 Earth electrode resistance test 4.7 Functionality test 4.8 Commissioning documents 4.9 Start up and shutdown procedures 4.10 Safety documentation 4.11 Handover report 4.12 Commissioning documents: 4.1.1 Pre-commissioning Checklist 4.1.2 Commissioning Test Procedures 4.1.3 Commissioning Data Sheets	1. Written tests 2. Oral Questioning 3. Practical assessment 4. Project 5. Third party report 6. Portfolio of evidence

	4.1.4 Calibration Certificates: 4.1.5 Instrument Calibration Certificates 4.1.6 Calibration Procedures 4.1.7 Spare Parts List: 4.1.8 Vendor Information 4.1.9 Maintenance Schedules and Procedures: 4.1.10 Preventive Maintenance Schedule 4.1.11 Corrective Maintenance Procedures 4.1.12 Emergency Procedures 4.1.13 Operator Training Manuals 4.1.14 Safety Manuals	

Suggested Methods of Instruction

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

Recommended Resources for 25 trainees

S/No.	Category/Item	Description/ Specifications	Quantity	Recommended Ratio (Item: Trainee)

A	**Learning Materials**			
1.	Reference books	A.K Sawhney Electrical and Electronic Measurement and Instrumentation. Arun. K Ghoshi Introduction to Measurements and Instrumentation 2nd edition R.K Rajput Electrical Measurements and Instrumentation 2nd edition	5 pcs	1:5
2.	Maintenance manuals	Assorted Systems component Maintenance reports, manufacture's manuals and data sheets Instrumentation Handbooks	5 pcs	1:5
3.	Charts	Assorted instrumentation systems circuit diagrams P& ID charts	1 pcs for each	1:25
4.	Software	Assorted CAD software e.g Circuit wizard, Auto CAD	25	1:1
5.	Audio visual presentations	Projector	1	1:25
B	**Learning Facilities & infrastructure**			
22.	Lecture/theory room	$60m^2$	1	1:25
23.	Workshop	$150m^2$	1	1:25
24.	Computer laboratory	$100m^2$	1	1:25

C	**Consumable materials**			
25.	Installation materials	Insulation tape, cables	25 pcs	1:1
26.	Assorted electrical components	Contactors, transformer, overload relays, timers	25 pcs	1:1
27.	Assorted instrumentation components	Sensors, transducers, actuators	25	1:5
D	**Tools and Equipment**			
28.	Assorted tools and equipment	Side cutters, Side cutters, Pliers, Screw driver, Crimping tools, Mult-meter, Oscilloscope, Solder guns	25 pcs	1:1
29.	PPEs	Safety boots, overall	25 pcs	1:1
30.	Function generator		5 pcs	1:5
31.	Variable power supply		5 pcs	1:5
32.	Trainers kit	Digital electronics, PWM kit	5 pcs	1:5
33.	PCB prototyping machine		2	1:13
34.	Hot air gun		5 pcs	1:5
35.	Drilling machines		5 pcs	1:5
36.	Work stations		25	1:1

MODULE III

DIGITAL LITERACY

UNIT CODE: 0611 451 01A

TVETCDACC UNIT CODE: ENG/CU/IC/BC/01/5/MA

Relationship to Occupational Standards

This unit addresses the unit of competency: Apply digital literacy.

Duration of Unit: 60 Hours

Unit Description

This unit covers the competencies required to apply digital literacy. It involves operating computer devices, solving tasks using office suite, managing data and information, accessing online/offline data and information, performing online communication and collaboration, applying cybersecurity skills, performing online jobs, and applying for job entries.

Summary of Learning Outcomes

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

S/NO	LEARNING OUTCOMES	DURATION (HOURS)
1.	Operate Computer Devices	6
2.	Solve Tasks Using Office Suite	14
3.	Manage Data and Information	6
4.	Perform Online Communication and Collaboration	4
5.	Apply Cybersecurity Skills	4
6.	Perform Online Jobs	4
7.	Apply job entry techniques.	2
	TOTAL HOURS	**60**

Learning Outcomes, Content, and Suggested Assessment Methods

Learning Outcome	Content	Suggested Assessment Methods
1. Operate Computer Devices	1.1. Meaning and importance of digital literacy 1.2. Functions and uses of computers devices: 1.2.1 Desktops 1.2.2 Laptops 1.2.3 Smartphones 1.2.4 Tablets 1.2.5 Smart watches 1.3. Classification of computers 1.4. Components of a computer system 1.5. Computer Hardware 1.5.1. The System Unit E.g. Motherboard, CPU, casing 1.5.2. Input Devices e.g. Pointing, keying, scanning, voice/speech recognition, direct data capture devices. 1.5.3. Output Devices e.g. hardcopy output and softcopy output 1.5.4. Storage Devices e.g. main memory e.g. RAM, secondary storage (Solid state devices, Hard Drives, CDs & DVDs, Memory cards, Flash drives 1.5.5. Computer Ports e.g. HDMI, DVI, VGA, USB type C etc. 1.6. Computer software: 1.6.1 System software e.g. Operating System (Windows, Macintosh, Linux, Android, iOS) 1.6.2 Application Software (Word Processors, Spreadsheets, Presentations). 1.6.3 Utility Software (Antivirus programs) 1.7. Classification of computer software	1. Written Assessment 2. Oral Questioning 3. Practical Assessment 4. Project 5. Third party report 6. Portfolio of evidence

Learning Outcome	Content	Suggested Assessment Methods
	1.8.Operating system functions 1.9.Procedure for turning/off a computer 1.10. Mouse use techniques 1.11. Keyboard Parts and Use Techniques 1.12. Desktop Customization 1.13. File and Files Management using an operating system 1.14. Computer Internet Connection Options 1.14.1. Mobile Networks/Data Plans 1.14.2. Wireless Hotspots 1.14.3. Cabled (Ethernet/Fiber) 1.14.4. Dial-Up 1.14.5. Satellite 1.15. Computer external devices management 1.15.1. Device connections 1.15.2. Device controls (volume controls and display properties)	
2. Solve Tasks Using Office Suite	2.1.Meaning and importance of word processing 2.2.Examples of word processors 2.3.Working with word documents 2.3.1. Open and close word processor 2.3.2. Create a new document 2.3.3. Save a document 2.3.4. Switch between open documents 2.4.Enhancing productivity 2.4.1. Set basic options/preferences 2.4.2. Help resources 2.4.3. Use magnification/zoom tools	1. Written Assessment 2. Oral Questioning 3. Practical Assessment 4. Project 5. Third party report 6. Portfolio of evidence

Learning Outcome	Content	Suggested Assessment Methods
	2.4.4. Display, hide built-in tool bar 2.4.5. Using navigation tools 2.5.Typing Text 2.6.Document editing (copy, cut, paste commands, spelling and Grammar check) 2.7.Document formatting 2.7.1. Formatting text 2.7.2. Formatting paragraph 2.7.3. Formatting styles 2.7.4. Alignment 2.7.5. Creating tables 2.7.6. Formatting tables 2.8.Graphical objects 2.8.1. Insert object (picture, drawn object) 2.8.2. Select an object 2.8.3. Edit an object 2.8.4. Format an object 2.9.Document Print setup 2.9.1. Page layout 2.9.2. Margins set up 2.9.3. Orientation 2.10. Word Document Printing 2.11. Meaning & Importance of electronic spreadsheets 2.12. Components of Spreadsheets 2.13. Application areas of spreadsheets 2.14. Using spreadsheet application 2.14.1. Parts of Excel screen: ribbon, formula bar, active cell, name box, column letter, row number, Quick Access	

Learning Outcome	Content	Suggested Assessment Methods
	Toolbar. 2.14.2. Cell Data Types 2.14.3. Block operations 2.14.4. Arithmetic operators (formula bar (-, +, *, /). 2.14.5. Cell Referencing 2.15. Data Manipulation 2.15.1. Using Functions (Sum, Average, SumIF, Count, Max, Max, IF, Rank, Product, mode etc) 2.15.2. Using Formulae 2.15.3. Sorting data 2.15.4. Filtering data 2.15.5. Visual representation using charts 2.16. Worksheet printing 2.17. Electronic Presentations 2.18. Meaning and Importance of electronic presentations 2.19. Examples of Presentation Software 2.20. Using the electronic presentation application 2.20.1. Parts of the PowerPoint screen (slide navigation pane, slide pane, notes, the ribbon, quick access toolbar, and scroll bars). 2.20.2. Open and close presentations 2.20.3. Creating Slides (Insert new slides, duplicate, or reuse slides.) 2.20.4. Text Management (insert, delete, copy, cut and paste,	

Learning Outcome	Content	Suggested Assessment Methods
	drag and drop, format, and use spell check). 2.20.5. Use magnification/zoom tools 2.20.6. Apply or change a theme. 2.20.7. Save a presentations 2.20.8. Switch between open presentations 2.21. Developing a presentation 2.21.1. Presentation views 2.21.2. Slides 2.21.3. Master slide 2.22. Text 2.22.1. Editing text 2.22.2. Formatting 2.22.3. Tables 2.23. Charts 2.23.1. Using charts 2.23.2. Organization charts 2.24. Graphical objects 2.24.1. Insert, manipulate 2.24.2. Drawings 2.25. Prepare outputs 2.25.1. Applying slide effects and transitions 2.25.2. Check and deliver 2.25.2.1. Spell check a presentation 2.25.2.2. Slide orientation 2.25.2.3. Slide shows, navigation 2.25.3. Print presentations (slides and handouts)	

Learning Outcome	Content	Suggested Assessment Methods
3. Manage Data and Information	3.1.Meaning of Data and information 3.2.Importance and Uses of data and information 3.3.Types of internet services 3.3.1. Communication Services 3.3.2. Information Retrieval Services 3.3.3. File Transfer 3.3.4. World Wide Web Services 3.3.5. Web Services 3.3.6. Automatic Network Address Configuration 3.3.7. NewsGroup 3.3.8. Ecommerce 3.4.Types of Internet Access Applications 3.5.Web browsing concepts 3.5.1. Key concepts 3.5.2. Security and safety 3.6.Web browsing 3.6.1. Using the web browser 3.6.2. Tools and settings 3.6.3. Clearing Cache and cookies 3.6.4. URIs 3.6.5. Bookmarks 3.6.6. Web outputs 3.7.Web based information 3.7.1. Search 3.7.2. Critical evaluation of information 3.7.3. Copyright, data protection 3.8.Downloads Management 3.9.Performing Digital Data Backup (Online and Offline)	1. Written Assessment 2. Oral Questioning 3. Practical Assessment 4. Project 5. Third party report 6. Portfolio of evidence 7.

Learning Outcome	Content	Suggested Assessment Methods
	3.10. Emerging issues in internet	
4. Perform Online Communication and Collaboration	4.1.Netiquette principles 4.2.Communication concepts 4.2.1. Online communities 4.2.2. Communication tools 4.2.3. Email concepts 4.3.Using email 4.3.1. Sending email 4.3.2. Receiving email 4.3.3. Tools and settings 4.3.4. Organizing email 4.4.Digital content copyright and licenses 4.5.Online collaboration tools 4.5.1. Online Storage (Google Drive) 4.5.2. Online productivity applications (Google Docs & Forms) 4.5.3. Online meetings (Google Meet/Zoom) 4.5.4. Online learning environments 4.5.5. Online calendars (Google Calendars) 4.5.6. Social networks (Facebook/Twitter - Settings & Privacy) 4.6.Preparation for online collaboration 4.6.1. Common setup features 4.6.2. Setup 4.7.Mobile collaboration 4.7.1. Key concepts 4.7.2. Using mobile devices 4.7.3. Applications	1. Written Assessment 2. Oral Questioning 3. Practical Assessment 4. Project 5. Third party report 6. Portfolio of evidence 7.

Learning Outcome	Content	Suggested Assessment Methods
	4.7.4. Synchronization	
5. Apply Cybersecurity Skills	5.1.Data protection and privacy 5.1.1. Confidentiality of data/information 5.1.2. Integrity of data/information 5.1.3. Availability of data/information 5.2.Internet security threats 5.2.1. Malware attacks 5.2.2. Social engineering attacks 5.2.3. Distributed denial of service (DDoS) 5.2.4. Man-in-the-middle attack (MitM) 5.2.5. Password attacks 5.2.6. IoT Attacks 5.2.7. Phishing Attacks 5.2.8. Ransomware 5.3.Computer threats and crimes 5.4.Cybersecurity control measures 5.4.1. Physical Controls 5.4.2. Technical/Logical Controls (Passwords, PINs, Biometrics) 5.4.3. Operational Controls 5.5.Laws governing protection of ICT in Kenya 5.5.1. The Computer Misuse and Cybercrimes Act No. 5 of 2018 5.5.2. The Data Protection Act No. 24 Of 2019	1. Written Assessment 2. Oral Questioning 3. Practical Assessment 4. Project 5. Third party report 6. Portfolio of evidence 7.

Learning Outcome	Content	Suggested Assessment Methods
6. Perform Online Jobs	6.1.Introduction to online working 6.1.1. Types of online Jobs 6.1.2. Online job platforms 6.1.2.1.Remotask 6.1.2.2.Data annotation tech 6.1.2.3.Cloud worker 6.1.2.4.Upwork 6.1.2.5.Oneforma 6.1.2.6.Appen 6.2.Online account and profile management 6.3.Identifying online jobs/job bidding 6.4.Online digital identity 6.5.Executing online tasks 6.6.Management of online payment accounts.	1. Written Assessment 2. Oral Questioning 3. Practical Assessment 4. Project 5. Third party report 6. Portfolio of evidence 7.
7. Apply job entry techniques.	7.1.Types of job opportunities 7.1.1. Self-employment 7.1.2. Service provision 7.1.3. product development 7.1.4. salaried employment 7.2.Sources of job opportunities 7.3.Resume/ curriculum vitae 7.3.1. What is a CV 7.3.2. How long should a CV be 7.3.3. What to include in a AC 7.3.4. Format of CV 7.3.5. How to write a good CV 7.3.6. Don’ts of writing a CV	1. Written Assessment 2. Oral Questioning 3. Practical Assessment 4. Project 5. Third party report 6. Portfolio of evidence 7.

Learning Outcome	Content	Suggested Assessment Methods
	7.4.Job application letter 7.4.1. What to include 7.4.2. Addressing a cover letter 7.4.3. Signing off a cover letter 7.5. Portfolio of Evidence 7.5.1. Academic credentials 7.5.2. Letters of commendations 7.5.3. Certification of participations 7.5.4. Awards and decorations 7.6.Interview skills 7.6.1. Listening skills 7.6.2. Grooming 7.6.3. Language command 7.6.4. Articulation of issues 7.6.5. Body language 7.6.6. Time management 7.6.7. Honesty 7.7.Generally knowledgeable in current affairs and technical area	

Suggested Delivery Methods

- Demonstration
- Practical
- Multimedia
- Group discussions
- Project
- Role play
- Case study

Recommended Resources for 25 Trainees

S/No.	Category/Item	Description/ Specifications	Quantity	Recommended Ratio (Item: Trainee)
A	**Learning Materials**			
1.	Textbooks	Digital Literacy: Concepts and Applications by Ben Brow	10 pcs	1:3
2.	Printed training materials	Sample CVs Sample job applications	5 pcs 5 pcs	1:5 1:5
3.	Online Resources	Khan Academy, Coursera, and YouTube for supplementary video content.	Accessible in 25 computers	1:1
B	**Learning Facilities & infrastructure**			
4.	Lecture/theory room	$60m^2$	1	1:25
5.	Computer workshop	160 m^2	1	1:25
6.	Computers	Operating System: 64-bit Windows 11 or 10 version 1809 or above Processor: 2.5 GHz (3+ GHz recommended), Memory: 8 GB (32GB recommended) Disk space: 10 GB Display: 1920 x 1080 resolution Display Card: 2 GB GPU (8 GB recommended) and DirectX 11 compliant	25 pcs	1:1

		(DirectX 12 recommended)		
7.	Projector	high-resolution projectors with HDMI input	1	1:25
8.	Smartboard/Smart TV	Specifications: 77-inch interactive whiteboard with touch and pen functionality.	1	1:25
9.	Whiteboard	Traditional whiteboard	1	1:25
10.	External storage media	USB flash drives (32GB), External HDD/SSD	25 pcs	1:1
11.	Webcams	HD (1080p)	25 pcs	1:1
12.	Printers	With Print, Copy, Scan and Fax	2	1:13
13.	Over-ear headphones	Large diaphragm	25 pcs	1:1
C	**Software**			
14.	Operating systems	Windows/Linux/Macintosh Operating System	For 25 computers	1:1
15.	Office	Microsoft Office Software	For 25 computers	1:1
16.	Workspace	Google Workspace Account	For 25 computers	1:1
17.	Antivirus Software		For 25 computers	1:1
18.	Photo editing software	Adobe Photoshop, Canva, GIMP	For 25 computers	1:1
19.	Video editing software	Adobe Premiere Pro, iMovie, DaVinci Resolve	For 25 computers	1:1
20.	Web Browsers	Chrome, Firefox, Edge, Safari	For 25 computers	1:1
D	**Consumables**			

21.	Pens, pencils, rulers and paper	Whiteboard markers, 2H pencils, plastic rulers, A2 white papers	Enough	
22.	Printing papers	A4 and A3	Enough	

ENGINEERING DRAWINGS

UNIT CODE: 0732 441 05A

TVETCDACC UNIT CODE: ENG/CU/IC/CC/01/5/MA

Relationship to Occupational Standards

This unit addresses the unit of competency: Prepare engineering drawings.

Duration of Unit: 60 Hours

Unit Description

This unit covers the competencies required to prepare and interpret engineering drawings. It involves managing basic operations in AutoCAD, developing 2D Drawings in AutoCAD, producing pictorial and orthographic drawings of components and .

Summary of Learning Outcomes

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

S/NO	LEARNING OUTCOMES	DURATION(HOURS)
1.	Manage basic operations in AutoCAD	10
2.	Develop 2D Drawings in AutoCAD	15
3.	Produce pictorial and orthographic drawings of components	20
4.	Develop electrical schematic drawings using simulation software	15
	TOTAL	**60**

Learning Outcomes, Content and Suggested Assessment Methods

Learning Outcome	Content	Suggested Assessment Methods

1. Manage basic operations in AutoCAD	1.1. Introduction to CAD 1.1.1. Definition of CAD 1.1.2. Uses of CAD 1.1.3. Merits and demerits of AutoCAD over traditional method of engineering drawing. 1.2. AutoCAD installation 1.2.1. Computer system requirements for AutoCAD 1.2.2. CAD software type and versions 1.2.2.1.AutoCAD Electrical 1.2.2.2.AutoCAD Architecture 1.2.2.3.AutoCAD Mechanical 1.3. AutoCAD installation procedure 1.4. Getting started with CAD 1.4.1. Creating a new project in CAD. 1.4.2. AutoCAD user interface 1.4.2.1.Ribbon 1.4.2.2.Panels 1.4.2.3.Model space 1.4.2.4.Layout tabs 1.4.2.5.Status bar 1.4.2.6.Properties 1.5. Working with commands 1.5.1. Methods of inputting command in CAD. 1.5.1.1.Use icons on Ribbon 1.5.1.2.Use the commands box 1.5.1.3.Use Shortcuts 1.5.2. Selection methods in CAD. 1.5.2.1.One click 1.5.2.2.Window selection 1.5.2.3.Cross selection 1.5.3. 2D Cartesian workspace 1.5.4. Opening an existing project 1.5.5. Saving a new project.	1. Written Assessment 2. Oral Questioning 3. Practical Assessment 4. Project 5. Third party report 6. Portfolio of evidence

2. Develop 2D Drawings in AutoCAD	2.1. Basic Drawings and Editing Commands 2.1.1. Types of lines and application 2.1.1.1.Construction lines 2.1.1.2.Centre lines 2.1.1.3.Hidden detail lines 2.1.1.4.Border lines 2.1.1.5.Outline 2.1.2. Drawing lines 2.1.2.1.Vertical lines 2.1.2.2.Horizontal lines 2.1.2.3.Angular lines 2.1.3. Erasing objects 2.1.3.1.Use of command box 2.1.3.2.Selecting and pressing delete 2.1.3.3.Use of erase icon on ribbon 2.1.4. Drawing plane geometry 2.1.4.1.Triangles 2.1.4.2.Circles and tangents 2.1.4.3.Arcs 2.1.4.4.Quadrilaterals 2.1.4.5.Polygons 2.1.4.6.Orthographic projections 2.1.4.6.1 First angle orthographic 2.1.4.6.2 Third angle orthographic 2.1.4.7.Surface development 2.1.4.8.Simple floor plans 2.1.4.9.Electrical drawings 2.1.4.9.1 Block diagram 2.1.4.9.2 Schematic diagram	1. Written Assessment 2. Oral Questioning 3. Practical Assessment 4. Project 5. Third party report 6. Portfolio of evidence 7.

	2.1.4.9.3 Line and wiring circuits 2.2. Drawing Precision in CAD 2.2.1. Using object snap overrides 2.2.2. Polar tracking at angles 2.2.3. Object snap tracking 2.2.4. Drawing with snap and grid 2.3. Making changes in your drawings 2.3.1. Selecting objects for editing 2.3.2. Moving 2.3.3. Copying 2.3.4. Rotating 2.3.5. Mirroring 2.3.6. Scaling 2.3.7. Trimming and extending 2.3.8. Stretching 2.3.9. Creating fillets and chamfers 2.3.10. Creating arrays 2.4. Annotations 2.4.1. Adding a text in a drawing 2.4.2. Modifying multiline text 2.4.3. Formatting multiline text 2.4.4. Creating tables 2.4.4.1.Title block 2.4.4.2.Modifying tables 2.5. Adding dimensions to drawings 2.5.1. Dimensioning concepts 2.5.2. Adding linear dimensions 2.5.3. Adding radial and angular dimensions 2.5.4. Editing dimensions 2.6. 2D drawings documentation 2.6.1. Printing concepts 2.6.2. Printing layouts 2.6.3. Print and plot settings	
3. Produce pictorial and orthographic	3.1. Pictorial and orthographic drawings 3.2. Drawing and interpretation of orthographic elevations using CAD	1. Written Assessment

drawings of components	3.3. Dimensioning of orthographic elevations 3.4. 3D CAD user interface 3.4.1. Ribbon 3.4.2. Panels 3.4.3. Model space 3.4.4. Layout tabs 3.4.5. Status bar 3.4.6. Properties 3.5. Working with 3D commands 3.5.1. Methods of inputting command in CAD. 3.5.1.1.Use icons on Ribbon 3.5.1.2.Use the commands box 3.5.1.3.Use Shortcuts 3.5.2. Selection methods in CAD. 3.5.2.1.One click 3.5.2.2.Window selection 3.5.2.3.Cross selection 3.6. 3D Cartesian workspace 3.6.1. 3D CAD drawings are drafted as per work requirement 3.7. Basic solids 3.7.1. Cylinder 3.7.2. Cubes 3.7.3. Cuboids 3.7.4. Prisms 3.7.5. Pyramids 3.7.6. Cones 3.8. Produce pictorial drawings 3.8.1. Oblique drawing 3.8.2. Isometric drawing 3.9. Produce Assembly drawings 3.10. 3D drawings documentation 3.10.1. Printing layouts 3.10.2. Print and plot settings	2. Oral Questioning 3. Practical Assessment 4. Project 5. Third party report 6. Portfolio of evidence
4. Develop electrical schematic drawings using	4.1. Introduction to schematic drawing and simulation software (e.g., Circuit Wizard, Multisim)	1. Written Assessment 2. Oral Questioning

simulation software	4.2. Navigating the software interface: menus, toolbars, and workspace 4.3. Selection and insertion of electrical and electronic components 4.4. Assigning correct symbols and values to components (resistors, capacitors, transistors, ICs, etc.) 4.5. Labelling components and circuits with reference designators and values 4.6. Use of virtual instruments (e.g., voltmeter, ammeter, oscilloscope) 4.7. Running simulations to test circuit functionality 4.8. Identifying and correcting circuit errors using built-in diagnostics 4.9. Saving schematic files in appropriate formats (native and export) 4.10. Printing and exporting schematic diagrams for documentation and reports	3. Practical Assessment 4. Project

Suggested Delivery Methods

- Trainer demonstration
- Simulation
- Discussions
- Direct instruction

List of Recommended Resources for 25 trainees

S/No.	Category/Item	Description/ Specifications	Quantity	Recommended Ratio (Item: Trainee)
A	**Learning Materials**			

1.	Textbooks	Introduction to Drafting and AutoCAD 2D Comprehensive Guide for Beginners and Intermediate Users by CAD Artifex Technical Drawing 101 with AutoCAD by Ashleigh Congdon-Fuller, Antonio Ramirez and Douglas Smith Circuit Simulation with Multisim by David Baez-Lopez SPICE for Circuits and Electronics Using PSpice by Muhammad H. Rashid	5 pcs 5 pcs 5 pcs	1:5 1:5 1:5
2.	Installation manuals	AutoCAD software installation manual, circuit wizard installation manual	25 pcs	1:51
3.	Power point presentations	For trainer's use	1	1:25
B	**Learning Facilities & infrastructure**			
4.	Lecture/theory room	$60m^2$	1	1:25
5.	Computer laboratory	$160m^2$	1	1:25
6.	Computer	Operating System: 64-bit Windows 11 or 10 version 1809 or above Processor: 2.5 GHz (3+ GHz recommended), Memory: 8 GB (32GB recommended) Disk space: 10 GB Display: 1920 x 1080 resolution	25 pcs	1:1

		Display Card: 2 GB GPU (8 GB recommended) and DirectX 11 compliant (DirectX 12 recommended)		
7.	Projector	At least 3000 lumens	1	1:25
8.	Interactive screen	75 inches	1	1:25
C	**Software**			
9.	Solid works	Solid works 2024 Standard	1	1:25
10.	AutoCAD	AutoCAD 2025	1	1:25
11.	Circuit Wizard or any other equivalent schematic circuit simulation software	Circuit Wizard 2025	1	1:25
12.	Solid works licenses	Solid works 2024 Standard version licenses	25	1:1
13.	AutoCAD licenses	AutoCAD 2025 licenses	25	1:1
14.	Circuit Wizard license	Circuit Wizard 2025 license	25	1:1

ELECTRONICS CIRCUIT FABRICATION

UNIT CODE: 0714 451 08A

TVETCDACC UNIT CODE: ENG/CU/IC/CR/01/5/MA

Relationship to Occupational Standards

This unit addresses the unit of competency: Fabricate electronic circuits.

Duration of Unit: 120 Hours

Unit Description

This unit covers the competencies required to fabricate electronic circuits. It involves building logic gate circuits, fabricating semiconductor diode circuits, building amplifier circuits, fabricating signal generators, signal filter circuits and microprocessor-based systems.

Summary of Learning Outcomes

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

S/NO	LEARNING OUTCOME	DURATION (HOURS)
1.	Build Logic Gate Circuits	20
2.	Fabricate semiconductor diode circuits	15
3.	Build amplifier circuits	30
4.	Fabricate signal generators	15
5.	Fabricate signal filter circuits	15
6.	Fabricate microprocessor-based systems	25
	TOTAL HOURS	**120**

Learning Outcomes, Content and Suggested Assessment Methods

Learning Outcome	Content	Suggested Assessment Methods
1. Build Logic Gate Circuits	1.1 Difference between analog and digital 1.2 Number systems 1.2.1 Types of Number Systems 1.2.1.1 Binary 1.2.1.2 Decimal 1.2.1.3 Hexadecimal 1.2.1.4 Octal 1.2.2 Conversions between Number Systems 1.2.3 Binary Arithmetic 1.2.3.1 Addition and subtraction 1.3 Logic gates 1.3.1 AND 1.3.2 OR 1.3.3 NOT 1.3.4 NAND 1.3.5 NOR 1.3.6 XOR 1.4 Truth tables for logic gates 1.5 Boolean algebra and simplification. 1.6 Combinational logic circuits 1.12.1 Half-adders build with two logic gates: 1.12.1.1 XOR 1.12.1.2 AND 1.12.2 Decoders: 1.12.2.1 2-to-4 1.12.2.2 3-to-8 1.12.3 Multiplexers 1.12.3.1 2-to-1 1.12.3.2 4-to-1 5.1 Test combinational logic circuits 5.2 Sequential logic circuits 1.2.1 SR Latch using NAND/NOR gates 1.2.2 D Flip-Flop 1.2.3 Counters	1. Written Assessment 2. Oral Questioning 3. Practical Assessment 4. Project 5. Third party report 6. Portfolio of evidence

Learning Outcome	Content	Suggested Assessment Methods
	1.2.3.1 Binary counters 1.2.3.2 Asynchronous counters 1.2.4 4-bit shift register 1.15 Test logic circuits	
2. Fabricate semiconductor diode circuits	2.1 Atomic structure 2.1.1 Structure of the Atom 2.1.2 Energy band theory 2.2 Types of materials 2.2.1. Insulators 2.2.2. Conductors 2.2.3. Semiconductors 2.3 Types of semiconductors materials 2.3.1. Intrinsic semiconductors 2.3.2. Extrinsic semiconductors 2.4 pn junction/crystal diode 2.5 Characteristics of the crystal diode 2.6 Biasing of the crystal diode 2.7 Special purpose diodes 2.7.1 LED 2.7.2 Photodiode 2.7.3 Optoisolator 2.7.4 Schockley diode 2.7.5 Application of semiconductor diodes 2.8 Fabrication tools and equipment 2.8.1 Hand Tools 2.8.1.1 Soldering iron 2.8.1.2 Desoldering pump 2.8.1.3 Pliers 2.8.1.4 Wire strippers 2.8.1.5 Cutters. 2.8.2 Measurement tools 2.8.2.1 Multimeter 2.8.2.2 Logic analyzer 2.8.2.3 Oscilloscope 2.8.2.4 LCR meter.	1. Written Assessment 2. Oral Questioning 3. Practical Assessment 4. Project 5. Third party report 6. Portfolio of evidence

Learning Outcome	Content	Suggested Assessment Methods
	2.8.2.5 Understanding 2.8.3 Soldering Stations 2.8.4 Breadboard 2.9 Build semiconductor diode circuits 2.9.1 Rectifiers 2.9.1.1 Half-wave rectifier 2.9.1.2 Full wave rectifier 2.9.1.3 Application of rectifiers 2.10 Types of converters 2.10.1 DC to AC Converter (Inverter) 2.10.2 DC to DC Converter 2.10.3 AC to AC Converter 2.10.4 Application of converters 2.11 Voltage regulation 2.11.1 Voltage regulator IC method. 2.12 Test semiconductor diode circuits 2.12.1 Measurement techniques for diode voltage and current. 2.12.2 Display input and output waveforms 2.12.3 Continuity test 2.12.4 Test LED illumination. 2.12.5 Testing diode faults	
3. Build amplifier circuits	3.1 Introduction to transistors i. BJT transistors 1. NPN 2. PNP ii. FET transistors 1. JFET 2. MOSFETs 3.2 Biasing techniques 3.3 Amplifier ICs 3.3.1 Introduction to common amplifier IC families: 3.3.1.1 TDA series 3.3.1.2 LM series	1. Written Assessment 2. Oral Questioning 3. Practical Assessment 4. Project 5. Third party report 6. Portfolio of evidence

Learning Outcome	Content	Suggested Assessment Methods
	3.3.1.3 LA series. 3.4 Construct amplifier circuits 3.4.1 Single-stage CE amplifier 3.4.2 Two-stage amplifier 3.4.3 Op-Amp inverting and non-inverting amplifiers 3.4.4 Simple audio amplifiers using amplifier ICs 3.5 Test amplifier circuits 3.5.1 Measure voltage and current flow 3.5.2 Observe input and output voltage waveforms 3.5.3 Check for distortion 3.5.4 Confirm continuity and polarity using a multimeter	
4. Fabricate signal generators	4.1 Introduction signal generator circuits 4.1.1 Oscillators 4.1.1.1 Crystal oscillator (radio frequency oscillator) 4.1.2 Multivibrator circuits: 4.1.2.1 Bistable 4.1.2.2 Astable 4.2 Construct signal generator circuits 4.2.1 Bistable multivibrator 4.2.2 Astable multivibrator 4.3 Generate waveforms using the function generator 4.4 Test signal generator circuits 5. Measure voltage, current, and display waveforms 6. Record the amplitude, frequency, and period	1. Written Assessment 2. Oral Questioning 3. Practical Assessment 4. Project 5. Third party report 6. Portfolio of evidence
5. Fabricate signal filter circuits	a. Introduction to types of active Opamp-based filters	7. Written Assessment

Learning Outcome	Content	Suggested Assessment Methods
	i. low-pass ii. high-pass iii. band-pass b. Construct signal filter circuits; 5.2.1 Low-pass filter circuit 5.2.2 High-pass filter circuit 5.2.3 Band-pass filter circuit c. Test signal filter circuits 5.3.1 Measure the output waveform 5.3.2 Verify the filter passes or blocks the correct frequency range. 5.3.3 Measure the cut-off frequency to match circuit specification.	8. Oral Questioning 9. Practical Assessment 10. Project 11. Third party report 12. Portfolio of evidence
6. Fabricate microcontroller-based systems	6.1 Introduction to Basic architecture of a microprocessor/microcontroller 6.1.1 CPU 6.1.2 Memory 6.1.3 Input/output ports 6.2 Basic microprocessors or microcontroller programming. 6.2.1 Arduino or 6.2.2 Raspberry-Pi 6.3 Interfacing of peripherals to a microprocessor/microcontroller. 6.3.1 LCD/LED displays 6.3.2 Keypads 6.3.3 Push buttons 6.3.4 Temperature sensors 6.3.5 Light sensors 6.3.6 Actuators: motors, or relays 6.4 Construct microprocessor-based systems 6.4.1 Simple LED control system (using microcontrollers)	1. Written Assessment 2. Oral Questioning 3. Practical Assessment 4. Project 5. Third party report 6. Portfolio of evidence

Learning Outcome	Content	Suggested Assessment Methods
	6.4.2 Temperature monitoring system with sensor feedback 6.4.3 Motor control system (DC/servo motors) 6.5 Test microprocessor-based systems 6.5.1 Measure voltages and signals 6.5.2 Debug programs and hardware circuits to identify and correct errors 6.5.3 Simulate inputs to verify system response. 6.5.4 Test communication between the microcontroller and peripherals.	

Suggested Methods of Instruction

- Group discussions
- Demonstration
- Case studies
- Industry visits

Recommended Resources for 25 trainees

S/No.	Category/Item	Description/ Specifications	Quantity	Recommended Ratio (Item: Trainee)
A	**Learning Materials**			
11.	Reference books	Mehta, V. K., & Mehta, R. (2020). Principles of electronics (12 edition). S. Chand and Company Limited, Theraja, B. L., & Theraja, A. K. (2005). A textbook of electrical technology (1st multicolour ed., Multicolour illustrative	10 pcs for each book	1:3

		ed., 23rd rev. multicoloured ed). S. Chand & Co. Bird, J. O. (2022). Bird's electrical and electronic principles and technology (Seventh edition). Routledge, Taylor & Francis Group. Wilcher, D. (2015). Arduino electronics blueprints: make common electronic devices interact with an Arduino board to build amazing out-of-the-box projects. Packt Publishing. Maini, A. K. (2008). Digital electronics: principles, devices and applications. Wiley India.		
12.	Software	Simulation software: Circuit wizard, Proteus, Multisim.	Enough	-
13.	Audio visual presentations	Projector at least 3000 lumens	1	1:25
B	**Learning Facilities & infrastructure**			
14.	Lecture/theory room	$60m^2$	1	1:25
15.	Workshop	$150m^2$	1	1:25
16.	Computer laboratory	$100m^2$	1	1:25
C	**Consumable materials**			
17.	Resistors 1/4W rating	1 Ω, 2.2 Ω, 3.3 Ω ,10 Ω, 22 Ω, 47 Ω, 68 Ω, 100 Ω, 120 Ω, 150 Ω, 220 Ω, 330 Ω, 470 Ω, 560 Ω 680 Ω, 1 kΩ, 1.2 kΩ, 2kΩ, 3.3 kΩ, 4.7 kΩ, 5.6kΩ, 10 kΩ, 22 kΩ, 33 kΩ, 47 kΩ, 100 kΩ, 220 kΩ, 330 kΩ, 470 kΩ, 1 MΩ, 2.2 MΩ	100 pcs for each category	4:1

18.	Potentiometers	1 kΩ, 10 kΩ, 50 kΩ, 100 kΩ	50 pcs for each category	2:1
19.	Polarised electrolytic capacitors	1µF(16V, 25V, 50V), 4.7µF(16V, 25V, 50V), 10µF(16V, 25V, 50V, 63V), 22µF(16V, 25V, 50V), 33µF(25V, 35V, 50V), 47µF(16V, 25V, 50V), 100µF(16V, 25V, 35V, 50V), 220µF(25V, 35V, 50V, 63V) 470µF(16V, 25V, 35V, 50V) 1000µF(16V, 25V, 35V, 50V), 2200µF(25V, 35V, 50V), 4700µF(25V, 35V, 50V)	50 pcs for each category for each voltage rating.	2:1
20.	Ceramic capacitors aassortment kit 10pf to 100nF (non-polarized)	10pF(100), 20pF(200), 30pF(300), 47pF(470), 56pF(560), 68pF(680), 100pF(101), 220pF(221), 330pF(331), 680pF(681), 1nF(102), 4.7nF(472), 10nF(101), 47nF(471), 100nF(104)	50 pcs for each category	2:1
21.	Polyester film capacitor assortment kit - 0.22nF to 470nF / 100V (non-polarised)	0.22nF(221), 0.33nF(331), 0.47nF(471), 0.56nF(561), 0.68nF(681), 1nF(102), 2.2nF(222), 2.7nf(272), 3.3nF(332), 3.9nF(392), 4.7nF(472), 6.8nF(682), 10nF(103), 15nF(153), 22nF(223), 33nF(333), 39nF(393), 47nF(473), 68nF(683), 82nF(823), 100nF(104), 150nF(154), 220nF(224), 470nF(474)	50 pcs for each category	2:1
22.	Transformer	120-240Vac, 12V-0-12V, 2A, 50Hz	25 pcs for each category	1:1

23.	Rectifier diode	1N4001, 1N4002.	25 pcs for each category	2:1
24.	Zener diodes 0.5W	5.1V, 7.5V, 12V, 18V, 24V	25pcs for each category	1:1
25.	Voltage regulators	L7805, L7809, L7812, L7815, L7824, L7905, L7912,	25pcs for each category	1:1
26.	MOSFET	IRFZ44N, IRF520, IRF540	25pcs for each category	1:1
27.	Assorted colors of light emitting diodes (LEDs)	3mm, 5mm	500 pieces for each category	20:1
28.	Schottky diode	IN5817, IN5819	10 pcs for each category	1:3
29.	Strip boards	Stripboard 6.5cm x 14.5cm Single Sided	50 pieces	2:1
30.	Solder wire	1mm-diameter, rosin activated, lead free soldering wire 50g	2pcs for each category	1:13
31.	Flux	Soldering paste flux 150g	2pcs for each category	1:13
32.	DIP IC sockets		100 pieces	4:1
33.	Assorted jumper wires (soft) for stripboard	Red, blue, green, yellow, black	50m for each category	2:1
34.	Assorted jumper wire (hard) for breadboard	Red, blue, green, black	50m for each category	2:1
35.	Audio connector jack pin		50 pcs	2:1
36.	Audio speaker		25 pcs	1:1
37.	Female - DC power connector		25 pcs	1:1
38.	Solder wire			

39.	Crocodile/ alligator clips	50cm Test Leads Alligator Clips Double-end	25 pcs	1:1
40.	555 Timer	NE555 IC DIP-8	25 pcs	1:1
41.	Arduino 8-Bit Processor chip	Atmel's ATMega328P	25 pcs	1:1
42.	Arduino board	Arduino Uno R3 (with removable IC Chip) complete with USB Cable	25 pcs	1:1
43.	LCD display	LCD 20X4 (2004)	25 pcs	1:1
44.	Assorted jumpers with connector pins	M-M jumpers, M-F jumpers, F-F jumpers	200 pcs for each category	8:1
45.	PIR Motion sensor module		10 pcs	1:3
46.	BJT (NPN) transistor	BC547, BC108, 2N3904, 2N2222, TIP31,	50 pcs	2:1
47.	BJT (PNP) transistor	BC557, 2N3906, 2N2907, TIP32,	25 pcs	1:1
48.	Light Dependent Resistor	LDR 12mm	25 pcs	1:1
49.	OPAMPs	LM358, LM741	25 pcs for each category	1:1
50.	Audio amplifier ICs	TDA2030, LM386, LA4445, LA4440	25 pcs for each category	1:1
51.	74 series logic gates - TTL Logic	7400, 7402, 7404, 7408, 7432,	25pcs for each category	1:1
52.	4000-series CMOS ICs	CD4011, CD4013, CD4027, CD4026, CD4047, CD4060, CD4051, CD4052, CD4093	25pcs for each category	1:1
53.	74 series ICs	74LS74, 74LS76, 74LS86, 74LS90, 74LS138, 74LS145, 74LS151, 74LS153 ICs	25pcs for each category	1:1
54.	SPDT Relay (125-250Vac)	5V DC SPDT Relay, 12V DC SPDT Relay.	25pcs for each category	1:1

55.	Multi-channel Relay Module (125-250Vac)	5V DC 4-Channel Relay, 12V DC 4-Channel Relay	25 pcs for each category	1:1
56.	Push button non-self-locking	mini-switch	25pcs for each category	1:1
57.	Push button self-locking	mini-switch	25pcs for each category	1:1
58.	Slide switch SPDT 3 pins	mini-switch	25pcs for each category	1:1
59.	DC motor	DC 3V-6V 2000RPM R140 motor	10 pcs	1:3
60.	NTC Thermistors	10kΩ,100kΩ	25pcs for each category	1:1
61.	Temperature sensor	Digital temperature sensor	25pcs for each category	1:1
62.	Fluid level sensor	eTape Liquid Level Sensors	2 pcs	1:13
63.	Soil Moisture Sensor		5 pcs for each category	1:5
64.	IR (infrared) sensor module	Detection Range: 10 cm to 80 Wavelength: Around 850 nm to 950 nm	13 pcs	1:2
65.	Ultrasonic Sensor	Operating Voltage: 5V DC	13 pcs	1:2
66.	Temperature and Humidity Sensor	Temperature Range: -40°C to +75°C Humidity Range: 0 to 100%	13 pcs	1:2
67.	Water Level Sensor Float Switch	Max Contact Rating: 10W	5 pcs	1:5
D	**Tools and Equipment**			
68.	Bread boards		25 pcs	1:1
69.	Assorted tools	Side cutters, Pliers, crimping, Tweezers, Long-nose, Assorted screw drivers.	25 pcs	1:1

70.	Solder gun/iron	Solder gun/iron 15W - 30W, Solder gun/iron 40W - 60W,	25 pcs for each category	1:1
71.	Solder tip cleaning wire and holder	Cleaning wire: Brass or stainless-steel wire with a suitable diameter for cleaning solder tips. Holder: Magnetic or spring-loaded holder for convenient storage and access.	25pcs for each category	1:1
72.	Solder sucker	Solder sucker with a durable rubber bulb and a suitable nozzle size for removing excess solder.	25 pcs for each category	1:1
73.	Digital Oscilloscope,	Dual-channel oscilloscope with a bandwidth of at least 100 MHz, sampling rate of 1 GSa/s, memory depth of at least 1 Mpts.	5 pcs	1:5
74.	Digital Multimeter	True RMS digital multimeter with auto-ranging capability, measuring AC/DC voltage up to 600V, AC/DC current up to 10A, resistance, capacitance, frequency, and diode test.	25 pcs	1:1
75.	Digital functional generator	Digital function generator capable of generating sine, square, triangle, and other waveforms with adjustable frequency (up to at least 20 MHz) and amplitude.	5 pcs	1:5
76.	Laser jet printer		2 pcs	1:13
77.	Variable power supply	With option for both voltage and current adjustment	5 pcs	1:5
78.	Power adapters	5V Power adapters 9V Power adapters 12V Power adapters.	10 pcs	1:3

79.	Trainers kit	Analogue training kits, Digital training kits,	5 pcs for each category	1:5
80.	PCB prototyping material	Copper board, ferrite chloride solution, see-through printing paper, HASL finishing PCB	25 for each category	1:1
81.	Drilling gun	Cordless drill/driver with variable speed and torque settings, including a chuck for various drill bit sizes.	3 pcs	1:8
82.	Work stations	Individual workbenches with features like tool holders, storage compartments, and built-in lighting.	5	1:5
D	**Software**			
83.	Arduino IDE	Latest stable version of the Arduino IDE	Installed in 25 computers	1:1
84.	Simulation software	Circuit wizard/Multisim/Proteus	Installed in 25 computers	1:1

ELECTRICAL PRINCIPLES

UNIT CODE: 0713 451 07A

TVETCDACC UNIT CODE: ENG/CU/IC/CC/02/5/MA

Relationship to Occupational Standards

This unit addresses the unit of competency: Apply electrical principles.

Duration of Unit: 100 Hours

Unit Description

This unit covers the competencies required to apply electrical principles. It involves applying electrical quantities, using cells and batteries, applying concepts of dc circuit, magnetism and electromagnetism, electrostatics principles, and ac circuits.

Summary of Learning Outcomes

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

S/NO	LEARNING OUTCOMES	DURATION (HOURS)
1.	Apply electrical quantities	8
2.	Use cells and batteries	12
3.	Apply concepts of dc circuit	20
4.	Apply magnetism and electromagnetism	25
5.	Apply electrostatics principles	15
6.	Apply ac circuits	20
	TOTAL HOURS	**100**

Learning Outcomes, Content and Suggested Assessment Methods

Learning Outcome	Content	Suggested Assessment Methods
1. Apply Electrical quantities	1.1.Fundamental Electrical Concepts 1.1.1. Electrical quantities 1.1.1.1.Charge 1.1.1.2.Current	1. Written Assessment 2. Oral Questioning

	1.1.1.3.Voltage 1.1.1.4.Power 1.1.1.5.Energy 1.1.2. Units of measurement (SI units) 1.1.2.1.SI unit definition 1.1.2.2.Electrical quantities SI units 1.1.3. Practical calculations involving electrical quantities 1.1.4. Measuring electrical quantities 1.1.4.1.Using electrical quantities measuring instruments • Voltmeters • Ammeters • Ohmmeters • Multimeters • Power meters • Oscilloscope	3. Practical Assessment 4. Project 5. Third party report 6. Portfolio of evidence 7.
2. Use cells and batteries	1.1.Introduction to Cells and Batteries 1.1.1. Role of cells and batteries as sources of electrical energy in various systems. 1.1.2. Basic Concepts 1.1.2.1.Cell 1.1.2.2.Battery 1.2.Types of Cells 1.2.1. Primary Cells and Secondary Cells 1.2.2. Examples of Primary Cells and Secondary Cells 1.2.3. Applications of Primary Cells and Secondary Cells 1.3.Battery Configurations and Ratings 1.3.1. Series Connection 1.3.2. Parallel Connection. 1.3.3. Ratings 1.3.3.1.Voltage 1.3.3.2.Capacity (mAh or Ah) 1.3.3.3.Energy Density 1.4.Working Principles of Cells and Batteries	1. Written Assessment 2. Oral Questioning 3. Practical Assessment 4. Project 5. Third party report 6. Portfolio of evidence

	1.4.1. Electrochemical Reaction 1.4.2. Basic Components 1.4.2.1.Anode 1.4.2.2.Cathode. 1.4.2.3.Electrolyte 1.4.3. Operation Cycle 1.4.3.1.Discharge 1.4.3.2.Recharge 1.4.4. E.M.F and internal resistance of cells 1.5.Types of Batteries and Applications 1.5.1. Lead-Acid Batteries 1.5.1.1.Advantages and disadvantages 1.5.1.2.Applications 1.5.2. Lithium-Ion (Li-ion) Batteries 1.5.2.1.Advantages and disadvantages 1.5.2.2.Applications 1.5.3. Lithium-Polymer (Li-Po) Batteries 1.5.3.1.Advantages and disadvantages 1.5.3.2.Applications 1.6.Battery Maintenance and Safety	
3. Apply Concepts of DC circuit	3.1. Basics of DC Circuits 3.1.1. Definition of a DC circuit 3.1.2. Key Components in a DC circuit 3.1.2.1.Voltage (V) 3.1.2.2.Current (I) 3.1.2.3.Resistance (R) 3.1.3. Ohm's Law 3.1.3.1.Relationship between voltage, current, and resistance 3.1.3.2.Applying Ohm’s law 3.2.Series and Parallel Circuits 3.2.1. Series Circuits 3.2.2. Parallel Circuits 3.2.3. Series-parallel circuits 3.3.Kirchhoff's Laws	1. Written Assessment 2. Oral Questioning 3. Practical Assessment 4. Project 5. Third party report 6. Portfolio of evidence 7.

	3.3.1. Kirchhoff's Current Law (KCL) 3.3.2. Kirchhoff's Voltage Law (KVL) 3.3.3. Applications of KCL and KVL 3.4.Voltage and current dividers 3.5. Power in DC Circuits 3.5.1. Power definition 3.5.2. $P = V \times I$ or $P = I^2 \times R$ or $P = \frac{V^2}{R}$ 3.5.3. Applications 3.5.3.1.Calculating energy consumption 3.5.3.2.Heat dissipation 3.5.3.3.Efficiency of DC circuit components. 3.6.Energy Stored in DC Circuits 3.6.1. Energy (E) definition 3.6.2. $E = P \times t$ where t is time 3.6.3. Applications 3.6.3.1.Estimating battery life 3.6.3.2.Capacitor charge/discharge 3.6.3.3.Energy storage. 3.7.Capacitors and Inductors in DC Circuits 3.7.1. Capacitors 3.7.1.1.Functions in DC circuits 3.7.1.2.Behaviour in DC Circuits 3.7.2. Inductors 3.7.2.1.Functions in DC circuits 3.7.2.2.Behaviour in DC Circuits 3.8.DC Circuit Applications 3.8.1.1.Lighting circuits 3.8.1.2.Motor control circuits	
4. Apply magnetism and electromagnetism	4.1 Introduction to Magnetism 4.3.1 Definition of terms • Magnetism • Magnetic field • Magnetic field lines • Magnetic field strength units	1. Written Assessment 2. Oral Questioning 3. Practical Assessment 4. Project

	• Magnetization 4.2 Magnetism and magnetic fields 4.3.1 Types of Magnetic Materials: • Ferromagnetic • Paramagnetic • Diamagnetic. • Permanent and Temporary Magnets 4.3 Electromagnetism Basics 4.3.1 Magnetic Field Around a Current-Carrying Conductor 4.3.2 Right-Hand Rule 4.3.3 Electromagnet 4.3.4 Applications of electromagnets 4.3.5 Key Principles of Electromagnetism • Ampere's Law • Faraday's Law of Electromagnetic Induction • Lenz's Law • Magnetic Flux 4.3.6 Applications of Electromagnetism • Transformers • Electric Motors and Generators • Relays and Solenoids • Magnetic Storage 4.4 Magnetic Circuits and Permeability 4.3.1 Introduction to Magnetic Circuits • Definition and components of magnetic circuits. • Difference between magnetic and electric circuits. • Overview of magnetic flux, MMF, reluctance, and permeability. 4.3.2 Magnetic Flux and MMF	5. Third party report 6. Portfolio of evidence 7.

	• Magnetic flux calculation and interpretation. • Concepts of magnetomotive force (MMF) and its importance in magnetic circuits. • Introduction to magnetic field strength (H) and flux density (B). 4.3.3 Permeability and Reluctance • Definition of permeability and how it affects magnetic materials. • Reluctance calculation and role in magnetic circuits. 4.3.4 Ohm's Law for Magnetic Circuits • Application of Ohm's Law analogy to magnetic circuits. • Calculation exercises. • Analyzing magnetic circuit diagrams. 4.3.5 Transformer and Motor Magnetic Circuits • Components of a Transformer • Primary windings • Secondary windings • Core materials • Application of magnetic circuits in transformers. • Overview of DC and AC motor magnetic circuits • Operational principles of DC and AC motor magnetic circuits. 4.3.6 Inductors • Magnetic circuits in inductors	

	• Relationship between inductance, flux linkage, and stored energy. • Hands-on inductor circuit building and testing. • Applications of inductors I. Filter circuits II. Storage devices 4.5 Magnetic and Electromagnetic Devices in Industrial Applications 4.3.1 Magnetic Sensors 4.3.2 Electromagnetic Brakes and Clutches. 4.6 Electromagnetic Safety and Shielding 4.3.1 Electromagnetic Interference (EMI). 4.3.2 Shielding 4.3.3 Safety Precautions	
5. Apply Electrostatics principles	5.1 Fundamental Concepts of Electrostatics 1.1.1. Electric Charge 1.1.2. Coulomb's Law 1.1.3. Electric Field 1.1.3.1.Definition and properties 1.1.3.2.Electric field lines 1.1.3.3.Electric field intensity 1.1.4. Electric Potential and Potential Energy 1.1.4.1.Electric potential difference (voltage) 1.1.4.2.Electric potential energy 1.1.4.3.Relationship between electric field and potential 1.1.5. Electrostatic Induction 1.1.6. Electrostatic Shielding 1.1.6.1.Protection from external electric fields 1.1.6.2.Faraday cage principle 5.2 Capacitance and Capacitors 1.2.1. Capacitance	1. Written Assessment 2. Oral Questioning 3. Practical Assessment 4. Project 5. Third party report 6. Portfolio of evidence 7.

	1.2.1.1. Definition and unit of capacitance 1.2.1.2. Factors affecting capacitance 1.2.2. Capacitors 1.2.2.1. Types of capacitors 1.2.2.2. Capacitor charging and discharging 1.2.2.3. Voltage-current relationship. 1.2.2.4. Capacitor behavior in AC and DC circuits. 1.2.3. Capacitor circuits 1.2.3.1. Series and parallel connection 1.2.3.2. RC circuits 1.2.3.3. LC circuits 1.2.3.4. RLC circuits 1.2.4. Capacitor Applications 1.2.4.1. Energy storage. 1.2.4.2. Filtering in power supplies. 1.2.4.3. Signal coupling and decoupling in circuits. 1.2.4.4. Timing circuits 1.2.4.5. Tuning and oscillation in radios and audio circuits. 1.2.5. Capacitor Testing and Maintenance 1.2.5.1. Multimeter Capacitance and leakage test. 1.2.5.2. Visual inspection 1.2.5.3. Safety considerations	
6. Apply AC circuits	6.1 AC Fundamentals 6.1.1 Definition and generation of AC voltage and current 6.1.2 Waveform characteristics: 6.1.2.1 Amplitude 6.1.2.2 Period 6.1.2.3 Frequency 6.1.2.4 phase angle	1. Written Assessment 2. Oral Questioning 3. Practical Assessment 4. Project

	6.1.3 RMS, peak, average, and instantaneous values 6.1.4 Phasor representation and vector diagrams 6.2 Calculations involving passive elements 6.2.1 Behavior of resistors, inductors, and capacitors in AC 6.2.2 Reactance (X_L, X_C) and impedance (Z) 6.2.3 Series and parallel RLC circuits 6.2.4 Voltage and current phase relationships 6.2.5 Use of Ohm's Law and impedance in AC: V=IZ 6.3 Power triangle 6.3.1 True power (P) 6.3.2 Reactive power (Q) 6.3.3 Apparent power (S) 6.3.4 Relationship among P, Q, and S 6.3.5 Units: 6.3.5.1 Watts 6.3.5.2 VARs 6.3.5.3 VA 6.4 Concept power factor (cos φ) and its significance 6.5 Calculations of power factor correction 6.5.1 Calculation of PFC capacitor values for motors 6.6 Methods of Power Factor Correction 6.6.1 Static correction (using shunt capacitors) 6.6.2 Automatic PFC systems (APFC panels) 6.6.3 Use of synchronous condensers 6.6.4 PFC in industrial setups (inductive loads) 6.7 Safety and maintenance of PFC devices 6.8 Inspection and testing of capacitor banks	5. Third party report 6. Portfolio of evidence 7.

Suggested Delivery Methods

- Demonstration
- Discussions
- Direct instruction
- Industry visits

List of Recommended Resources for 25 trainees

S/No.	Category/Item	Description/ Specifications	Quantity	Recommended Ratio (Item: Trainee)
A	**Learning Materials**			
1.	Textbooks	Comprehensive guides on electrical principles, such as Electrical Engineering Fundamentals by Vincent Del Toro. Electrical and Electronic Principles and Technology ByJohn Bird, John Bird	5 pcs 5 pcs	1:5 1:5
2.	Lab Manuals	Manuals detailing step-by-step experimental procedures for basic electrical concepts	Enough	-
3.	Charts and Posters	Visual aids illustrating Ohm's Law, Kirchhoff's Laws, AC/DC principles, and single/three-phase power concep	5 copies	1:5
4.	Safety Guidelines	OSHA-compliant electrical safety procedures and best practices.	5 copies	1:5
5.	Videos and Tutorials	Demonstrations of key electrical concepts and	Enough	-

		principles in practical scenarios.		
B	**Learning Facilities & infrastructure**			
6.	Lecture/theory room	$60m^2$	1	1:25
7.	Workshop	$160m^2$ With ventilation system of specifications: Fume extractor with HEPA filter, adjustable airflow With fire extinguishers, first aid kits, ESD mats, grounding straps With workbenches of specifications: ESD-safe, adjustable height, 1500mm x 750mm With soldering stations Specifications: Adjustable temperature control (200°C - 480°C), ESD-safe With hot air rework stations	1 25 pcs 25 pcs 10 pcs	1:25 1:1 1:1 1:3
8.	Projector	3000 lumens	1 pc	1:25
9.	Interactive display screen	75 inches	1 pc	1:25
10.	Computers with internet access	Processor: Intel Core i5/i7 or equivalent RAM: 8GB or higher Storage: 256GB SSD or higher	10 pcs	1:3
C	**Equipment**			

11.	Oscilloscope	Specifications: Digital, 100MHz bandwidth, 4 channels	5 pcs	1:5
12.	Multimeter	Specifications: Digital, true RMS, auto-ranging, measure voltage, current, resistance, capacitance	25 pcs	1:1
13.	Function generator	Specifications: Frequency range 0.1Hz to 10MHz, various waveforms (sine, square, triangle)	10 pcs	1:3
14.	Transformers	Single-phase step-down transformers (230V/12V).	25 pcs	1:1
15.	Power supply	Specifications: Dual output, 0-30V, 0-5A, adjustable	10 pcs	1:3
16.	Component tester	Specifications: Test resistors, capacitors, inductors, diodes, transistors	5 pcs	1:5
17.	Tweezers	Specifications: ESD-safe, various tips (straight, angled)	25 pcs each category	1:1
18.	Cutters	ESD-safe, flush cutters	25 pcs	1:1
19.	Pliers	ESD-safe needle-nose pliers	25 pcs	1:1
20.	Screwdrivers	Specifications: Precision set, various sizes (Phillips, flathead)	5 sets	1:5
21.	ESD mats	Specifications: Workbench and floor mats, grounding cords	10 pcs	1:3
22.	Wrist straps	Specifications: Adjustable, grounding cord with 1MΩ resistor	25 pcs	1:1

23.	Electrical Trainers	Modular trainer kits for basic electrical circuits, including resistors, capacitors, and inductors.	5 sets	1:5
C	**Consumable materials**			
24.	Resistors	Specifications: 1/4 watt, 1%, various values (10Ω - 1MΩ)	100 pcs each category	4:1
25.	Capacitors	Specifications: Ceramic, electrolytic, tantalum, various values (1pF - 1000µF)	100 pcs each category	4:1
26.	Inductors	Specifications: Various values (1µH - 10mH)	100 pcs each category	4:1
27.	Diodes	Specifications: 1N4001, 1N4148, Zener diodes of various voltages	100 pcs each category	4:1
28.	Transistors	Specifications: NPN (2N2222), PNP (2N2907), MOSFET (IRF540N)	100 pcs each category	4:1
29.	Integrated Circuits	Specifications: Op-amps (LM741), Timers (NE555)	100 pcs each category	4:1
30.	Connectors and headers	Specifications: Male and female headers, USB connectors, screw terminals	Enough	
31.	Solder wire	Specifications: Lead-free, 0.8mm diameter, Sn63/Pb37 composition	25 rolls	1:1
32.	Soldering Flux	Specifications: Rosin flux, liquid and paste	Enough	
33.	Cleaning reagents	Isopropyl of 99% purity	20 litres	1:1.25

34.	Brushes	Specifications: Anti-static, soft bristles	25	1:1
35.	Solder wires	Red and black	5 rolls each category	1:5
36.	Bread boards	Specifications: 830 tie-points, solderless, multiple power rails	50 pcs	1:2
37.	Printed Circuit Boards	Pre-designed PCBs and blank boards for soldering exercises and circuit prototyping.	50 pcs	1:2
38.	Strip boards		200	1:8
39.	100 Light Emitting Diodes	Red/yellow/green/white	100 pcs each category	4:1
D	**Software**			
40.	Simulation software	LTSpice, Proteus and Multisim Specifications: Simulate electronic circuits, support for various components and models	Installed in 25 computers	1:1

HYDRAULIC AND PNEUMATIC SYSTEM INSTALLATION

UNIT CODE: 0715 451 19A

TVETCDACC UNIT CODE: ENG/CU/IC/CR/02/5/MA

Relationship to Occupational Standards

This unit addresses the unit of competency: Install hydraulic and pneumatic systems.

Duration of Unit: 120 Hours

Unit Description

This unit covers the competencies required to install hydraulic and pneumatic systems. It involves conducting hydraulic and pneumatic system site survey, preparing for installation of hydraulic and pneumatics, mounting hydraulic systems, mounting pneumatic systems, and testing and commissioning of hydraulic and pneumatic systems.

Summary of Learning Outcomes

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

S/NO	LEARNING OUTCOME	DURATION (HOURS)
1.	To conduct hydraulic and pneumatic system site survey	15
2.	To prepare for installation of hydraulic and pneumatics	20
3.	To mount hydraulic system	35
4.	To mount pneumatic systems	30
5.	To test and commission hydraulic and pneumatic systems	20
	TOTAL HOURS	**120**

Learning Outcomes, Content and Suggested Assessment Methods

Learning Outcome	Content	Suggested Assessment Methods

1. Conduct hydraulic and pneumatic system site survey	1.1 Health and safety procedures 1.2 Introduction to hydraulic and pneumatic systems 1.2.1 Hydraulic and pneumatic system components and symbols 1.2.2 General layout of hydraulic and pneumatic system 1.2.3 Applications of hydraulic and pneumatic systems 1.3 Factors influencing the location of Hydraulic and pneumatic system 1.3.1 Safety 1.3.2 Accessibility 1.3.3 Environmental Conditions 1.3.4 Utilities 1.3.5 Space Requirements 1.3.6 Noise and Vibration 1.3.7 Regulatory Compliance 1.4 Site condition evaluation 1.4.1 Temperature 1.4.2 Humidity 1.4.3 Dust and contaminants 1.4.4 Vibration 1.4.5 Electromagnetic interference (EMI) 1.4.6 Space constraints 1.4.7 Accessibility 1.4.8 Ground conditions 1.4.9 Utilities 1.4.10 Fire hazards 1.4.11 Noise pollution 1.4.12 Safety equipment 1.5 Hydraulic and pneumatic system installation layout 1.5.1 Functional layout 1.5.2 Flow-based layout 1.5.3 Modular layout 1.5.4 Compact layout 1.6 Hydraulic and pneumatic system layout measurements 1.6.1 Component dimensions 1.6.2 Pressure drop 1.6.3 Flow rate 1.6.4 Ambient temperature 1.6.5 Vibration levels 1.6.6 Noise levels	1. Written tests 2. Oral Questioning 3. Practical assessment 4. Project 5. Third party report 6. Portfolio of evidence

	1.7 Site survey report 1.7.1 System objectives 1.7.2 System description 1.7.3 Environmental conditions 1.7.4 Layout 1.7.5 Measurement records 1.7.6 Material take-off list	
2. Prepare for installation of hydraulic and pneumatics	2.1 Reading and interpreting diagrams 2.1.1 Symbols and notations 2.1.2 Hydraulic connections and pathways 2.1.3 Component identification and specifications 2.1.4 Types of hydraulic and pneumatic diagrams 2.1.1.1 Schematic diagrams 2.1.1.2 Circuit diagrams 2.1.1.3 Block diagrams 2.2 Developing a hydraulic system installation work plan 2.2.1 Defining scope and objectives 2.2.2 Scheduling and milestones 2.2.3 Resource allocation 2.3 Components selection as per job specifications 2.4 Hydraulic and pneumatic system Installation documents 2.3.1 Installation schedule 2.3.2 Installation manual 2.3.3 Installation checklist 2.3.4 Installation reports	1. Written tests 2. Oral Questioning 3. Practical assessment 4. Project 5. Third party report 6. Portfolio of evidence

3. Mount hydraulic system	3.1 Tools and equipment 3.1.1 Adjustable wrenches 3.1.2 Hydraulic torque wrench 3.1.3 Sets of combinational wrenches 3.1.4 Assorted size socket wrenches 3.1.5 Assorted sizes of screw drivers 3.1.6 Assorted sizes of Allen keys 3.1.7 Cordless drills 3.1.8 Angle grinders 3.1.9 Steel pipe benders 3.1.10 Hydraulic hose cutters 3.1.11 Flushing equipment 3.1.12 Digital multimeters 3.1.13 Lifting jacks 3.2 Hydraulic system components 3.2.1 Single acting hydraulic cylinders 3.2.2 Double acting hydraulic cylinders 3.2.3 Hydraulic motors 3.2.4 Directional control valves 3.2.5 Pressure control valves 3.2.6 Flow control valves 3.2.7 Oil reservoirs 3.2.8 Solenoid valves 3.2.9 Filters 3.2.10 Hydraulic system accumulators 3.2.11 Industrial pressure sensors 3.2.12 Industrial temperature sensors 3.2.13 Industrial flow rate sensors 3.3 Types of hydraulic piping materials 3.3.1 Steel pipes 3.3.2 Stainless steel pipes 3.3.3 Plastic pipes 3.3.4 Copper pipes 3.3.5 Aluminium pipes 3.4 Hydraulic pipes selection criteria 3.4.1 Pressure rating 3.4.2 Temperature range 3.4.3 Compatibility with hydraulic fluid 3.4.4 Environmental consideration 3.5 Hydraulic piping techniques 3.5.1 Cutting 3.5.2 Bending 3.5.3 Joining	1. Written tests 2. Oral Questioning 3. Practical assessment 4. Project 5. Third party report 6. Portfolio of evidence

	3.6 Installing hydraulic system pipes and fittings 3.6.1 Types of fittings: compression fittings, flare fittings, bite-type fittings, O-ring face seal fittings 3.6.2 Preparing, aligning and installing hydraulic pipes and fittings 3.6.3 Piping supports 3.7 Mounting Accessories and Equipment 3.7.1 Mounting hydraulic components. 3.7.2 Mounting techniques. 3.7.3 Positioning and securing accessories and equipment 3.7.4 Ensuring accessibility for maintenance and operation	
4. Mount pneumatic systems	4.1 Preparation of list of tools and equipment 4.2 Tools and equipment 4.2.1 Adjustable wrenches 4.2.2 Hydraulic torque wrench 4.2.3 Sets of combinational wrenches 4.2.4 Assorted size socket wrenches 4.2.5 Assorted sizes of screw drivers 4.2.6 Assorted sizes of Allen keys 4.2.7 Ball-pen hammers 4.2.8 Rubber mallet hammers 4.2.9 Claw hammers 4.2.10 Tape measures 4.2.11 Utility knives 4.2.12 Cordless drills 4.3 Pneumatic components 4.3.1 Directional control valves 4.3.2 Pressure control valves 4.3.3 Flow control valves 4.3.4 Compressors 4.3.5 Solenoid valves 4.3.6 Pneumatic relays 4.3.7 Pneumatic timers 4.3.8 Limit switches 4.3.9 Industrial pressure sensors 4.3.10 Industrial temperature sensors 4.3.11 Flow meters	1. Written tests 2. Oral Questioning 3. Practical assessment 4. Project 5. Third party report 6. Portfolio of evidence

	4.4 Types of piping materials 4.4.1 Pneumatic metallic pipes 4.4.2 Pneumatic plastic pipes 4.4.3 Pneumatic hoses 4.5 Piping techniques 4.5.1 Cutting 4.5.2 Bending 4.5.3 Joining 4.6 Installing Piping as per Layout 4.6.1 Aligning pipes according to the layout 4.6.2 Ensuring proper support and securing of pipes 4.7 Mounting Accessories and Equipment 4.7.1 Mounting pneumatic components. 4.7.2 Mounting techniques. 4.7.3 Positioning and securing accessories and equipment 4.7.4 Ensuring accessibility for maintenance and operation 4.8 Pneumatic system fittings 4.8.1 Types of Fittings: Push-in fittings, compression fittings, threaded fittings 4.8.2 Fittings installation 4.8.3 Preparing, aligning and installing pneumatic fittings.	
5. Test and commission hydraulic and pneumatic systems	5.1 Test run for hydraulic and pneumatic systems. 5.4.1 Pressure test 5.4.2 Flow rate test 5.4.3 Performance test 5.4.4 Air dryness test. 5.2 Electrical tests 5.3 Housekeeping i. Importance of housekeeping ii. Housekeeping procedure; cleaning up the installation site, organizing tools, materials and equipment. iii. Types of waste and their disposal methods iv. Segregation of waste v. Safe and environmental-friendly disposal practices.	1. Written tests 2. Oral Questioning 3. Practical assessment 4. Project 5. Third party report 6. Portfolio of evidence

	5.4 Preparing Maintenance Reports 5.4.1 Date and time of maintenance 5.4.2 Description of tasks performed 5.4.3 Parts replaced or repaired 5.4.4 Observations and recommendations 5.4.5 Personnel involved 5.4.6 Importance of maintenance reports 5.5 End user training 5.6 Handover of pneumatic systems 5.7 Commissioning documents 5.7.1 Commissioning plan 5.7.2 Test procedures and checklist 5.7.3 Instrumentation data sheet 5.7.4 Calibration certificate 5.7.5 Safety documentation 5.7.6 Commissioning reports 5.7.7 Handover report 5.7.8 Test results	

Suggested Delivery Methods

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

List of Recommended Resources for 25 trainees

S/No.	Category/Item	Description/ Specifications	Quantity	Recommended Ratio (Item: Trainee)
A	**Learning Materials**			
1.	Reference books	Industrial automation and robotics: An introduction by Jean Riescher Westcott	5 pcs	1:5
		Hydraulic and pneumatic actuators-welcome to mechatronics by Dr. Kevin Craig	5 pcs	1:5
		Hydraulics and pneumatics, Third edition: A technician's and engineer's guide by Andrew Paar	5 pcs	1:5
2.	Manuals	Hydraulic system Installation manuals Trainer manuals Trainee manuals	5 pcs 1 pc 25 pcs	1:5 1:25 1:1
	Learning Facilities & infrastructure			
3.	Theory room	$60m^2$	1	1:25
4.	Workshop	$150m^2$	1	1:25
5.	Projector		1 pc	1:25
6.	Interactive display screen	75 inches	1 pc	1:25
7.	Computers with internet access		25 pcs	1:25

8.	Directional control valves	2/2, 3/2, 4/2, 5/2, 5/3 way for sizes 1/8", 1/4", 3/8", 1/2"	25 pcs each category	1:25 pcs each category
9.	Pressure control valves	Pressure relief/ pressure reducing/pressure regulator for sizes 1/8", 1/4", 3/8", 1/2" of pressure range 0-145 psi	10 pcs each category	1:2.5 pcs each category
10.	Flow control valves	Needle valves, check valve	10 pcs each category	1:2.5 pcs each category
11.	Compressors	Reciprocating, rotary screw, rotary vane of power 1-500 HP and tank size 10-500 liters, 230 V	2 pcs	1:12.5
12.	Solenoid valves	Direct-acting, pilot-operated of port sizes 1/8", 1/4", 3/8", 1/2"	50 pcs	2:1
13.	Pneumatic relays	Volume boosters, signal amplifiers of port sizes 1/8", 1/4", 3/8", 1/2"	25 pcs	1:1
14.	Pneumatic timers	On-delay, off-delay of port sizes 1/8", 1/4", 3/8", 1/2"	25 pcs	1:1
15.	Limit switches	Mechanical, optical, inductive, capacitive	25 pcs each category	1:1 for each category
16.	Industrial pressure sensors	Gauge, absolute, differential	10 pcs	1:2.5
17.	Industrial temperature sensors	RTD, thermocouple, thermistor	10 pcs for each category	1:2.5 for each category
18.	Single acting hydraulic cylinders	Tie-Rod Cylinder Telescopic Cylinder Compact Cylinder	5 pcs for each category	1:5

		High-Pressure Cylinder		
19.	Double acting hydraulic cylinders	Tie-Rod Cylinder Telescopic Cylinder Compact Cylinder High-Pressure Cylinder	5 pcs for each category	1:5
20.	Hydraulic motors	Gear Motors Piston Motors Radial Piston Motors Axial Piston Motors	5 pcs for each category	1:5
21.	Hydraulic pipes	Steel pipes Stainless steel pipes Plastic pipes Copper pipes Aluminium pipes	10m for each category	1.5
22.	Flow meters	4-20mA, 0-10V, RS485	10 pcs	1:2.5
23	Adjustable wrenches	Metric and standard sizes	10 pcs	1:2.5
24.	Hydraulic torque wrench	Metric and standard sizes	5 pcs	1:5
25.	Sets of combinational wrenches	Metric and standard sizes	5 sets	1:5
26.	Assorted size socket wrenches	Metric and standard sizes	5 sets	1:5
27.	Assorted sizes of screw drivers	Metric and standard sizes	5 sets	1:5
28.	Assorted sizes of Allen keys	Metric and standard sizes	5 sets	1:5
29.	Ball-pen hammers		25 pcs	1:1
30.	Rubber mallet hammers		5 pcs	1:5
31	Claw hammers		5 pcs	1:5
32.	Tape measures	8 m	10 pcs	1:2.5
33.	Utility knives		10 pcs	1:2.5
34.	Cordless drills	16 V	5 pcs	1:5
35.	Angle grinders	Power: 500W to 2500W Disc Diameter:	5 pcs	1:5

		100mm (4"), 115mm (4.5"), 125mm (5"), 180mm (7"), 230mm (9") Voltage: 220V		
36.	Steel pipe benders	1/4" to 2" pipe diameter	10 pcs	1:2.5
37.	Hose cutters	Up to 2" (50mm) outer diameter	5 pcs	1:5
	Digital multimeters		25 pcs	1:1
38.	Lifting jacks		1 pc	1:25
39.	Workbenches	With vices, access top power and clamps	10 pcs	2:5
40.	Pneumatic system training panels		10 panels	2:5
41.	**Consumable materials**			
42.	Writing materials	Pens, pencils, paper	Enough	
43.	Seals and O-rings for valves and fittings	Various diameters and thicknesses,		
44.	Pneumatic steel pipes	1/4" to 4" nominal diameter and wall thickness 1.5 mm to 5 mm	100m	4:1
45.	Pneumatic fittings	Types: Quick-connect, barbed, threaded, push- to-connect Port Sizes: 1/8", 1/4", 3/8", 1/2", 3/4", 1"	Enough	
46.	Pneumatic tubing	4 mm to 12 mm outer diameter and wall thickness 1 mm to 2 mm	100m	4:1
47.	First aid kit	Full kits	5 pcs	1:5

MODULE IV

WORK ETHICS AND PRACTICES

UNIT CODE: 0417 451 03B

TVETCDACC UNIT CODE: ENG/CU/IC/BC/03/5/MA

Relationship to Occupational Standards

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

Duration of Unit: 40 Hours

Unit Description

This unit covers the competencies required to apply work ethics and practices. It involves applying self-management skills, promoting ethical practices and values, promoting teamwork, maintaining professional and personal development, applying problem-solving skills, and promoting customer care.

Summary of Learning Outcomes

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

S/NO	LEARNING OUTCOMES	DURATION(HOURS)
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	1.1.Self-awareness 1.2.Formulating personal vision, mission, and goals	1. Written Assessment 2. Oral Questioning

Learning Outcome	Content	Suggested Assessment Methods
	1.3.Healthy lifestyle practices 1.4.Strategies for overcoming work challenges 1.5.Emotional intelligence 1.6. Coping with Work Stress. 1.7.Assertiveness versus aggressiveness and passiveness 1.8.Developing and maintaining high self-esteem 1.9.Developing and maintaining positive self-image 1.10. Time management 1.11. Setting performance targets 1.12. Monitoring and evaluating performance targets	3. Practical Assessment 4. Project 5. Third party report 6. Portfolio of evidence
2. Promote ethical practices and values	2.1.Integrity 2.2.Core Values, ethics and beliefs 2.3.Patriotism 2.4.Professionalism 2.5.Organizational codes of conduct 2.6.Industry policies and procedures	1. Written Assessment 2. Oral Questioning 3. Practical Assessment 4. Project 5. Third party report 6. Portfolio of evidence
3. Promote Teamwork	3.1.Types of teams 3.2.Team building 3.3.Individual responsibilities in a team 3.4.Determination of team roles and objectives 3.5.Team parameters and relationships 3.6.Benefits of teamwork 3.7.Qualities of a team player 3.8.Leading a team	1. Written Assessment 2. Oral Questioning 3. Practical Assessment 4. Project 5. Third party report 6. Portfolio of evidence

Learning Outcome	Content	Suggested Assessment Methods
	3.9. Team performance and evaluation 3.10. Conflicts and conflict resolution 3.11. Gender and diversity mainstreaming 3.12. Developing Healthy workplace relationships 3.13. Adaptability and flexibility 3.14. Coaching and mentoring skills	
4. Maintain professional and personal development	4.1. Personal vs professional development and growth 4.2. Avenues for professional growth 4.3. Recognizing career advancement 4.4. Training and career opportunities 4.5. Assessing training needs 4.6. Mobilizing training resources 4.7. Licenses and certifications for professional growth and development 4.8. Pursuing personal and organizational goals 4.9. Managing work priorities and commitments 4.10. Dynamism and on-the-job learning	1. Written Assessment 2. Oral Questioning 3. Practical Assessment 4. Project 5. Third party report 6. Portfolio of evidence
5. Apply Problem-solving skills	5.1 Causes of problems 5.2 Methods of solving problems 5.3 Problem-solving process 5.4 Decision making	1. Written Assessment 2. Oral Questioning 3. Practical Assessment

Learning Outcome	Content	Suggested Assessment Methods
	5.5 Creative thinking and critical thinking process in development of innovative and practical solutions	4. Project 5. Third party report 6. Portfolio of evidence
6. Promote Customer care.	6.1 Identifying customer needs 6.2 Qualities of good customer service 6.3 Customer feedback methods 6.4 Resolving customer concerns 6.5 Customer outreach programs 6.6 Customer retention	1. Observation 2. Written assessment 3. Oral assessment 4. Third party reports 5. Portfolio of evidence

Suggested Delivery Methods

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

Recommended Resources for 25 Trainees

S/No.	Category/Item	Description/ Specifications	Quantity	Recommended Ratio (Item: Trainee)
A	**Learning Materials**			
1.	Textbooks	The 7 Habits of Highly Effective People by Stephen R. Covey. The Courage to Meet the Demands of Reality by Dr. Henry Cloud.	10 pcs 10 pcs	1:3 1:3

		The Five Dysfunctions of a Team by Patrick Lencioni. Drive: The Surprising Truth About What Motivates Us by Daniel H. Pink	10 pcs 10 pcs	1:3 1:3
2.	Online resources	MindTools, Coursera, and LinkedIn	Online	
3.	Ethical guidelines	Industry-specific ethical guidelines and codes of conduct	10 copies	1:3
4.	Workplace etiquette manuals	Guides on professional behavior, dress code, punctuality, and communication in the workplace	10 copies	1:3
5.	Employee handbooks	Sample handbooks that outline expectations, policies, and procedures related to work ethics	10 copies	1:3
6.	Videos	Short films or documentaries on ethics	25 samples	1:1
7.	Podcasts	Episodes focused on work ethics	5 samples	1:5
B	**Learning Facilities & infrastructure**			
8.	Lecture/theory room	60m^2	1	1:25
9.	Computer workshop	160 m^2	1	1:25
10.	Computers	Operating System: 64-bit Windows 11 or 10 version 1809 or above Processor: 3 GHz (3+ GHz recommended), Memory: 8 GB (32GB recommended) Disk space: 10 GB	25 pcs	1:1

		Display: 1920 x 1080 resolution Display Card: 2 GB GPU (8 GB recommended) and DirectX 11 compliant (DirectX 12 recommended)		
11.	Projector	high-resolution projectors with HDMI input	1	1:25
12.	Smartboard/Smart TV	Specifications: 77-inch interactive whiteboard with touch and pen functionality.	1	1:25
13.	Whiteboard	Traditional whiteboard	1	1:25
14.	Printers	With Print, Copy, Scan and Fax	2	1:13
C	**Software**			
15.	Operating systems	Windows/Linux/Macintosh Operating System	Installed in 25 computers	1:1
16.	Web Browsers	Chrome, Firefox, Edge, Safari	Installed in 25 computers	1:1
17.	Ethical decision-making tools	Online simulations that present ethical dilemmas for trainees to navigate	Installed in 25 computers	1:1
18.	Survey and Feedback Tools	Google Forms, SurveyMonkey	Installed in 25 computers	1:1
D	**Consumables**			
19.	Pens, pencils, rulers and paper	Whiteboard markers, 2H pencils, plastic rulers, A2 white papers	Enough	
20.	Printing papers	A4 and A3	Enough	
21.	Flashcards	Assorted colours	Enough	
22.	Charts	Assorted colours	Enough	

COMMUNICATION SKILLS

UNIT CODE: 0031 451 02B

TVETCDACC UNIT CODE: ENG/CU/IC/BC/02/5/MA

Relationship to 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 communication skills, non-verbal skills, oral communication skills and group communication skills.

Summary of Learning Outcomes

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

S/NO	LEARNNG OUTCOMES	DURATION (HOURS)
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 HOURS	**40**

Learning Outcomes, Content, and Suggested Assessment Methods

Learning Outcome	Content	Suggested Assessment Methods
1. Apply communication channels.	1.1. Communication process 1.2. Principles of effective communication 1.3. Channels/medium/modes of communication	1. Written Assessment 2. Oral Questioning 3. Practical Assessment 4. Project 5. Third party report 6. Portfolio of evidence

Learning Outcome	Content	Suggested Assessment Methods
	1.4. Factors to consider when selecting a channel of communication 1.5. Barriers to effective communication 1.6. Flow/patterns of communication 1.7. Sources of information 1.8. Organizational policies	
2. Apply written communication skills.	2.1. Types of written communication 2.2. Elements of communication 2.3. Organization requirements for written communication	1. Written Assessment 2. Oral Questioning 3. Practical Assessment 4. Project 5. Third party report 6. Portfolio of evidence
3. Apply non-verbal skills.	3.1. Utilize body language and gestures 3.2. Apply body posture 3.3. Apply workplace dressing code	1. Oral assessment 2. Written assessment 3. Observation 4. Portfolio of Evidence 5. Practical assessment 6. Third party report
4. Apply oral communication skills.	4.1. Types of oral communication pathways 4.2. Effective questioning techniques 4.3. Workplace etiquette 4.4. Active listening	2. Oral assessment 3. Written assessment 4. Observation 5. Portfolio of Evidence 6. Practical assessment 7. Third party report
5. Apply group communication skills.	5.1. Establishing rapport 5.2. Facilitating resolution of issues 5.3. Developing action plans 5.4. Group organization techniques 5.5. Turn-taking techniques 5.6. Conflict resolution techniques 5.7. Team-work	2. Oral assessment 3. Written assessment 4. Observation 5. Portfolio of Evidence 6. Practical assessment

Suggested delivery methods

- Discussion
- Roleplay

- Simulation
- Direct instruction
- Demonstration
- Field trips

Recommended Resources for 25 trainees

S/No.	Category/Item	Description/ Specifications	Quantity	Recommended Ratio (Item: Trainee)
A	**Learning Materials**			
1.	Textbooks	Crucial Conversations: Tools for Talking When Stakes Are High by Kerry Patterson, Joseph Grenny, et al. How to Win Friends and Influence People by Dale Carnegie. The Art of Communicating by Thich Nhat Hanh Talk Like TED: The 9 Public-Speaking Secrets of the World's Top Minds by Carmine Gallo	10 pcs 10 pcs 10 pcs Online	1:3 1:3 1:3
2.	Online resources	MindTools, Coursera, and LinkedIn TED talks YouTube channels Webinars	Online Online Online Online	
B	**Learning Facilities & infrastructure**			
3.	Lecture/theory room	60m^2	1	1:25
4.	Computer workshop	160 m^2	1	1:25

5.	Computers	Operating System: 64-bit Windows 11 or 10 version 1809 or above Processor: 2.5 GHz (3+ GHz recommended), Memory: 8 GB (32GB recommended) Disk space: 10 GB Display: 1920 x 1080 resolution Display Card: 2 GB GPU (8 GB recommended) and DirectX 11 compliant (DirectX 12 recommended)	25 pcs	1:1
6.	Projector	high-resolution projectors with HDMI input	1	1:25
7.	Smartboard/Smart TV	Specifications: 77-inch interactive whiteboard with touch and pen functionality.	1	1:25
8.	Whiteboard	Traditional whiteboard	1	1:25
9.	External storage media	USB flash drives (32GB), External HDD/SSD	25 pcs	1:1
10.	Webcams	HD (1080p)	25 pcs	1:1
11.	Microphones	Wireless	5 pcs	1:5
12.	Printers	With Print, Copy, Scan and Fax	2	1:13
13.	Over-ear headphones	Large diaphragm	25 pcs	1:1
C	**Software**			
14.	Operating systems	Windows/Linux/Macintosh Operating System	For 25 computers	1:1

15.	Presentation software	Microsoft power point, Prezi, Google slides	For 25 computers	1:1
16.	Speech practice Tools	Orai or Ummo	For 25 computers	1:1
17.	Writing tools	Microsoft word, Grammarly, Hemingway editor	For 25 computers	1:1
18.	Survey tools	Google Forms, SurveyMonkey	For 25 computers	1:1
19.	Video conferencing tools	Zoom, Microsoft Teams, Google Meet	For 25 computers	1:1
20.	Web Browsers	Chrome, Firefox, Edge, Safari	For 25 computers	1:1
D	**Consumables**			
21.	Pens, pencils, rulers and paper	Whiteboard markers, 2H pencils, plastic rulers, A2 white papers	Enough	
22.	Printing papers	A4 and A3	Enough	
23.	Flashcards	Assorted colours	Enough	

ENTREPRENEURIAL SKILLS

UNIT CODE: 0413 451 04B

TVETCDACC UNIT CODE: ENG/CU/IC/BC/04/5/MA

Relationship to 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 apply entrepreneurial skills. It involves applying financial literacy, entrepreneurial concepts, identifying entrepreneurship opportunities, applying business legal aspects, innovating business strategies and developing a business plan.

Summary of Learning Outcomes

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

S/NO	LEARNING OUTCOME	DURATION (HOURS)
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 a business plan	12
	TOTAL HOURS	**40**

Learning Outcomes, Content and Suggested Assessment Methods

Learning Outcome	Content	Suggested Assessment Methods
1. Apply financial literacy	1.1 Personal finance management 1.2 Balancing between needs and wants 1.3 Budget Preparation 1.4 Saving management	1. Written Assessment 2. Oral Questioning 3. Practical Assessment 4. Project 5. Third party report 6. Portfolio of evidence

Learning Outcome	Content	Suggested Assessment Methods
	1.5 Factors to consider when deciding where to save 1.6 Debt management 1.7 Factors to consider before taking a loan 1.8 Investment decisions 1.9 Types of investments 1.10 Factors to consider when investing money 1.11 Insurance services 1.12 Insurance products available in the market 1.13 Insurable risks	
2. Apply the entrepreneurial concept	2.1. Difference between Entrepreneurs and Business persons 2.2. Types of entrepreneurs 2.3. Ways of becoming an entrepreneur 2.4. Characteristics of Entrepreneurs 2.5. salaried employment and self-employment 2.6. Requirements for entry into self-employment 2.7. Roles of an Entrepreneur in an enterprise 2.8. Contributions of Entrepreneurship	1. Written Assessment 2. Oral Questioning 3. Practical Assessment 4. Project 5. Third party report 6. Portfolio of evidence
3. Identify entrepreneurship opportunities	3.1. Sources of business ideas 3.2. Factors to consider when evaluating business opportunity 3.3. Business life cycle	1. Written Assessment 2. Oral Questioning 3. Practical Assessment 4. Project 5. Third party report 6. Portfolio of evidence

Learning Outcome	Content	Suggested Assessment Methods
4. Apply business legal aspects	4.1.Forms of business ownership 4.2.Business registration and licensing processing 4.3.Types of contracts and agreements 4.4.Employment laws 4.5.Taxation laws	1. Written Assessment 2. Oral Questioning 3. Practical Assessment 4. Project 5. Third party report 6. Portfolio of evidence
5. Innovate Business Strategies	6.1.Creativity in business 6.2.Innovative business strategies 6.3.Entrepreneurial Linkages 6.4.ICT in business growth and development	1. Written Assessment 2. Oral Questioning 3. Practical Assessment 4. Project 5. Third party report 6. Portfolio of evidence
6. Develop a business plan	6.1.Business description 6.2.Marketing plan 6.3.Organizational/Management plan 6.4.Production/operation plan 6.5.Financial plan 6.6.Executive summary 6.7.Business plan presentation 6.8.Business idea incubation	2. Written Assessment 3. Oral Questioning 4. Practical Assessment 5. Project 6. Third party report 7. Portfolio of evidence

Suggested Delivery Methods

- Case studies
- Field trips
- Group Discussions
- Demonstration
- Team training
- Guest speakers

Recommended Resources for 25 Trainees

S/No.	Category/Item	Description/ Specifications	Quantity	Recommended Ratio (Item: Trainee)
A	**Learning Materials**			
1.	Textbooks	The Lean Startup by Eric Ries. Zero to One by Peter Thiel Start with Why by Simon Sinek	10 pcs 10 pcs 10 pcs	1:3 1:3 1:3
B	**Learning Facilities & infrastructure**			
2.	Lecture/theory room	$60m^2$	1	1:25
3.	Computer workshop	160 m^2	1	1:25
4.	Computers	Operating System: 64-bit Windows 11 or 10 version 1809 or above Processor: 2.5 GHz (3+ GHz recommended), Memory: 8 GB (32GB recommended) Disk space: 10 GB Display: 1920 x 1080 resolution Display Card: 2 GB GPU (8 GB recommended) and DirectX 11 compliant (DirectX 12 recommended)	25 pcs	1:1
5.	Projector	high-resolution projectors with HDMI input	1	1:25
6.	Smartboard/Smart TV	Specifications: 77-inch interactive whiteboard with touch and pen functionality.	1	1:25

7.	Whiteboard	Traditional whiteboard	1	1:25
8.	Printers	With Print, Copy, Scan and Fax	2	1:13
C	**Software**			
9.	Operating systems	Windows/Linux/Macintosh Operating System	Installed in 25 computers	1:1
10.	Web Browsers	Chrome, Firefox, Edge, Safari	Installed in 25 computers	1:1
11.	Software for business planning	LivePlan, Bizplan	Installed in 25 computers	1:1
12.	Market research tools	Google Trends or SurveyMonkey or Statista	Installed in 25 computers	1:1
13.	Marketing platforms	Google Ads or Hootsuite	Installed in 25 computers	1:1
14.	Graphic design software	Adobe creative cloud or canva	Installed in 25 computers	1:1
D	**Consumables**			
15.	Pens, pencils, rulers and paper	Whiteboard markers, 2H pencils, plastic rulers, A2 white papers	Enough	
16.	Printing papers	A4 and A3	Enough	

BASIC MATHEMATICS

UNIT CODE: 0541 451 05A

TVETCDACC UNIT CODE: ENG/CU/IC/CC/03/5/MA

Relationship to Occupational Standards

This unit addresses the unit of competency: Apply engineering mathematics.

Duration of Unit: 80 Hours

Unit Description

This unit covers the competencies required to apply basic mathematics. It involves applying number system, algebra, matrices, statistics, and trigonometry.

Summary of Learning Outcomes

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

S/NO	LEARNING OUTCOMES	DURATION (HOURS)
1.	Apply number systems	8
2.	Apply algebra	12
3.	Apply matrices	20
4.	Apply Statistics	20
5.	Apply Trigonometry	20
	TOTAL HOURS	**80**

Learning Outcomes, Content and Suggested Assessment Methods

Learning Outcome	Content	Suggested Assessment Methods

1. Apply number systems	1.1.Types of number systems: Number system conversions and properties 1.1.1.1.Natural Numbers 1.1.1.2.Whole Numbers 1.1.1.3.Integers 1.1.1.4.Rational Numbers 1.1.1.5.Irrational Numbers 1.1.1.6.Real Numbers 1.1.1.7.Percentages 1.2. GCD and LCM 1.3.Arithmetic operations on integers 1.3.1. The number line 1.3.2. Addition and Subtraction of Integers 1.3.2.1.Rules for adding and subtracting positive and negative integers. 1.3.2.2.Practice problems. 1.3.3. Multiplication and Division of Integers 1.3.4. Order of Operations 1.3.4.1.Applying the BODMAS rule 1.3.4.2.Powers and roots. 1.3.5. Squares and square roots 1.4.Fractions 1.4.1. Proper, improper fractions and mixed numbers 1.4.2. Operations on fractions 1.5.Decimals 1.5.1. Fractions and decimals 1.5.2. Decimal places 1.5.3. Standard form 1.5.4. Operations on decimals 1.5.5. Real life problems involving decimals	1. Written Assessment 2. Oral Questioning 3. Practical Assessment 4. Project 5. Third party report 6. Portfolio of evidence

2. Apply algebra	2.1.Indices and logarithms 2.1.1. Indices 2.1.1.1.Define Base and index 2.1.1.2.Laws of indices 2.1.1.3.Indicial equations 2.1.2. Logarithms 2.1.2.1.Laws of logarithm 2.1.2.2.Logarithmic equations 2.1.2.3.Conversion of bases 2.1.3. Use of log tables 2.1.4. Use of calculator 2.1.5. Applications of logarithms 2.1.5.1.Multiplication 2.1.5.2.Division 2.1.5.3.Finding roots 2.2.Algebra 2.2.1. General Algebraic expressions 2.2.2. Algebraic expressions with fractions 2.2.3. Simplification of algebraic expressions 2.2.4. Factorization by grouping 2.2.5. Removal of brackets 2.2.6. Substitution and evaluation 2.2.7. Problem solving in real situation 2.3.Linear Equations 2.3.1. Definition and standard form. 2.3.2. Simultaneous equations 2.3.3. Methods of solving: Graphical, substitution, and elimination methods. 2.3.4. Applications in engineering problems. 2.4.Quadratic expressions and Equations 2.4.1. Definition and standard form of quadratic expressions 2.4.2. Expansion of algebraic expressions 2.4.3. The three quadratic identities	1. Written Assessment 2. Oral Questioning 3. Practical Assessment 4. Project 5. Third party report 6. Portfolio of evidence 7.

	2.4.4. Using the three quadratic identities 2.4.5. Methods of solving: Factoring, completing the square, and quadratic formula. 2.4.6. Real-world engineering applications. 2.5. Algebraic functions and graph 2.5.1. Types of functions 2.5.1.1. Linear, quadratic, polynomial, rational, and exponential functions 2.5.1.2. Characteristics and properties of each function type. 2.5.2. Graphing Functions 2.5.2.1. Cartesian coordinate system. 2.5.2.2. Plotting and interpreting graphs of algebraic functions. 2.5.2.3. Using graphs to solve engineering problems.	
3. Apply matrices	3.1. Introduction to matrices 3.1.1. Definition of a matrix. 3.1.2. Different types of matrices: row, column, square, rectangular, diagonal, identity, zero. 3.1.3. Notation and elements of a matrix. 3.1.4. Basic operations: addition, subtraction, scalar multiplication. 3.1.5. Special Matrices 3.1.5.1. Identity matrix, diagonal matrix, symmetric	1. Written Assessment 2. Oral Questioning 3. Practical Assessment 4. Project 5. Third party report 6. Portfolio of evidence 7.

	matrix, skew-symmetric matrix. 3.2. Matrix Multiplication 3.2.1. Rules and properties of matrix multiplication. 3.2.2. Properties of Matrix Multiplication 3.2.2.1. Associative, distributive, and commutative properties. 3.2.2.2. Transpose of a matrix and properties. 3.3. Determinants and Inverses 3.3.1. Calculating determinants for 2x2 matrices. 3.3.2. Adjoint method to find the inverse 3.3.3. Conditions for the existence of an inverse. 3.4. Solving Systems of Linear Equations 3.4.1. Representation of linear systems using matrices 3.4.2. Using the inverse determinant method to solve simultaneous equations	
4. Apply Statistics	4.1. Introduction to Statistics 4.1.1. Definition of Statistics 4.1.2. Types of Data and applications	1. Written Assessment 2. Oral Questioning

	4.1.2.1. Qualitative (Categorical) Data 4.1.2.2. Quantitative (Numerical) Data 4.1.2.3. Discrete and continuous data. 4.1.3. Scales of Measurement 4.1.3.1. Nominal Scale 4.1.3.2. Ordinal Scale 4.1.3.3. Interval Scale 4.1.3.4. Ratio Scale 4.1.4. Applications of Statistics in engineering 4.2. Data Collection and Organization 4.2.1. Data Collection Methods 4.2.1.1. Primary Data Collection 4.2.1.2. Secondary Data Collection. 4.2.2. Data Organization 4.2.2.1. Frequency Distribution 4.2.2.2. Graphs and Charts • Bar Charts • Histograms • Pie Charts • Line Graphs • Pictograms • Frequency polygon • Ogive 4.2.2.3. Organize and represent data collected from a sample survey or experiment. 4.3. Measures of Central Tendency 4.3.1. Mean (Arithmetic Average) 4.3.2. Median 4.3.2.1. Definition, steps to calculate the median in a data set.	3. Practical Assessment 4. Project 5. Third party report 6. Portfolio of evidence 7.

	4.3.2.2. Handling even and odd numbers of data points. 4.3.2.3. Examples and practice problems. 4.3.3. Mode 4.3.3.1. Definition and calculation of mode. 4.3.3.2. Identification of unimodal, bimodal, and multimodal data sets. 4.3.3.3. Examples and practice problems. 4.4. Measures of Dispersion 4.4.1. Range 4.4.2. Variance and Standard Deviation 4.4.3. Interquartile Range (IQR) 4.5. Interpretation of Statistical Data Interpretation 4.5.1. Understanding data trends and patterns. 4.5.2. Making inferences from data sets. 4.6. Hypothesis Testing 4.6.1. Basic concepts of null and alternative hypotheses. 4.6.2. Understanding p-values and significance levels. 4.6.3. Application of hypothesis testing in decision-making. 4.6.4. Case studies showing the use of statistics in decision-making processes in engineering field	
5. Apply Trigonometry	5.1. Importance of trigonometry in engineering. 5.2. Trigonometric Ratios and Functions 5.2.1. Definitions of sine, cosine, tangent, cosecant, secant, and cotangent.	1 Written Assessment 2 Oral Questioning 3 Practical Assessment 4 Project

	5.2.2. Evaluating trigonometric rations of angles 5.2.3. Fractional and surd forms of trigonometric Ratios 5.2.4. Unit circle and angle measurement 5.2.4.1.Degrees and radians 5.2.4.2.Graphs of trigonometric functions. 5.3.Trigonometric Identities 5.3.1. Fundamental identities 5.3.1.1.Pythagorean 5.3.1.2.Reciprocal 5.3.1.3.Quotient identities 5.3.2. Co-function identities and even-odd properties. 5.3.3. Sum and difference formulas, double-angle, and half-angle formulas. 5.4.Solving Trigonometric Equations 5.4.1. Basic Trigonometric Equations 5.4.1.1.Solving equations involving basic trigonometric functions. 5.4.1.2.Using identities to simplify and solve equations. 5.4.2. Inverse Trigonometric Functions 5.4.2.1.Inverse sine, Inverse cosine and Inverse tangent. 5.4.2.2.Solving equations using inverse trigonometric functions. 5.4.3. Applications of Trigonometric Equations 5.4.3.1.Engineering problems involving periodic	5 Third party report 6 Portfolio of evidence 7

	functions and waveforms. 5.5.Trigonometry in Triangles 5.5.1. Right-Angle Triangles 5.5.1.1.Solving for sides and angles using trigonometric ratios. 5.5.1.2.Applications in engineering problems: inclined planes and forces. 5.5.2. Non-Right-Angle Triangles 5.5.2.1.Law of Sines and Law of Cosines. 5.5.2.2.Solving oblique triangles. 5.5.2.3.Hero's formula 5.5.2.4.Applications in engineering fields of structural analysis and navigation.	

Suggested Delivery Methods

- Demonstration
- Discussions
- Direct instruction

List of Recommended Resources for 25 trainees

S/No.	Category/Item	Description/ Specifications	Quantity	Recommended Ratio (Item: Trainee)
A	**Learning Materials**			
1.	Textbooks	Engineering Mathematics by K.A. Stroud Advanced Engineering Mathematics by Erwin Kreyszig	5 pcs 5 pcs	1:5 1:5

B	**Learning Facilities & infrastructure**			
2.	Lecture/theory room	$60m^2$	1	1:25
3.	Computer	Operating System: 64-bit Windows 11 or 10 version 1809 or above Processor: 2.5 GHz (3+ GHz recommended), Memory: 8 GB (32GB recommended) Disk space: 10 GB Display: 1920 x 1080 resolution Display Card: 2 GB GPU (8 GB recommended) and DirectX 11 compliant (DirectX 12 recommended)	25 pcs	1:1
4.	Projector		1	1:25
5.	Interactive screen	Specifications: 77-inch interactive whiteboard with touch and pen functionality.	1	1:25
C	**Software**			
6.	MATLAB	License: Educational licenses available. Features: Matrix manipulations, plotting of functions and data, implementation of algorithms, creation of user interfaces, interfacing with programs in other languages.	Installed in 25 computers	1:1

7.	GeoGebra	License: Free educational software. Interactive geometry, algebra, statistics, and calculus applications	Installed in 25 computers	1:1
D	**Consumables**			
8.	Pens, pencils, rulers and paper	Whiteboard markers, 2H pencils, plastic rulers, A2 white papers	Enough	

LOGIC CONTROLLERS' INSTALLATION

UNIT CODE: 0714 451 17A

TVETCDACC UNIT CODE: ENG/CU/IC/CR/03/5/MA

Relationship to Occupational Standards

This unit addresses the unit of competency: Install logic controllers.

Duration of Unit: 120 Hours

Unit Description

This unit covers the competencies required to install logic controllers. It involves conducting logic controllers site survey, installing logic controller hardware, interfacing logic controller hardware, installing logic controller software, performing logic controller programming, and testing and commissioning logic controller system.

Summary of Learning Outcomes

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

S/NO	LEARNING OUTCOMES	DURATION(HOURS)
1.	Conduct logic controllers site survey	10
2.	Install logic controller hardware	25
3.	Interface logic controller hardware	10
4.	Install logic controller software	20
5.	Perform logic controller programming	35
6.	Perform logic controller system Test and commissioning	20
	TOTAL	**120**

Learning Outcomes, Content and Suggested Assessment Methods

Learning Outcome	Content	Suggested Assessment Methods

1. Conduct logic controllers site survey	1.1 Health and safety procedures: 1.1.1 PPEs 1.1.2 IEC 61131 1.2 Logic controller system site survey. 1.2.1 Gathering preliminary information. 1.2.2 Planning site survey 1.2.3 site survey checklist 1.3 Site conditions 1.3.1 Temperature 1.3.2 Humidity 1.3.3 Distance 1.3.4 Dust 1.3.5 Light Intensity 1.3.6 Pressure 1.4 Logic controllers Installation Layout Considerations 1.4.1 Accessibility 1.4.2 Environmental conditions 1.4.3 Power supply 1.4.4 Grounding 1.4.5 Ventilation 1.4.6 Cable routing 1.4.7 Safety 1.5 Logic controllers Installation layouts 1.5.1 Centralized control panel 1.5.2 Distributed control system (DCS) 1.5.3 Field-mounted controllers 1.6 Logic controllers Layout measurements 1.6.1 Controller dimensions 1.6.2 Power supply dimensions 1.6.3 Enclosure dimensions 1.6.4 Mounting surface 1.6.5 Mounting dimensions 1.6.6 Weight capacity 1.6.7 Clearances 1.6.8 Emergency stop buttons 1.6.9 Grounding points 1.7 Site survey report 1.7.1 System objectives 1.7.2 System description 1.7.3 Environmental conditions 1.7.4 Layout 1.7.5 Measurement records 1.7.6 Material take-off list	1. Written Assessment 2. Oral Questioning 3. Practical Assessment 4. Project 5. Third party report 6. Portfolio of evidence

2. Install logic controller hardware	2.1 PLC and microcontroller system installation Safety and compliance 2.1.1 Safety standards and regulations (IEC 61131) 2.1.2 Potential hazards and risk mitigation 2.2 Introduction to PLCs 2.2.1 Terminologies used in PLCs and microcontrollers. 2.2.2 PLC and microcontrollers Architecture 2.2.3 Power supply unit, 2.2.4 CPU. 2.2.5 Applications 2.2.6 Merits and demerits. 2.3 Logic Controller Hardware Selection Considerations 2.3.1 Processing Power 2.3.2 Communication Capabilities 2.3.3 Environmental Factors 2.3.4 Safety and Reliability 2.3.5 Scalability 2.3.6 Cost 2.4 Logic Controller Mounting Methods 2.4.1 DIN Rail Mounting 2.4.2 Panel Mounting 2.4.3 Rack Mounting 2.4.4 Wall Mounting 2.4.5 Portable Enclosure 2.5 Power Supply Connection for Logic Controllers: 2.5.1 AC (alternating current) 2.5.2 DC (direct current) 2.6 Types of Logic Controller Hardware I/O Modules 2.6.1 Digital I/O modules 2.6.2 Analog I/O modules 2.6.3 Specialized I/O modules 2.7 I/O Module Selection Considerations 2.7.1 I/O type 2.7.2 Number of channels 2.7.3 Signal range 2.7.4 Compatibility 2.8 Logic controller hardware installation 2.8.1 Hardware installation specifications	1. Written Assessment 2. Oral Questioning 3. Practical Assessment 4. Project 5. Third party report 6. Portfolio of evidence

	2.8.2 System design drawings 2.8.3 Equipment installation manuals 2.8.4 Mounting enclosures and equipment 2.9 Logic controller hardware termination 2.9.1 Laying of trunking and conduits 2.9.2 Cable routing 2.9.3 Wiring selection 2.9.4 Wiring compliance to regulation 2.9.5 Power supply wiring and termination 2.9.6 I/O modules wiring and termination 2.10 Logic Controller Hardware Configuration: 2.10.1 Communication settings 2.10.2 I/O assignments 2.10.3 Control program 2.10.4 Parameters 2.11 Logic Controller Hardware Testing: 2.11.1 Hardware diagnostics 2.11.2 I/O module testing 2.11.3 Communication testing	
3. Interface logic controller hardware	3.1 Logic Controller Hardware I/O Module Selection Factors 3.1.1 I/O type 3.1.2 Number of channels 3.1.3 Signal range 3.1.4 Accuracy 3.1.5 Isolation 3.1.6 Environmental conditions 3.1.7 Compatibility 3.2 Logic Controller Hardware Input Devices 3.2.1 Sensors 3.2.2 Switches 3.2.3 Encoders 3.2.4 Analog input cards 3.3 Logic Controller Hardware Output Devices 3.3.1 Solenoids 3.3.2 Motors 3.3.3 Pumps 3.3.4 Heaters 3.3.5 Lights 3.4 Methods to Connect I/O Modules to Logic Controllers 3.4.1 Backplane bus 3.4.2 Expansion modules	1. Written Assessment 2. Oral Questioning 3. Practical Assessment 4. Project 5. Third party report 6. Portfolio of evidence

	3.4.3 Fieldbus networks	
4. Install logic controller software	4.1 Logic Controller PC Software Selection Factors 4.1.1 Compatibility 4.1.2 Features 4.1.3 Ease of use 4.1.4 Cost 4.2 Logic Controller Pc Software Installation Steps 4.3 Run Logic Controller Software 4.4 Configuration Of Logic Controller Software 4.5 Testing Logic Controller Software 4.6 Programming software documentation 4.6.1 System requirements 4.6.2 Software licences 4.6.3 Updates and patches 4.6.4 Support resources	1. Written Assessment 2. Oral Questioning 3. Practical Assessment 4. Project 5. Third party report 6. Portfolio of evidence
5. Perform logic controller programming	5.1 Process requirements identification 5.1.1 Identification of control objectives 5.1.2 Identification of input and output requirements 5.1.3 Selecting control algorithms 5.1.4 Developing control flow charts 5.2 Logic controller programming languages 5.3 PLC programming languages 5.3.1 Ladder diagrams (LD) 5.3.2 Instruction list (IL) 5.3.3 Functional block diagrams (FBD) 5.3.4 Structured text (ST) 5.3.5 Sequential function chart (SFC) 5.4 Basic logic controller programming elements: 5.5.1 Normally closed contact 5.5.2 Normally open contact. 5.5.3 Coil 5.5.4 Timers 5.5.5 Counters 5.5.6 Mathematical functions 5.5.7 Logic operation 5.5 logic controller program code development 5.6 Logic controller program code simulation 5.7 Logic controller program code	1 Written Assessment 2 Oral Questioning 3 Practical Assessment 4 Project 5 Third party report 6 Portfolio of evidence

	simulation 5.8 logic controller program code testing and debugging 5.9 Installing/downloading compiled program to logic controller	
6. Perform logic controller system Test and commissioning	6.1 Logic controller systems electrical tests 6.1.1 Continuity test 6.1.2 Polarity test 6.1.3 Earth loop impedance test 6.1.4 Insulation resistance test 6.1.5 Earth electrode resistance test 6.2 Logic controller system functionality test 6.4.1 Pre-test Inspections 6.4.2 Component sequence 6.4.3 Component verification 6.4.4 Firmness 6.4.5 Correct labelling 6.4.6 Correct component termination. 6.4.7 Functional testing 6.4.8 Performance test 6.4.9 Safety tests 6.3 Project handover and need for end user training 6.4 Commissioning documents 6.4.1 Commissioning plan 6.4.2 Test procedures and checklist 6.4.3 Instrumentation data sheet 6.4.4 Calibration certificate 6.4.5 Start up and shutdown procedures 6.4.6 Safety documentation 6.4.7 Training materials 6.4.8 Commissioning reports 6.4.9 Handover report 6.4.10 Test results 6.4.11 As-built drawings	1. Written Assessment 2. Oral Questioning 3. Practical Assessment 4. Project 5. Third party report 6. Portfolio of evidence

Suggested Delivery Methods

- Trainer demonstration
- Simulation
- Discussions

- Direct instruction

List of Recommended Resources for 25 trainees

S/No.	Category/Item	Description/ Specifications	Quantity	Recommended Ratio (Item: Trainee)
A	**Learning Materials**			
1.	Textbooks	*McMillan K. Gregory,* Process/industrial instruments and controls handbook, fifth edition *W. BOLTON, programmable logic controllers, sixth edition.*	Online	1:1
2.	Installation manuals	PLC systems. Manuals for Siemens, Allen-Bradley, Mitsubishi, Omron and Schneider	5 pcs	1:5
B	**Learning Facilities& infrastructure**			
3.	Lecture/theory room	$60m^2$	1	1:25
4.	Workshop	$150m^2$	1	1:25
5.	Projector		1 pc	1:25
6.	Interactive display screen	75 inches	1 pc	1:25
7.	Computers with internet access	Processor: Intel Core i5/i7 or equivalent RAM: 8GB or higher Storage: 256GB SSD or higher	25 pcs	1:25
8.	PLC	Logo/Siemens (S7-1500) /Mitsubishi FX5U/Omron CP2E/Modicon M262	5 pcs/5 pcs/5 pcs/5 pcs	1:5 for each category
9.	Microcontroller	ATMEL328P/CORTEX-M3/INTEL-8051	25 pcs for each categor	1:1 for each category

			y	
9.	HMI panels	Siemens/Mitsubishi/Omron/Schneider	5 pcs/5 pcs/5 pcs/5 pcs	1:5 for each category
10.	Limit switches	Mechanical, optical, inductive, capacitive	25 pcs each category	1:1 for each category
11.	Industrial pressure sensors	0-10 bar, 4-20mA output	25 pcs	1:1
12.	Proximity sensors	NPN/PNP, 10-30V DC	25 pcs	1:1
13.	Industrial temperature sensors	RTD/PT100, -50 to 200°C	25 pcs	1:1
14.	Flow sensors	4-20mA, 0-10V, RS485	25 pcs	1:1
15.	Level sensor	Ultrasonic 4-20mA, 0-10V	25 pcs	1:1
16.	Power supply units	Output Voltage: 24V DC Output Current: 5A or higher Input Voltage: 220V AC	10 pcs	1:2.5
17.	Adjustable wrenches	Metric and standard sizes	10 pcs	1:2.5
18.	Sets of combinational wrenches	Metric and standard sizes	5 sets	1:5
19.	Assorted size socket wrenches	Metric and standard sizes	5 sets	1:5
20.	Assorted sizes of screw drivers	Insulated, flathead	5 sets	1:5
21.	Assorted sizes of Allen keys	Metric and standard sizes	5 sets	1:5
22.	Wire Strippers	Suitable for 0.5 mm^2 to 4 mm^2 wires	10 pcs	1:2
23.	Ball-pen hammers		25 pcs	1:1
24.	Tape measures	8 m	10 pcs	1:2.5
25.	Utility knives		10 pcs	1:2.5

26.	Cordless drills	16 V	5 pcs	1:5
27.	Relays	24V DC coil, 10A contacts	25 pcs	1:1
28.	Solenoid valves	24V DC, 1/4" or 1/2" connections	25 pcs	1:1
29.	Motor starters	24V DC control voltage, suitable for 1 HP motors	25 pcs	1:1
30.	Contactors	Voltage:24V DC coil/230V AC coil Number of Poles: 3-pole or 4-pole Auxiliary Contacts: 1 NO + 1 NC Mounting: DIN rail or panel mount	25 pcs	1:1
31.	Push buttons	Voltage:24V DC coil/230V AC coil Contact Configuration: 1 NO or 1 NC Illumination: Non-illuminated or LED illuminated Color Options: Red, Green, Yellow, Blue, Black	100 pcs	1:4
32.	Select switches	Voltage:24V DC coil/230V AC coil Contact Configuration: 2 NO, 2 NC, or 1 NO + 1 NC Positions: 2-position or 3-position Illumination: Non-illuminated or LED illuminated Color Options: Black, Red, Green	100 pcs	1:4
33.	Digital multimeters	With voltage, current, and resistance measurement	25 pcs	1:1
34.	Terminal Blocks	2.5 mm^2 to 10 mm^2	50 pcs	1:2
35.	DIN Rails	Standard 35 mm	50 m	2m:1
36.	Workstations	Custom-built or pre-configured workstations Mounting space for PLCs, HMIs, and power supplies Integrated wiring channels and terminals Built-in safety features such as circuit breakers	25 stations	1:1
37.	Network switches	Cisco 24 ports	2	1:12.5

38.	Routers	TP link	10	1:2.5
C	**Consumable materials**			
39.	Writing materials	Pens, pencils, paper	enough	
40.	Signal cables	0.5 mm^2 to 1.5 mm^2, shielded	200 metres for each category	50m:1 for each category
41.	Power cables	1.5 mm^2 to 4 mm^2	200 metres for each category	50m:1 for each category
42.	Communication cables	Cat6 Ethernet cables	200 m	50m:1
43.	Control wires	18 AWG Twisted pairs/22 AWG Multi-conductor control cable/ 20 WG flexible control cable (19/32)	200 metres for each category	50m:1 for each category
44.	Safety Glasses	ANSI Z87.1 compliant	25 pcs	1:1
45.	Gloves	Insulated, suitable for electrical work	25 pairs	1:1
46.	Ear Protection	Noise reduction rating (NRR) of 25 dB or higher	25 pcs	1:1
47.	First aid kit	Full kits	5 pcs	1:5
D	**Software**			
48.	Programming and simulation software	TIA Portal, GX Works3, CX-programmer or Sysmac Studio, Eco Structure Machine Expert, Logo soft, Arduino IDE	Installed in 25 Computers	1:1
49.	Human Machine interface software	Siemens WinCC, GT Designer3, Omron NB series/Vijeo Designer	Installed in 25 Computers	1:1

ELECTRICAL MACHINES INSTALLATION

UNIT CODE: 0713 451 20A

TVETCDACC UNIT CODE: ENG/CU/IC/CR/04/5/MA

Relationship to Occupational Standards

This unit addresses the unit of competency: Install electrical machines.

Duration of Unit: 120 Hours

Unit Description

This unit covers the competencies required to install electrical machines. It involves installing electrical machines, testing electrical machine installations, and maintaining electrical machine installations.

Summary of Learning Outcomes

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

S/NO	LEARNING OUTCOMES	DURATION (HOURS)
1.	Install electrical machine	72
2.	Test electrical machine installation	30
3.	Maintain electrical machine installation	18
	TOTAL HOURS	**120**

Learning Outcomes, Content and Suggested Assessment Methods:

Learning Outcome	Content	Suggested Assessment Methods
1. Install electrical machine	1.1.Wiring diagrams 1.2.Materials, tools and equipment's 1.3.Types of machine layout e.g. 1.3.1. Fixed position layout	1. Written Assessment 2. Oral Questioning

	1.3.2. Product layout 1.3.3. Process layout 1.3.4. Combinational 1.4.Mounting techniques of electrical machines 1.5.Construction of machine support 1.6.Types of electrical machines and applications: 1.6.1. DC motors 1.6.2. DC generators 1.6.3. AC single phase motors 1.6.4. AC three phase machines: 1.7.4.1 Induction 1.7.4.2 Synchronous 1.6.5. Transformer 1.7.Calculations involving electrical machines 1.8.Electrical machine control gear 1.8.1. Contactors 1.8.2. Overload Relays 1.8.3. Circuit Breakers 1.8.4. Motor Starters 1.19.9.1 DOL 1.19.9.2 Star delta 1.19.9.3 Forward reverse 1.8.5. Push Buttons & Switches 1.8.6. Manual control (start/stop) 1.8.7. Timers 1.8.8. Sensors and Relays 1.8.9. Variable Speed Drives (VSDs) 1.9.Mounting structures/housing 1.9.1. Structural strength 1.9.2. Size 1.10. Conduits, trunks, and enclosures installation 1.11. Cables and conductor installation.	3. Practical Assessment 4. Project 5. Third party report 6. Portfolio of evidence 7.

	1.12. Cabling in machine 1.12.1. Current capacity 1.12.2. Type of the cable 1.13. Cable termination 1.14. Cables labelling 1.15. IET Electrical machine installation regulations 1.16. Installation route 1.16.1. Surface 1.16.2. Underground 1.16.3. Concealed 1.17. Installation conditions e.g. temperature, humidity, moisture, dust 1.18. Housekeeping practices. 1.18.1. Disposal of waste 1.18.2. Cleaning 1.18.3. Tools storage	
2. Test electrical machine installation	2.1.Types of tests on electrical machines 2.1.1 Visual inspection 2.1.2 Insulation resistance test 2.1.3 Continuity test 2.1.4 Earth continuity and earth loop impedance test 2.1.5 Polarity test 2.1.6 Functional (on-load/off-load) test 2.1.7 Open circuit test 2.1.8 Short circuit test 2.2.Testing tools 2.2.1 Multimeter 2.2.2 Insulation resistance tester 2.2.3 Earth electrode resistance tester 2.2.4 Ohmmeter 2.3.Visual inspection procedures 2.3.1 Checking cable terminations and routing 2.3.2 Verifying protection devices and labeling 2.3.3 Ensuring compliance with IET color codes and IP ratings	1. Written Assessment 2. Oral Questioning 3. Practical Assessment 4. Project 5. Third party report 6. Portfolio of evidence

	2.3.4 Identifying signs of damage, corrosion, or loose connections 2.4.Mechanical and structural checks 2.4.1 Verifying mounting bolts, frames, and enclosures for firmness 2.4.2 Checking vibration isolation measures 2.4.3 Ensuring alignment of couplings and drive systems 2.5.Continuity tests 2.6.Earthing and bonding tests 2.6.1 Compliance with IET earth fault protection requirements 2.7. On-load and off-load tests 2.7.1 Motor no-load run test 2.7.2 Full-load current and voltage measurements 2.7.3 Functional checks (rotation direction, speed, temperature rise) 2.7.4 Vibration and noise checks 2.8. Documentation and reporting: 2.8.1 Recording test results using standard forms 2.8.2 Use of inspection and test certificates 2.8.3 Interpreting results and recommending actions	
3. Maintain electrical machine installation	3.1.Maintenance schedules 3.2.System maintenance check list 3.3.Maintenance tools and equipment 3.4.Inspection and tests 3.5.Fault diagnosis 3.6.Fault rectification 3.7.Reports preparation	1. Written Assessment 2. Oral Questioning 3. Practical Assessment 4. Project 5. Third party report 6. Portfolio of evidence

Suggested Methods of Instruction

- Practical

- Projects
- Demonstrations
- Group Discussions
- Field trips
- On-job-training

Recommended Resources for 25 trainees

S/No.	Category/Item	Description/ Specifications	Quantity	Recommended Ratio (Item: Trainee)
A	**Learning Materials**			
1.	Textbooks	V.K Mehta Principles of Electrical Machines B. Scaddan Electrical installation work J. Hyde Electrical Installation Principles and Practices	5 pcs	1:5
2.	Installation manuals	Electrical machine manuals	5 pcs	1:5
3.	Charts	Single line diagram Motor starting circuits Circuit diagrams Colour codes	1 pcs for each	1:25
4.	Power point presentations	For trainer's use	1	1:25
B	**Learning Facilities & infrastructure**			
6.	Lecture/theory room	$60m^2$	1	1:25
7.	Workshop	$150m^2$	1	1:25
8.	Site			
C	**Consumable materials**			
9.	Electrical wires	$1.5mm^2$(red, black green)	5 rolls	1:5
		$2.5mm^2$(red, black green)	5 rolls	1:5

		4.0 mm^2(red, black green)	3 rolls	1:10
		6.0 mm^2(red, black green)	2 rolls	1:12
		10 mm^2(red, black green)	2 rolls	1:12
10.	Insulation tapes		25 pcs	1:1
11.	Accessories	Push buttons, relays, Timers, contactors, Thermo overloads, DIN rail, Circuit breakers, TPN	25 pcs	1:1
12.	Pipes and trunkings	PVC conduits, Steel conduits, Mini trunking	25 pcs	1:1
D	**Tools and Equipment**			
13.	3-Phase motors	Power range (e.g., 1/2 HP to 5 HP), voltage rating (e.g., 230V, 415V), RPM, frame size	5 pcs	1:5
14.	Synchronous Motors	Power range, voltage rating, RPM, synchronous speed, excitation method. Example: 3-phase synchronous motor, 2 HP, 415V, 1800 RPM	5 pcs	1:5
15.	Single Phase motors	Power range (e.g., 1/4 HP to 1 HP), voltage rating (e.g., 230V), type (e.g., split-phase, capacitor-start), RPM	5 pcs	1:5
16.	Electric Generator	Power output (e.g., 5 kVA), voltage output (e.g., 230V), frequency (e.g., 50 Hz), type (e.g., gasoline, diesel).	5 pcs	1:5
17.	DC motors	Voltage rating (e.g., 12V, 24V), power	5 pcs	1:5

		rating, RPM, type (e.g., brushed, brushless)		
18.	Hacksaws	Hacksaws with adjustable blades for cutting various materials (e.g., metal, PVC).	25 pcs	1:1
19.	Striping knives	Wire stripping knives with adjustable blades for various wire gauges.	25 pcs	1:1
20.	Side cutters	Diagonal cutting pliers with hardened jaws for clean cuts on wires.	25 pcs	1:1
21.	Pliers	Combination pliers with long nose and cutting edges.	25 pcs	1:1
22.	Tape measure	Retractable tape measure with metric and imperial markings.	25 pcs	1:1
23.	Try Square	Metal try square for checking and marking right angles.	25 pcs	1:1
24.	Spirit level	Pocket-sized spirit level with vials for checking horizontal and vertical surfaces.	25 pcs	1:1
25.	Assorted Screw driver	Set of screw drivers with various tip sizes (Phillips and flathead) and lengths.	25 pcs each	1:1
26.	Assorted hammers	Claw hammers for driving nails and other fasteners.	25 pcs each	1:1
27.	Crimping tools	Crimping tools for various connector types (e.g., terminal blocks, cable lugs).	5 pcs each	1:5
28.	PPEs	Safety glasses, safety gloves, safety shoes, hard hats.	25 pcs each	1:1

29.	Multimeters	Digital multimeters for measuring voltage, current, resistance, and continuity.	5 pcs	1:5
30.	Clamp meters	Clamp-on ammeters for measuring AC/DC current without breaking the circuit.	5 pcs	1:5
31.	Earth resistance meter	Megger for measuring earth ground resistance.	5 pcs	1:5
32.	Stocks & Dies	Thread cutting tools for creating internal and external threads.	5 pcs	1:5
33.	Vices	Bench vices for holding workpieces during cutting, bending, and other operations.	5 pcs	1:5
34.	Oscilloscope	Dual-channel oscilloscope for analyzing electrical signals (optional for advanced troubleshooting).	5 pcs	1:5
35.	Pipe bending Machine	Hydraulic or mechanical pipe bender for bending conduit and pipes.	5 pcs	1:5
36.	Bending spring	Pipe bending springs to prevent pipe collapse during bending.	5 pcs	1:5
37.	Drilling machines	Benchtop drill presses for drilling holes in various materials.	5 pcs	1:5
38.	Work stations	Individual workbenches with features like tool holders and storage.	25	1:1
39.	Installation boards	Training boards simulating real-world electrical installations (e.g., lighting circuits, motor control circuits).	13 pcs	1:2

MODULE V

ENGINEERING TECHNICIAN MATHEMATICS

UNIT CODE: 0541 551 10A

TVETCDACC UNIT CODE: ENG/CU/IC/CC/01/6/MA

Relationship to Occupational Standards

This unit addresses the unit of competency: Apply Engineering technician mathematics.

Duration of Unit: 100 Hours

Unit Description

This unit covers the competencies required to apply engineering technician mathematics. It involves applying complex numbers, calculus, Laplace transforms, and vector theorem.

Summary of Learning Outcomes

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

S/NO	Learning Outcomes	DURATION(HOURS)
1.	Apply complex numbers	15
2.	Apply calculus	30
3.	Apply Laplace transforms	20
4.	Apply vector theorem	15
	TOTAL HOURS	**100**

Learning Outcomes, Content and Suggested Assessment Methods

Learning Outcome	Content	Suggested Assessment Methods

1. Apply complex numbers	1.1.Introduction to Complex Numbers 1.1.1. Definition of a complex number 1.1.2. Real and imaginary parts. 1.1.3. Complex numbers represented on Argand diagrams 1.2.Conversion from rectangular to polar and vice versa 1.3.Operations involving complex numbers 1.4. De Moivre's theorem 1.4.1 Compute powers and roots of complex numbers. 1.4.2 Solve trigonometric identities using complex numbers. 1.5.Applications of complex numbers in AC circuit analysis.	1 Written assessment 2 Oral assessment 3 Practical 4 Portfolio of evidence

2. Apply calculus	2.1. Definition of derivatives of a function 2.2. Differentiation from fist principle 2.3. Tables of some common derivatives 2.4. Rules of differentiation 2.4.1. Sum and difference rule 2.4.2. Product rule 2.4.3. Quotient rule 2.4.4. Chain rule 2.4.5. Parametric differentiation 2.4.6. Implicit differentiation 2.5. Rate of change and small change 2.6. Stationery points of functions of two variables 2.7. Definition of integration 2.8. Indefinite and definite integral 2.9. Methods of integration application of integration. 2.9.1. Substitution 2.9.2. Reduction formula 2.9.3. By parts 2.9.4. Partial fractions 2.10. Integrals of hyperbolic and inverse functions 2.11. Application of integration	1 Written Assessment 2 Oral Questioning 3 Practical Assessment 4 Portfolio of evidence

3. Apply Laplace transforms	3.1. Solution to Laplace transforms using initial and final value theorems 3.1.1 Conditions for existence of Laplace transforms 3.1.2 Common Laplace transforms 3.1.2.1 unit step 3.1.2.2 exponential 3.1.2.3 sine 3.1.2.4 cosine 3.1.3 Initial value theorem: 3.1.4 Final value theorem 3.1.5 Application to check behaviour of systems at t=0 and t=∞. 3.2. Solution to inverse Laplace transforms using partial fractions: 3.2.1 Definition of inverse Laplace transform 3.2.2 Use of standard Laplace transform tables 3.2.3 Decomposition of rational functions into partial fractions 3.2.4 Solving for coefficients using substitution or the cover-up method	1 Oral Questioning 2 Written Assessment 3 Practical Assessment 4 Portfolio of evidence

	3.2.5 Finding time-domain function f(t) from F(s) 3.2.6 Application to time responses in control systems 3.3. Solution to differential equations using Laplace transforms 3.3.1 Formulation of first- and second-order linear differential equations from physical systems i.e., electrical 3.3.2 Solving algebraic equation in the s-domain 3.3.3 Applying inverse Laplace to find solution in time domain 3.3.4 Interpretation of solutions in context of system response such as step or impulse input.	
5 Apply vector theorem	5.3 Vectors and scalar in two and three dimensions 5.4 Operations on vectors: 5.4.1 Addition 5.4.2 Subtraction 5.5 Scalar and vector of vectors 5.5.1 Dot product 5.5.2 Cross product 5.6 Vector field	1 Oral Questioning 2 Written Assessment 3 Practical Assessment 1 Portfolio of evidence

	5.6.1 Introduction to vector fields 5.6.2 Solutions of problems involving vector fields 5.7 Gradient, Divergence and curl 5.7.1 Solutions of involving Gradient, Divergence and curl 5.8 Application of vectors	

Suggested Delivery Methods

- Demonstration
- Discussions
- Practical
- Project work
- Direct instruction

List of Recommended Resources for 25 trainees

S/No.	**Category/Item**	**Description/ Specifications**	**Quantity**	**Recommended Ratio** (Item: Trainee)
A	**Learning Materials**			
23.	Textbooks	Engineering Mathematics by K.A. Stroud	5 pcs 5 pcs	1:5 1:5

		Advanced Engineering Mathematics by Erwin Kreyszig		
B	**Learning Facilities & infrastructure**			
24.	Lecture/theory room	$60m^2$	1	1:25
25.	Computer	Operating System: 64-bit Windows 11 or 10 version 1809 or above Processor: 2.5 GHz (3+ GHz recommended), Memory: 8 GB (32GB recommended) Disk space: 10 GB Display: 1920 x 1080 resolution Display Card: 2 GB GPU (8 GB recommended) and DirectX 11 compliant (DirectX 12 recommended)	25 pcs	1:1
26.	Projector		1	1:25
27.	Interactive screen	Specifications: 77-inch interactive whiteboard	1	1:25

		with touch and pen functionality.		
C	**Software**			
28.	MATLAB	License: Educational licenses available. Features: Matrix manipulations, plotting of functions and data, implementation of algorithms, creation of user interfaces, interfacing with programs in other languages.	Installed in 25 computers	1:1
29.	GeoGebra	License: Free educational software. Interactive geometry, algebra, statistics, and calculus applications	Installed in 25 computers	1:1
D	**Consumables**			
30.	Pens, pencils, rulers and paper	Whiteboard markers, 2H pencils, plastic rulers, A2 white papers	Enough	

ADVANCED ELECTRONICS CIRCUIT FABRICATION

UNIT CODE: 0714 551 08A

TVETCDACC UNIT CODE: ENG/CU/IC/CC/02/6/MA

UNIT DURATION: 100 Hours

Relationship to Occupational Standards

This unit addresses the unit of competency: Fabricate advanced electronics circuit.

Unit Description

This unit describes competences required to fabricate advanced electronics circuit. It involves applying Boolean algebra concepts, advanced digital logic and converter circuits, transistors, special semiconductor devices, amplifiers and opto-electronics.

Summary of Learning Outcomes

S/NO	LEARNING OUTCOMES	DURATION (HOURS)
1.	Apply Boolean algebra concepts	20
2.	Apply knowledge of advance digital logic and converter circuits	15
3.	Apply transistors.	25
4.	Apply special semiconductor devices.	15
5.	Apply amplifiers.	30
6.	Apply opto-electronics	15
	TOTAL HOURS	**120**

Learning Outcomes, Content and Suggested Assessment Methods

Learning Outcome	Content	Suggested Assessment Methods
1. Apply Boolean algebra concepts	1.1 Principles of logic gates 1.2 Logic families 1.3 Laws of Boolean algebra	• Practical test • Project

	1.4 Logic expressions simplification 1.5 K-MAPS	• Third Party Report • Portfolio of evidence • Written test • Oral questioning
2. Apply knowledge of advance digital logic and converter circuits	2.1 Principles of operation of shift registers 2.1.1 data storage 2.1.2 serial communication 2.1.3 sensor interfacing such as digital I/O expansion in PLCs or microcontrollers 2.2 Operation principles of synchronous and asynchronous counters 2.2.1 frequency counting 2.2.2 event counting 2.2.3 digital timing in process control systems. 2.3 Operation principles of digital converters circuits 2.3.1 ADCs 2.3.2 DACs 2.4 Interpretation of manufacturer's datasheets and timing diagrams	• Practical test • Project • Third Party Report • Portfolio of evidence • Written test • Oral questioning
3 Apply transistors.	3.1 Bipolar junction transistors (BJTs) 3.1.1 Types of BJTs 3.1.2 Operation and characteristics of BJTs 3.2 BJT configurations 3.3 BJT load line analysis	• Practical test • Project • Third Party Report • Portfolio of evidence • Written test

	3.3.1 DC load line 3.3.2 AC load line 3.4 BJT transistor biasing methods 3.5 Field Effect Transistors (FETs) 3.5.1 Types of JFET & MOSFET 3.5.2 Operation and characteristics of FETs 3.6 Biasing techniques of FETs 3.7 Application of FETs	• Oral questioning
4. Apply special semiconductor devices.	4.1 Special semiconductor devices 4.1.1 SCR 4.1.2 LASCR 4.1.3 TRIAC 4.1.4 DIAC 4.1.5 SCS 4.1.6 UJT 4.2 Operation principle of special semiconductor devices 4.3 Schematic symbols of special semiconductor devices 4.4 Application of special semiconductor devices	• Practical test • Project • Third Party Report • Portfolio of evidence • Written test • Oral questioning
5. Apply amplifiers.	5.10 Classification of amplifiers based on; 5.10.1 Stages 5.10.2 Coupling method 5.10.3 Frequency 5.11 Types of amplifiers 5.11.1 RC coupled amplifiers 5.11.2 Power amplifiers	• Practical test • Project • Third Party Report • Portfolio of evidence • Written test • Oral questioning

	5.11.3 Tuned amplifiers 5.12 Feedback 5.12.1 Principle of feedback 5.12.2 Positive feedback 5.12.3 Negative feedback 5.13 Operational amplifiers (OPAMPs) 5.13.1 Construction of opamps 5.13.2 Characteristics of the ideal and practical opamps 5.13.3 Opamp configurations 5.13.3.1 Inverting Amplifier 5.13.3.2 Non-Inverting Amplifier 5.13.3.3 Voltage Follower (Buffer) 5.13.3.4 Summing Amplifier 5.13.3.5 Differential Amplifier 5.13.3.6 Instrumentation Amplifier 5.13.3.7 Integrator 5.13.3.8 Differentiator 5.14 Application of Amplifiers	
6. Apply opto-electronics	6.1 Opto-electronic devices 6.1.1 LEDs 6.1.2 OLED 6.1.3 LASER diode 6.1.4 Photo transistors	• Practical test • Project • Third Party Report • Portfolio of evidence

	6.1.5 Photo diodes 6.1.6 Optocoupler 6.1.7 LASCR 6.2 Liquid crystal displays 6.2.1 Dynamic scattering LCDs 6.2.2 Field effect scattering LCDs 6.3 LASERs and MASERs 6.4 Drive requirements for displays 6.5 Applications of optoelectronics	• Written test • Oral questioning

Suggested Methods of Instruction

- Role playing
- Viewing of related videos
- Discussion
- Direct Instruction

Recommended Resources for 25 Trainees

S No.	Category Item	Description Specifications	Quantity	Recommended Ratio (Item: Trainee)
A	**Learning Materials**			
85.	Reference books	5.2.1 Digital Electronics: Principles, Devices and Applications 5.2.2 By Anil K. Maini	5 pcs	1:5
86.	Installation manuals	Assorted Systems component Manufacturer's manuals and data sheets	5 pcs	1:5

		Instrumentation Handbooks		
87.	Charts	Assorted Circuit diagrams charts	1 pcs for each	1:25
88.	Software	Assorted simulation software e.g Deeds,	25	1:1
89.	Audio visual presentations	Projector	1	1:25
B	**Learning Facilities & infrastructure**			
90.	Lecture theory room	$60m^2$	1	1:25
91.	Workshop	$150m^2$	1	1:25
92.	Computer laboratory	$100m^2$	1	1:25
C	**Consumable materials**			
93.	Assorted electronics components	ICs, resistors, capacitors	25 pcs	1:1
D	**Tools and Equipment**			
94.	Assorted tools and equipment	Side cutters, Side cutters, Pliers, Screw driver, Multi-meter, Oscilloscope, Solder guns, breadboards	25 pcs	1:1
95.	PPEs	Safety boots, overall	25 pcs	1:1
96.	Function generator		5 pcs	1:5
97.	Variable power supply		5 pcs	1:5
98.	Trainers kit	Assorted logic gate, combinational circuits trainer kits with component	5 pcs	1:5

		Manufacturer's manuals and data sheets		
99.	Hot air gun		5 pcs	1:5
100.	Work stations		25	1:1

ELECTRICAL MEASUREMENT AND FAULT DIAGNOSIS

UNIT CODE: 0713 551 09A

TVETCDACC UNIT CODE: ENG/CU/IC/CC/03/6/MA

Relationship to Occupational Standards

This unit addresses the unit of competency: Perform electrical measurements and fault diagnosis.

Duration of Unit: 60 Hours

Unit Description

This unit covers the competencies required to monitor control and instrumentation systems. It involves applying electrical measurement instruments, waveform analyzing instruments, sensors and transducers and calibrating measurement instruments.

Summary of Learning Outcomes

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

S/NO	LEARNING OUTCOMES	DURATION(HOURS)
1.	Apply electrical measurement instruments	15
2.	Apply waveform analysing instruments,	18
3.	Apply sensors and transducers	12
4.	Calibrate measurement instruments.	15
	TOTAL	**60**

Learning Outcome	Content	Suggested Assessment Methods
1. Apply electrical measurement instruments	1.1 Health and safety procedures e.g. PPEs, Hazards, Accidents etc. 1.2 Electrical Quantities e.g. 1.2.1 AC/DC Current 1.2.2 AC/DC Voltage 1.2.3 Power 1.2.4 Resistance 1.2.5 Capacitance 1.2.6 Inductance 1.3 Electrical Units e.g. 1.3.1 Amperes 1.3.2 Volts 1.3.3 Watts 1.3.4 Ohms 1.3.5 Farads 1.3.6 Henrys 1.4 Measurement Standards 1.4.1 International 1.4.2 Primary 1.4.3 Secondary 1.4.4 Working 1.5 Electrical Measuring Instruments e.g. 1.5.1 Voltmeter 1.5.2 Ammeters 1.5.3 Ohmmeter 1.5.4 Multimeter etc	2. Written tests 3. Observation 4. Oral questioning

Learning Outcome	Content	Suggested Assessment Methods
	1.6 Converters e.g. Analogue to Digital converters, Digital to Analogue converters etc. 1.7 Measurement presentation mechanisms e.g. Display, Recording 1.8 Performance characteristics 1.8.1 Static characteristics e.g. precision, resolution repeatability, reproducibility, drift etc 1.8.2 Dynamic characteristics e.g. fidelity, measuring lag, measuring error etc	
2 Apply waveform analyzing instruments	2.1 Health and safety procedures: ppes and hazards. 2.2 Types of waveforms: sinusoidal wave, step, ramp, impulse. 2.3 Waveform analysis instruments 2.3.1 Type's e.g. oscilloscope spectrum analysis, wave analysers etc 2.3.2 Construction of waveform analysis equipment 2.4 Operation of waveform analysis instruments 2.5 Analysis of performance of waveform analysis instruments	5. Written tests 6. Observation 7. Oral questioning

Learning Outcome	Content	Suggested Assessment Methods
3 Apply sensors and transducers	3.1 Definition of terms 3.2 Transducers/Sensors 3.2.1 Types/principles of operation transducers/sensors: restive, capacitive 3.2.2 Sensors/transducer e.g. displacement, force, flow pressure etc. 3.3 Signal processors 3.3.1 Definition of terms 3.3.2 Importance 3.3.3 Methods of processing: amplification, attenuation filtration 3.3.4 Applications of signal processors 3.4 Data analysis and documentation 3.5 Signal presentation	8. Written tests 9. Observation 10. Oral questioning
4 Calibrate measurement instruments	4.1 Measurement and recording of initial values 4.2 Integration of measuring instrument into calibrating instrument: compatibility, settings configuration 4.3 Measuring instrument physical variables from calibrator 4.4 Measurement error calculation: parallax, relative, environmental, instrumental, random etc.	11. Observation 12. Oral questioning 13. Written tests

Learning Outcome	Content	Suggested Assessment Methods
	4.5 Resetting the readings of calibrated instrument to zero error/span error 4.6 Calibration documentation 4.6.1 Traceability table 4.6.2 Repeatability table 4.6.3 Calibration Certificate 4.6.4 Equipment tag	

Suggested Methods of Instruction

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

Recommended Resources for 25 trainees

S/No.	Category/Item	Description/ Specifications	Quantity	Recommended Ratio (Item: Trainee)
A	**Learning Materials**			
1.	Textbooks	A Course in Electrical and Electronic Measurements and	5 pcs	1:5

		Instrumentation by A.K. Sawhney, Puneet Sawhney,		
2.	User manuals		5 pcs	1:5
3.	Measuring instruments manuals	Voltmeter Multimeters Ammeters Megaohmeter	5pcs	1:5
4.	Charts	Single line diagram Circuit diagrams Colour codes	1 pc for each	1:25
5.	Power point presentations	For trainer's use	1	1:25
B	**Learning Facilities & infrastructure**			
5.	Lecture/theory room	$60m^2$	1	1:25
6.	Workshop	$160m^2$	1	1:25
7.	Site			
C	**Consumable materials**			
8.	Electrical wires	$1.5mm^2$(red, black green)	5 rolls	1:5
		$2.5mm^2$(red, black green)	5 rolls	1:5
		4.0 mm^2(red, black green)	3 rolls	1:10
		6.0 mm^2(red, black green)	2 rolls	1:12
		10 mm^2(red, black green)	2 rolls	1:12
9.	Insulation tapes		25 pcs	1:1

10.	Accessories	Breadboard, strip board, resistors, capacitors, inductors, transformers, power supply units, function generator, signal tracers, diagnostic software, sensors etc	25 pcs each	1:1
D	**Tools and Equipment**			
11.	Striping knives		25 pcs	1:1
12.	Side cutters		25 pcs	1:1
13.	Pliers		25 pcs	1:1
14.	Tape measure		25 pcs	1:1
15.	Try Square		25 pcs	1:1
16.	Assorted Screw driver		25 pcs	1:1
17.	Assorted hammers		25 pcs	1:1
18.	Crimping tools		5 pcs	1:5
19.	PPEs		25 pcs	1:1
20.	Work stations		25	1:1
21.	Installation boards		13 pcs	1:2

CONTROL AND INSTRUMENTATION SYSTEMS MONITORING

UNIT CODE: 0714 551 21A

TVETCDACC UNIT CODE: ENG/CU/IC/CR/01/6/MA

Relationship to Occupational Standards

This unit addresses the unit of competency: Monitor control and instrumentation systems.

Duration of Unit: 120 Hours

Unit Description

This unit covers the competencies required to monitor control and instrumentation systems. It involves conducting control and instrumentation monitoring site survey, installing control and instrumentation monitoring systems, testing and commissioning instrumentation systems.

Summary of Learning Outcomes

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

S/NO	LEARNING OUTCOMES	DURATION(HOURS)
1.	To conduct control and instrumentation monitoring site survey	32
2.	To install control and instrumentation monitoring system	54
3.	To test and commission instrumentation system	34
	TOTAL	**120**

Learning Outcomes, Content and Suggested Assessment Methods

Learning Outcome	Content	Suggested Assessment Methods

1. Conduct Control and instrumentation monitoring site survey	1.1 Safety procedures and hazard Identification 1.1.1 Electrical hazards 1.1.2 Chemical hazards 1.1.3 Physical hazards 1.1.4 Biological hazards 1.1.5 Ergonomic hazards 1.2 Site conditions 1.2.1 temperature 1.2.2 humidity 1.2.3 distance 1.2.4 dust 1.2.5 light intensity 1.2.6 pressure 1.3 Visit 1.1.1 Risk Assessment 1.1.2 Control Measures 1.1.2.1 Engineering controls 1.1.2.2 Administrative controls 1.1.3 Site Survey Procedures 1.1.3.1 Lockout/Tagout 1.1.3.2 Confined Space Entry 1.1.3.3 Hot Work Permits 1.1.3.4 PPE Use 1.1.3.5 Safe Work Practices 1.1.4 Emergency Preparedness 1.1.4.1 First aid and medical assistance 1.1.4.2 Fire safety 1.1.4.3 Evacuation procedures	1. Written tests 2. Oral Questioning 3. Practical assessment 4. Project 5. Third party report 6. Portfolio of evidence

	1.1.5 Post-Survey Procedures 1.1.5.1 Incident Reporting 1.1.5.2 Debriefing 1.1.5.3 Documentation 1.4 Site condition evaluation 1.2.1 Temperature 1.2.2 Distance 1.2.3 Dust 1.2.4 Light intensity 1.2.5 Pressure 1.5 Instrumentation systems layouts 1.3.1 Pressure system 1.3.2 Flow system 1.3.3 Level system 1.3.4 Temperature system 1.6 Monitor instrumentation measurements 1.4.1 Pressure measurements 1.4.2 Flow measurements 1.4.3 Level measurements 1.4.4 Temperature measurements 1.4.5 Optical measurements 1.7 Installation of monitoring systems 1.8 Interpretation of technical reports 1.5.1 Manuals 1.5.2 Technical drawings 1.9 Site survey reports	

2. Install Control and instrumentation monitoring system	2.1 Health and safety procedures 2.2 Types of working drawings 2.2.1 Schematic diagram 2.2.2 Wiring diagram 2.2.3 Line diagram 2.3 Control and instrumentation monitoring system Tools 2.3.1 Measuring tools 2.3.2 Marking tool 2.3.3 Cutting tools 2.3.4 Fastening tools 2.3.5 Fixing tools 2.3.6 Crimping tool 2.4 Monitoring system instruments 2.4.1 Sensors 2.4.2 Transducers 2.4.3 Data loggers 2.4.4 Controllers 2.4.5 HMIs 2.4.6 Remote monitoring systems 2.5 Types of instrumentation wiring systems 2.5.1 Conduit wiring 2.5.2 Batten wiring 2.5.3 Metallic conduits 2.5.4 Cable trays 2.5.5 Ducts 2.5.6 Trunkings 2.6 Fixing and termination of monitoring instruments	1. Written tests 2. Oral Questioning 3. Practical assessment 4. Project 5. Third party report 6. Portfolio of evidence

	2.6.1 Pressure gauge 2.6.2 Tachometer 2.6.3 Loadcells 2.6.4 Piezometer 2.6.5 Strain gauge 2.6.6 Multimeter 2.6.7 Thermo couple 2.7 Cable laying, lugging and tagging 2.8 Termination of monitoring system cables 2.8.1 Power cable 2.8.2 Signal cable	
3. Test and commission instrumentation system	3.1 Importance of instrumentation system testing 3.2 Meaning of terms 3.2.1 Inspection 3.2.2 Testing 3.3 Types of tests e.g. 3.3.1 Electrical tests 3.3.2 Functionality tests 3.3.2.1 Test Signal Conditioning Elements 3.3.2.2 Test Signal Processing elements 3.3.2.3 Test Data presentation elements 3.4 Testing tools and equipment 3.4.1 Multimeter 3.4.2 Insulation resistance tester 3.4.3 Signal generators	1. Written tests 2. Oral Questioning 3. Practical assessment 4. Project 5. Third party report 6. Portfolio of evidence

	3.5 Troubleshooting techniques 3.6 Performance characteristics 3.6.1 Statics and dynamics 3.6.2 Error and loading effects 3.6.3 Accuracy 3.6.4 Precision 3.6.5 Linearity 3.6.6 Sensitivity 3.6.7 Resolution 3.6.8 Response time 3.6.9 Drift 3.6.10 Calibration 3.6.11 Functional integration 3.7 Need for end user training 3.8 Commissioning documents 3.8.1 Start up and shutdown procedures 3.8.2 Safety documentation 3.8.3 Handover report	

Suggested Methods of Instruction

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

Recommended Resources for 25 trainees

S/No.	Category/Item	Description/ Specifications	Quantity	Recommended Ratio (Item: Trainee)
A	**Learning Materials**			
101.	Reference books	A.K Sawhney Electrical and Electronic Measurement and Instrumentation. Arun. K Ghoshi Introduction to Measurements and Instrumentation 2nd edition R.K Rajput Electrical Measurements and Instrumentation 2nd edition	5 pcs	1:5
102.	Installation manuals	Assorted Systems component Manufacturer's manuals and data sheets Instrumentation Handbooks	5 pcs	1:5
103.	Charts	Assorted Circuit diagrams P& ID charts	1 pcs for each	1:25
104.	Software	Assorted simulation software e.g Circuit wizard, Auto CAD	25	1:1
105.	Audio visual presentations	Projector	1	1:25

B	**Learning Facilities & infrastructure**			
37.	Lecture/theory room	60m^2	1	1:25
38.	Workshop	150m^2	1	1:25
39.	Computer laboratory	100m^2	1	1:25
C	**Consumable materials**			
40.	Installation materials	Insulation tape,cables	25 pcs	1:1
41.	Assorted electrical components	Contactors, transformer, overload relays, timers	25 pcs	1:1
42.	Assorted instrumentation components	Sensors, transducers, actuators	25	1:5
D	**Tools and Equipment**			
43.	Assorted tools and equipment	Side cutters, Side cutters, Pliers, Screw driver, Crimping tools, Mult-meter, Oscilloscope, Solder guns	25 pcs	1:1
44.	PPEs	Safety boots,overall	25 pcs	1:1
45.	Function generator		5 pcs	1:5
46.	Variable power supply		5 pcs	1:5
47.	Trainers kit	Digital electronics, PWM kit	5 pcs	1:5

48.	PCB prototyping machine		2	1:13
49.	Hot air gun		5 pcs	1:5
50.	Drilling machines		5 pcs	1:5
51.	Work stations		25	1:1

MODULE VI

CONTROL SYSTEMS

UNIT CODE: 0714 551 12A

TVETCDACC UNIT CODE: ENG/CU/IC/CC/04/6/MA

Relationship to Occupational Standards

This unit addresses the unit of competency: Apply control systems.

Duration of Unit: 120 Hours.

Unit Description

This unit covers the competencies required to apply control systems. It involves applying basic concepts of control systems, system modelling, performance, compensation and servo systems.

Summary of Learning Outcomes

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

S/NO	LEARNING OUTCOMES	DURATION(HOURS)
1.	Apply basic concepts of control systems	20
2.	Apply system modelling	25
3.	Apply system performance	30
4.	Apply system compensation	25
5.	Apply servo systems	20
	TOTAL HOURS	**120**

Learning Outcomes, Content and Suggested Assessment Methods

Learning Outcome	Content	Suggested Assessment Methods
1. Apply basic concepts of control systems	1.1 Types of control systems 1.1.1 Man-made system	• Practical

	1.1.2 Natural system 1.1.3 Hybrid system 1.1.4 Controlled variable 1.2 Open and closed loop systems 1.3 Feedback 1.3.1 Positive feedback 1.3.2 Negative feedback 1.3.3 Effects of feedback on overall gain, sensitivity, stability and noise. 1.4 Block diagrams 1.4.1 Basic elements of block diagram 1.4.2 Block diagram representation of electrical systems 1.4.3 Block diagram algebra 1.4.3.1 Series connection 1.4.3.2 Parallel connection 1.4.3.3 Feedback connection 1.5 Simplification of block diagrams 1.5.1 Canonical forms 1.5.2 Transfer functions 1.5.3 Superposition 1.6 Signal flow graphs 1.6.1 Basic elements of signal flow graphs 1.6.2 Construction of signal flow graphs 1.7 Simplification of system loops 1.7.1 Masons rule 1.7.2 Complex loop 1.7.3 Loop reduction 1.8 Conversion of block diagrams to signal flow graphs	• Portfolio of evidence • Third party report • Oral questioning • Written tests

	1.8.1 Nodes 1.8.2 Sinks	
2. Apply system modelling	2.1 Need for modelling 2.2 Mathematical models 2.2.1 Differential equation model 2.2.2 Transfer function model 2.2.3 State space model 2.3 Derivation of transfer functions for simple networks 2.3.1 Electrical 2.3.2 Mechanical 2.3.3 Laplace transforms, jω, D-operations 2.4 Electrical-mechanical analogy 2.4.1 Force- Voltage 2.4.2 Force – current 2.4.3 Translational vs Rotational 2.5 Modelling of practical systems 2.5.1 Generators 2.5.2 Temperature control systems 2.5.3 Calculations	• Practical • Portfolio of evidence • Third party report • Oral questioning • Written tests
6. Apply system performance	3.1 Time response analysis 3.1.1 Transient response 3.1.2 Steady state response 3.2 Test signals 3.2.1 Unit step 3.2.2 Unit ramp 3.2.3 Unit parabolic 3.2.4 Unit impulse 3.3 Dynamic response for 1st and 2nd order systems 3.3.1 Response terms	• Practical • Portfolio of evidence • Third party report • Oral questioning • Written tests

	3.3.2 Standard 2nd order equation 3.3.3 Response graphs 3.3.4 Derivation of dimensionless 2nd order equation 3.4 Damping methods 3.4.1 Velocity feedback 3.4.2 Error rate 3.4.3 Viscous friction damping 3.4.4 Effects of damping ratio 3.4.5 Calculation of limiting values 3.5 Time domain specifications 3.5.1 Delay time 3.5.2 Rise time 3.5.3 Peak time 3.5.4 Peak overshoot 3.5.5 Settling time 3.6 Types of system stability 3.6.1 Relative stability 3.6.2 Absolute stability 3.6.3 Asymptotic Stability 3.6.4 Marginal Stability 3.6.5 Bounded input-bounded output 3.7 System stability analysis methods 3.7.1 Routh's stability criterion 3.7.2 Nyquist diagrams 3.7.3 Bode plots 3.7.4 Nichol's chart 3.7.5 Root locus 3.8 Process control strategies 3.8.1 Proportional (P),	

	3.8.2 Integral (I), 3.8.3 Derivative (D), 3.8.4 Proportional plus Integral (PI), 3.8.5 Proportional plus Derivative (PD), 3.8.6 Proportional plus Integral plus Derivative (PID)	
1. Apply system compensation	4.1 Need for compensation 4.2 Compensating networks transfer functions 4.1.1 Lead compensator 4.1.2 Lag compensator 4.1.3 Lead-lag compensator 4.3 Designing a Bode compensator 4.4 Compensation using 3-term controller	• Practical • Portfolio of evidence • Third party report • Oral questioning • Written tests
2. Apply servo systems	5.1 Servo mechanisms 5.1.1 Position 5.1.2 Speed 5.1.3 Acceleration 5.2 AC and DC Servo amplifiers 5.2.1 Linear 5.2.2 Pulse-width modulation 5.2.3 Digital 5.3 Operation of stepper motors 1.3.1 Construction 1.3.2 Control circuits 1.3.3 Calculations 1.3.4 Interfacing 1.3.5 Applications 5.4 Characteristics curves of ac and dc servo motors 5.4.5 Torque Vs Speed curve	• Practical • Portfolio of evidence • Third party report • Oral questioning • Written tests

	5.4.6 Torque Vs Current curve 5.4.7 Efficiency Vs Load curve 5.4.8 Calculations	

Suggested Methods of Instruction

- Projects
- Practical
- Demonstration
- Group Discussions
- Direct Instruction
- Illustration

Recommended Resources for 25 trainees

S/No.	Category/Item	Description/ Specifications	Quantity	Recommended Ratio (Item: Trainee)
A	**Learning Materials**			
1.	Textbooks	S.K.B Pearson Control Systems Theory and Application Control systems by Yousef Zadek	5 pcs of each	1:5
2.	Installation manuals	Electrical machine manuals	5 pcs	1:5
3.	Charts	Single line diagram	1 pcs for each	1:25

		Motor starting circuits Circuit diagrams Colour codes		
4.	Softwares	PLC software Arduino IDE Matlab		
5.	Projector and screen	For trainer's use	1	1:25
B	**Learning Facilities & infrastructure**			
6.	Lecture/theory room	$60m^2$	1	1:25
7.	Workshop	$150m^2$	1	1:25
8.	Computer Laboratory	$100m^2$	1	1:25
C	**Consumable materials**			
9.	Electrical wires	$1.5mm^2$(red, black green)	1 rolls	1:5
		$2.5mm^2$(red, black green)	5 rolls	1:5
		4.0 mm^2(red, black green)	3 rolls	1:10
		6.0 mm^2(red, black green)	2 rolls	1:12
		10 mm^2(red, black green)	2 rolls	1:12
10.	Cables	USB, Ethernet, UART, 4-20mA current loop cable	5 pcs	1:5
11.	Insulation tapes		25 pcs	1:1
12.	Accessories	Sensors, Actuators, Limit	25 pcs	1:1

		switches, Push buttons, Timers, Relays, input/output modules, keyboard		
13.	Pipes and trunkings	PVC conduits, Mini trunking	25 pcs	1:1
D	**Tools and Equipment**			
14.	PLC module		5	1:5
15.	Microcontroller tool kit		5	1:5
16.	PPEs		25 pcs	1:1
17.	Multimeter		5 pcs	1:5
18.	Oscilloscope		5 pcs	1:5
19.	Servomotors		5 pcs	1:5

RESEARCH METHODS

UNIT CODE: 0111 551 11A

TVETCDACC UNIT CODE: ENG/CU/IC/CC/05/6/MA

Relationship to Occupational Standards

This unit addresses the unit of competency: Apply research methods.

Duration of Unit: 60 Hours

Unit Description

This unit covers the competencies required to apply research methods. It involves identifying research problems, conducting literature review, developing research methodology, analyze collected data, and prepare research report.

Summary of Learning Outcomes

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

S/NO	LEARNING OUTCOMES	DURATION(HOURS)
1.	Identify research problem	8
2.	Conduct literature review	10
3.	Develop Research Methodology	12
4.	Analyse collected data	14
5.	Prepare research report	16
	TOTAL	**60**

Learning Outcomes, Content and Suggested Assessment Methods

Learning Outcome	Content	Suggested Assessment Methods
1. Identify research problem	1.1 Methods of identifying research problem	1 Interview 2 Observation 3 Supervised exercises

	1.2 Gathering background information 1.3 Research variables 1.4 Research objectives 1.5 Formulating research questions 1.6 Significance of research 1.7 Establishment of scope of study	4 Third party reports 5 Written texts
2. Conduct literature review	2.1 Sources of literature review 2.1.1 Primary 2.1.2 Secondary 2.2 Keywords and phrases 2.3 Ethical research guidelines on referencing and citation 2.4 Organization and reporting of collected literature	1 Interview 2 Observation 3 Supervised exercises 4 Third party reports 5 Written texts
3. Develop research Methodology	3.1 Types of research designs 3.1.1 Descriptive 3.1.2 Correlational 3.1.3 Experimental 3.1.4 Longitudinal 3.1.5 Cross-sectional 3.2 Identification of study population 3.3 Sampling techniques 3.3.1 Simple random 3.3.2 Systematic 3.3.3 Stratified 3.3.4 Clustered	1 Interview 2 Observation 3 Supervised exercises 4 Third party reports 5 Written texts

	3.4 Research proposal guidelines and requirements 3.5 Budget preparation	
4. Analyze collected data	4.1 Methods of data collection 4.1.1 Surveys and questionnaires 4.1.2 Interviews 4.1.3 Focus groups 4.1.4 Observations 4.1.5 Case studies 4.2 Research guidelines on data collection 4.3 Data cleaning 4.4 Data analysis tools 4.4.1 Statistical software 4.4.2 Qualitative analysis software 4.4.3 Spreadsheet software 4.5 Data presentation 3.2.1 Data visualization tools 3.2.2 Presentation software	1 Interview 2 Observation 3 Supervised exercises 4 Third party reports 5 Written texts
5. Prepare research report	5.1 Discussion of research findings 5.2 Drawing of conclusions based on findings 5.3 Recommendations 5.4 Referencing systems 5.4.1 APA 5.4.2 MLA 5.4.3 Havard	1 Interview 2 Observation 3 Supervised exercises 4 Third party reports 5 Written texts

	5.4.4 IEEE 5.5 Appendices 5.6 Research report presentation	

Suggested Methods of Instruction

- Practical
- Lab and field projects
- Demonstrations
- Group discussions
- Direct instructions
- Role playing
- Interactive lectures
- Individual assignments
- Viewing of related videos

Recommended Resources for 25 Trainees

S/No.	Category/Item	Description/ Specifications	Quantity	Recommended Ratio (Item: Trainee)
A	**Learning Materials**			
1.	Reference books	• Research Methodology: A Step-by-Step Guide for Beginners by Ranjit Kumar • Research Methodology: Tools And Techniques By Dr. Prabhat Pandey	5 pcs	1:5

		and Dr. Meenu Mishra Pandey		
2.	Charts	Research design flow chart	1 pc for each	1:25
3.	Software	Data analysis software i.e SPSS, Microsoft Excel Data presentation software i.e. Microsoft powerpoint, Tableau, Canva, Microsoft Excel. Planning and management software. i.e. Google Calendar	25	1:1
4.	Audio visual presentations	Projector	1	1:25
B	**Learning Facilities & infrastructure**			
5.	Lecture/theory room	$60m^2$	1	1:25
6.	Computer laboratory	$100m^2$	1	1:25
7.	Research Centre	$100m^2$	1	1:25
C	**Consumable materials**			
8.	Field research materials	Sampling supplies i.e. soil, bags, notebook, battery and fuel	25 pcs	1:1
9.	Social research materials	Surveys and questionnaires	25 pcs	1:1
10.	Laboratory research materials	Chemical reagents, glassware and plastic ware	25	1:5
D	**Tools and Equipment**			

11.	Assorted research and data collection tools and equipment	Camera, Digital storage device, computer,	25 pcs	1:1

INDUSTRIAL MEASUREMENT INSTRUMENTS CALIBRATION

UNIT CODE: 0714 551 22A

TVETCDACC UNIT CODE: ENG/CU/IC/CR/02/6/MA

Relationship to Occupational Standards

This unit addresses the unit of competency: Calibrate industrial measurement instruments.

Duration of Unit: 120 Hours

Unit Description

This unit covers the competencies required to calibrate industrial measurement instruments. It involves preparing industrial measurement instruments, performing industrial measurements, testing industrial measuring instruments and adjusting industrial measurement to pre-set value.

Summary of Learning Outcomes

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

S/NO	Learning Outcomes	DURATION(HOURS)
1.	To prepare industrial measurement instruments	31
2.	To perform industrial measurements	42
3.	To test industrial measuring instruments	27
4.	To adjust industrial measurement to pre-set value	20
	TOTAL HOURS	**120**

Learning Outcomes, Content and Suggested Assessment Methods

Learning Outcome	Content	Suggested Assessment Methods
1. Prepare industrial measurement instruments	1.1 Health and safety procedures 1.2 Industrial measurement Quantities 1.2.1 Flow meter 1.2.2 Load cells 1.2.3 Pressure transmitters 1.2.4 Level Transmitters 1.2.5 Temperature transmitters 1.2.6 Piezo Electric sensors 1.3 Calibration and alignment 1.4 Calibration procedure 1.5 Industrial measurement instrument is disengagement 1.5.1 Safety procedures 1.5.2 Instruments manufacture manuals	1. Written tests 2. Oral Questioning 3. Practical assessment 4. Project 5. Third party report 6. Portfolio of evidence
2. Perform industrial measurements	2.2 Industrial measurement Quantities 2.2.1 Flow rate 2.2.2 Pressure 2.2.3 Temperature 2.2.4 Level 2.2.5 Mass 2.2.6 Time 2.2.7 Frequency 2.2.8 Speed 2.2.9 Energy 2.3 Measuring instruments 2.3.1 Pressure gauges 2.3.2 tachometer	1. Written tests 2. Oral Questioning 3. Practical assessment 4. Project 5. Third party report 6. Portfolio of evidence

	2.3.3 multimeter 2.3.4 thermocouple 2.3.5 energy meter 2.3.6 flow meter 2.4 Units of measurements 2.4.1 pascal 2.4.2 volts 2.4.3 amperes 2.4.4 degree Celsius 2.4.5 watts 2.4.6 meter cube per second 2.5 Measurement analysis and recording	
3. Test industrial measuring instruments	3.2 Measuring instrument initial values: 3.3.1 Identification of the instrument type: pressure, temperature, flow, or level 3.3.2 Observation of pre-calibration values 3.3.3 Check response and output stability 3.3.4 Recording initial readings in logbooks or calibration forms 3.3 Integration of measuring instrument with calibration instrument: 3.3.1 Selection of appropriate calibration instruments 3.3.1.1 Electrical (multimeter, loop calibrator, multifunction calibrator)	1. Written tests 2. Oral Questioning 3. Practical assessment 4. Project 5. Third party report 6. Portfolio of evidence

	3.3.1.2 Pressure (dead weight tester, digital pressure calibrator) 3.3.1.3 Temperature (dry block calibrator, thermocouple simulator) 3.3.2 Matching signal types and measurement ranges: 3.3.2.1 4–20 mA loops, 0–10 V signals, RTD or thermocouple inputs 3.3.3 Correct connection procedures: 3.3.4 Instrument isolation: 3.3.4.1 Disconnecting from live processes 3.3.4.2 Bypassing control systems if necessary 3.4 Sourcing of Physical Variable from Calibrator 3.4.1 Setting calibrator to generate the required physical variable: 3.4.2 Application of variable in defined steps or continuous sweep 3.4.3 Maintaining accuracy and stability during source application 3.4.4 Using software-controlled calibrators where applicable 3.4.5 Observing environmental effects on physical variable delivery 3.5 Calibration documentations 3.5.1 Traceability table	

	3.5.2 Repeatability table 3.5.3 Calibration Certificate 3.5.4 Equipment tag	
4. Adjust industrial measurement to pre-set value	4.1 Error calculation 4.2 Industrial measuring instruments value adjustments to zero and span error 4.3 Calibration Documentations 4.4.1 Instrument types 4.4.2 Calibration frequency 4.4.3 Calibration standards 4.4.4 Accuracy requirements 4.4.5 Documentation requirements	1. Written tests 2. Oral Questioning 3. Practical assessment 4. Project 5. Third party report 6. Portfolio of evidence

Suggested Delivery Methods

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

List of Recommended Resources for 25 trainees

S/No.	Category/Item	Description/ Specifications	Quantity	Recommended Ratio (Item: Trainee)

A	**Learning Materials**			
1.	Textbooks	*McMillan K. Gregory,* Process/industrial instruments and controls handbook, fifth edition *W. BOLTON, programmable logic controllers, sixth edition.*	Online	1:1
2.	Installation manuals	PLC systems. Manuals for Siemens, Allen-Bradley, Mitsubishi, Omron and Schneider	5 pcs	1:5
B	**Learning Facilities& infrastructure**			
3.	Lecture/theory room	$60m^2$	1	1:25
4.	Workshop	$150m^2$	1	1:25
5.	Projector		1 pc	1:25
6.	Interactive display screen	75 inches	1 pc	1:25
7.	Computers with internet access	Processor: Intel Core i5/i7 or equivalent RAM: 8GB or higher Storage: 256GB SSD or higher	25 pcs	1:25
8.	Handheld Calibrators	• Yokogawa HART Communicator • Emerson AMS Device Manager • ABB FieldXpert • Honeywell DTM+ • Endress+Hauser FieldCare	1 pc	1:25
C	**Consumable materials**			
D	**Software**			

INSTRUMENTATION AND CONTROL SYSTEM SUPERVISION

UNIT CODE: 0714 551 23A

TVETCDACC UNIT CODE: ENG/CU/IC/CR/03/6/MA

Relationship to Occupational Standards

This unit addresses the unit of competency: Supervise instrumentation and control systems.

Duration of Unit: 120 Hours

Unit Description

This unit covers the competencies required to supervise instrumentation and control systems. It involves preparing instrumentation and control systems installation work plans, allocating instrumentation and control systems personnel duties, controlling instrumentation and control systems material usage, inspecting instrumentation and control systems installation work and commissioning instrumentation and control systems installation work.

Summary of Learning Outcomes

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

S/NO	LEARNING OUTCOMES	DURATION(HOURS)
1.	To prepare instrumentation and control systems installation work plans	20
2.	To allocate instrumentation and control systems personnel duties	15
3.	To control instrumentation and control systems Material usage	35
4.	To inspect instrumentation and control systems installation work	30
5.	To commission Instrumentation and control system installation work	20
	TOTAL HOURS	**120**

Learning Outcomes, Content and Suggested Assessment Methods

Learning Outcome	Content	Suggested Assessment Methods
1. Prepare instrumentation and control systems installation work plans	1.1 Introduction to instrumentation and control systems installation work plans 1.1.1 Creation of an instrumentation and control system work plan 1.2 Documentation of the scope of Instrumentation and control system installation. 1.3 Preparation of Instrumentation and control system installation project timelines 1.3.1 Bar charts 1.3.2 Gantt charts 1.4 Assembling of Tools and equipment Instrumentation and control system installation project	1. Written tests 2. Oral Questioning 3. Practical assessment 4. Project 5. Third party report 6. Portfolio of evidence
2. Allocate instrumentation and control system personnel duties	2.1 Classification of project tasks for instrumentation and control system installation project 2.2 Pre-Project Planning 2.2.1 Design and engineering 2.2.2 Procurement and logistics 2.2.3 Site Preparation and civil works 2.2.4 Equipment installation 2.2.5 Configuration and integration 2.2.6 Testing and Quality assurance 2.2.7 Commissioning and handover 2.2.8 Post-Installation support	1. Written tests 2. Oral Questioning 3. Practical assessment 4. Project 5. Third party report 6. Portfolio of evidence

	2.3 Assign instrumentation and control system installation project tasks to personnel 2.3.1 Project Manager 2.3.2 Site engineer 2.3.3 Field technicians/installers 2.3.4 Engineer (network, civil, electrical instrumentation and control system s design) 2.3.5 Safety officer 2.3.6 Procurement specialist 2.3.7 Quality Assurance (QA) Engineer 2.3.8 Environmental officer (Optional, for larger projects) 2.3.9 Client/Stakeholder representative 2.3.10 Commissioning engineer 2.4 Distribution of instrumentation and control system installation project tools and equipment	
3. Control instrumentation and control system installation material usage	3.1 Identification of Instrumentation and control system installation materials 3.2 Terminology on control of Instrumentation and control system installation material usage 3.2.1 Material management 3.2.2 Inventory management 3.2.3 Bill of Materials (BOM 3.2.4 Supply Chain Management 3.2.5 Inspection Compliance 3.2.6 Usage Rate 3.2.7 Cost Variance	1. Written tests 2. Oral Questioning 3. Practical assessment 4. Project 5. Third party report 6. Portfolio of evidence

	3.2.8 Waste Management 3.2.9 Material Handling 3.3 Assembling the materials for Instrumentation and control system installation 3.4 Procedure of Issuance of Instrumentation and control system installation materials 3.4.1 Material Requisition 3.4.2 Review and Approval 3.4.3 Material Preparation and Documentation 3.4.4 Issuance of Materials 3.4.5 Material Delivery to Site 3.4.6 Usage and Tracking 3.4.7 Return of Excess or Unused Materials 3.4.8 Record Keeping and Auditing 3.4.9 Final Material Reconciliation	
4. Inspect Instrumentation and control system installation work	4.1 Identification of Instrumentation and control system installation project tools and equipment 4.2 Physical Inspection of instrumentation and control system 4.2.1 Functional Testing of Installed Systems 4.2.2 Correct Equipment Installation 4.2.3 Cable Management 4.2.4 Proper Grounding and Bonding 4.2.5 Environmental Conditions (temperature, humidity) 4.2.6 Surge Protection and Shielding	1. Written tests 2. Oral Questioning 3. Practical assessment 4. Project 5. Third party report 6. Portfolio of evidence

	4.2.7 Mounting and Support Structures Stability 4.2.8 Adherence to Safety Standards 4.2.9 Adherence to Industry Regulations and Standards 4.2.10 Equipment Accessibility for Maintenance 4.2.11 Site Cleanliness and Orderliness 4.2.12 Testing of Communication Links (performance and quality) 4.2.13 Compliance with Design Specifications 4.2.14 Integrity of Cable Connections and Terminations 4.2.15 Labelling of Equipment and Cables 4.2.16 Power Supply and Backup Systems 4.3 Technical inspection of instrumentation and control system 4.3.1 Compliance with Technical Specifications 4.3.2 Data Transmission Speeds 4.3.3 Electrical Testing (voltage, current, grounding) 4.3.4 System Configuration and Software Settings 4.3.5 Proper Functionality of Network systems 4.4 Documentation of inspection report	

5. Commission instrumentation and control system installation work	5.1 Assembly of instrumentation and control installation project tools and equipment 5.2 Pre-commissioning activities 5.2.1 Visual inspection of wiring, piping, and instrument mounting 5.2.2 Checking for proper termination, grounding, and shielding 5.2.3 Power-on checks (input power, fuses, signal integrity) 5.2.4 Ensuring all process isolation and safety procedures are in place 5.2.5 Use of pre-commissioning checklist 5.3 Functional testing 5.3.1 Testing instruments for correct input-output behavior 5.3.2 Verification of alarm set points, range settings, and scaling 5.3.3 Testing PLC/DCS input-output (I/O) response 5.3.4 Testing interlocks and control logic (manual and auto modes) 5.3.5 Simulating process conditions for device response 5.3.6 Troubleshooting and resolving non-functional components 5.3.7 Documenting test outcomes in functional test reports 5.4 Performance testing 5.4.1 Comparing system performance with design specifications	1. Written tests 2. Oral Questioning 3. Practical assessment 4. Project 5. Third party report 6. Portfolio of evidence

	5.4.2 Checking process accuracy, response time, stability, and repeatability 5.4.3 Verifying integrated operation of sensors, actuators, and controllers 5.4.4 Stress-testing system under normal and peak operating conditions 5.4.5 Recording all test data and deviations 5.4.6 Generating performance test reports and obtaining client/project approval	

Suggested Methods of Delivery

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

Recommended Resources for 25 trainees

S/No.	Category/Item	Description/ Specifications	Quantity	Recommended Ratio (Item: Trainee)
A	**Learning Materials**			
1.	Installation manuals		5 pcs	1:5
2.	Charts		1 pc for each	1:25

B	**Learning Facilities & infrastructure**			
5.	Lecture/theory room	60m^2	1	1:25
6.	Workshop	160m^2	1	1:25
7.	Laboratory	100m^2	1	1:25
C	**Consumable materials**			
8.	Electrical wires	1.5mm^2(red, black green)	5 rolls	1:5
		2.5mm^2(red, black green)	5 rolls	1:5
		4.0 mm^2(red, black green)	3 rolls	1:10
		6.0 mm^2(red, black green)	2 rolls	1:12
		10 mm^2(red, black green)	2 rolls	1:12
9.	Insulation tapes		25 pcs	1:1
10.	Accessories	Switches, sockets, Junction boxes, Consumer units, Lamp holders, Patrice boxes, Circuit breakers	25 pcs	1:1
11.	Mounting racks		10	1:3

12.	Pipes and trunkings	PVC conduits, Steel conduits, Mini trunking	25 pcs	1:1
D	**Tools and Equipment**			
13.	Hacksaws		25 pcs	1:1
14.	Striping knives		25 pcs	1:1
15.	Side cutters		25 pcs	1:1
16.	Pliers		25 pcs	1:1
17.	Tape measure		25 pcs	1:1
18.	Try Square		25 pcs	1:1
19.	Spirit level		25 pcs	1:1
20.	Assorted Screw driver		25 pcs	1:1
21.	Assorted hammers		25 pcs	1:1
22.	Crimping tools		5 pcs	1:5
23.	PPEs		25 pcs	1:1
24.	Multimeters		5 pcs	1:5
25.	Clamp meters		5 pcs	1:5
26.	Earth resistance meter		5 pcs	1:5
27.	Stocks & Dies		5 pcs	1:5
28.	Vices		5 pcs	1:5
29.	Oscilloscope		5 pcs	1:5
30.	Pipe bending Machine		5 pcs	1:5
31.	Bending spring		5 pcs	1:5

32.	Drilling machines		5 pcs	1:5
33.	Work stations		25	1:1
34.	Installation boards		13 pcs	1:2
35.	Hydrometer		5 pcs	1:5
36.	Solar irradiance meter		1 pc	1:25
37.	Grid tie Synchroniser		1	1:25
38.	Battery capacity tester		1	1:25