REPUBLIC OF KENYA

COMPETENCY BASED MODULAR CURRICULUM

FOR

ELECTRONICS ENGINEERING

KNQF LEVEL 6

(CYCLE 3)

PROGRAMME ISCED CODE: 0713 554MA

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 and electronics 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

ACKNOWLEDGEMENT

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

I recognize with appreciation the role of the Electrical and electronics 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 and electronics 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 and electronics Sector acquire competencies to perform their work more efficiently and effectively.

CEO/COUNCIL SECRETARY

TVET CDACC

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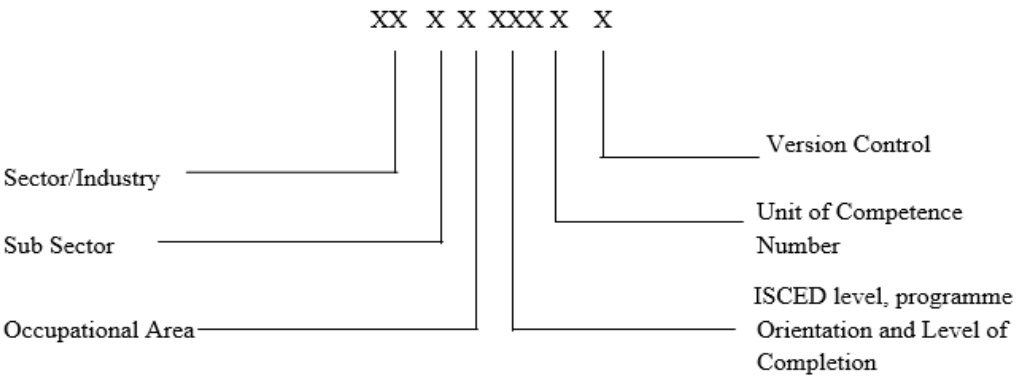
ABBREVIATIONS AND ACRONYMNS

A	Control Version
BC	Basic Competencies
CC	Common Competencies
CDACC	Curriculum Development, Assessment and Certification Council
CR	Core Competencies
CU	Curriculum
EE	Electronics Engineering
EHS	Environment, Health and Safety
ENG	Engineering
ET	Electronics Technician
IBMS	Integrated Building Management System
IEE	Institute of Electrical Engineers
KEBS	Kenya Bureau of Standards
OS	Occupational Standards
OSHA	Occupational Safety and Health Act
PPE	Personal Protective Equipment
TVET	Technical and Vocational Education and Training
WIBA	Work injury benefits Act

KEY TO UNIT CODE



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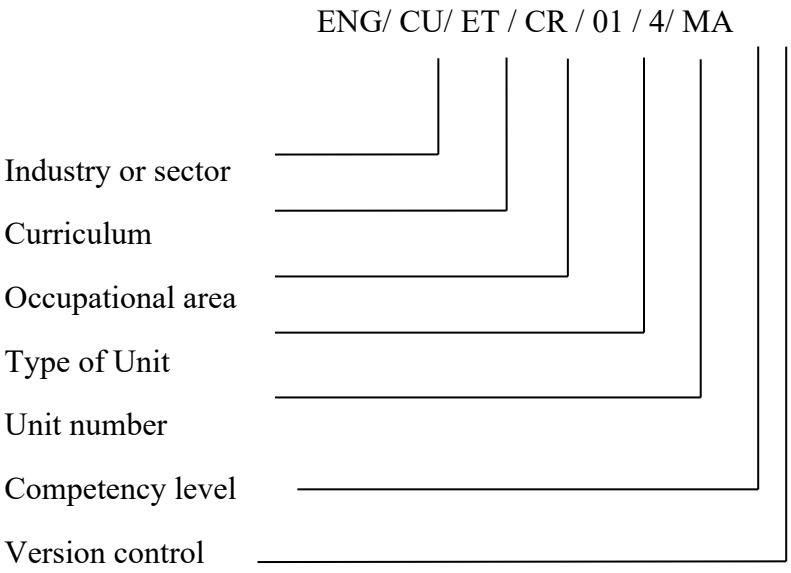

COURSE OVERVIEW

Electronics Engineering Level 6 curriculum consists of competencies required to perform electrical installation, install power supply systems, apply electrical instrumentation and maintain Electrical and Electronic Equipment and Appliance.

Electronics Engineering Level 6 qualification comprises of the following units:

Module I				
ISCED Unit Code	**TVET CDACC Unit Code**	**Unit Title**	**Duration in Hours**	**Credit Factor**
0713 251 15A	ENG/CU/ET/CR/01/3/MA	Electrical installation I	80	8.0
0714 251 16A	ENG/CU/ET/CR/02/3/MA	Electrical and Electronics Equipment and Appliances repairs	80	8.0
0714 251 17A	ENG/CU/ET/CR/03/3/MA	Electrical instrumentation	80	8.0
		Sub Total	**240**	**24**
Module II				
0713 351 18A	ENG/CU/ET/CR/01/4/MA	Electrical Installation II	90	9
0714 351 19A	ENG/CU/ET/CR/02/4/MA	Power Supply System I	70	7
0714 351 20A	ENG/CU/ET/CR/03/4/MA	Electrical and Electronic Equipment and Appliances Maintenance	70	7
		Sub Total	**230**	**23**
Module III				
0611 451 01A	ENG/CU/ET/BC/01/5/MA	Digital Literacy	40	4
0031 441 02A	ENG/CU/ET/BC/02/5/MA	Communication skills	40	4
0713 441 05A	ENG/CU/ET/CC/01/5/MA	Electrical Principles I	80	8
0732 441 06A	ENG/CU/ET/CC/02/5/MA	Technical drawing	100	10
0713 441 07A	ENG/CU/ET/CC/03/5/MA	Engineering mathematics I	120	12
0713 451 21A	ENG/CU/ET/CR/01/5/MA	Power Supply System II	100	10
		Sub Total	**480**	**48**
Module IV				

0417 441 03A	ENG/CU/ET/BC/03/5/MA	Work Ethics and Practices	40	4
0413 441 04A	ENG/CU/ET/BC/04/5/MA	Entrepreneurial skills	40	4
0713 441 08A	ENG/CU/ET/CC/04/5/MA	Analogue Electronics	80	8
0713 441 09A	ENG/CU/ET/CC/05/5/MA	Digital Electronics	60	6
0713 441 10A	ENG/CU/ET/CC/06/5/MA	Electrical principles II	60	6
0713 451 22A	ENG/CU/ET/CR/02/5/MA	Electrical instrumentation II	100	10
0713 451 23A	ENG/CU/ET/CR/03/5/MA	Security System Installation	100	10
		Sub Total	**480**	**48**
Module V				
0541 541 11A	ENG/CU/ET/CC/01/6/MA	Engineering mathematics II	100	10
0714 541 12A	ENG/CU/ET/CC/02/6/MA	Electrical principles III	80	8
0713 551 24A	ENG/CU/ET/CR/01/6/MA	Electrical Installation III	100	10
0714 551 25A	ENG/CU/ET/CR/02/6/MA	Electrical Machine Control Systems	200	20
		Sub Total	**480**	**48**
Module VII				
0111 541 21A	ENG/CU/ET/CC/03/6/MA	Research Methods	80	8
0713 551 22A	ENG/CU/ET/CC/04/6/MA	Electronics Project Supervision	60	6
0714 551 26A	ENG/CU/ET/CR/03/6/MA	Industrial automation	200	20
0714 551 27A	ENG/CU/ET/CR/04/6/MA	Automation and radio frequency system maintenance	140	14
		Sub Total	**480**	**48**
0714 551 28A	ENG/CU/ET/CR/05/6/MA	Industrial Training	480	48
		Sub Total	**480**	**48**
Grand Total			**2870**	**287**

Entry Requirements

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

a) Kenya Certificate of Secondary Education with Grade C – (minus)

Or

b) Certificate in Electronics Engineering or related KNQF Level 5 course

Or

c) Equivalent qualifications as determined by TVETA.

Trainer Qualification

Qualifications of a trainer for this course include:

a) Possession of a higher qualification than Electronics Engineering technology level 6 or in related trade area; and
b) License by TVETA.
c) License by KETRB/EBK

Industry Training

An individual enrolled in this course will be required to undergo Industry training for a minimum period of 480 hours in the Electronics 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 weighting for each unit of learning shall be as follows:
   i) 10-90 for units in module I and II

ii) 30-70 for units in module III and module 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

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.

f) 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

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

Certification

An individual will be awarded a Certificate of Competency on demonstration of competence in a core unit of competency. To be issued with the Kenya National TVET Certificate in Electronics Engineering Level 6, an individual must demonstrate competence in all the units of competency in this qualification pack.

These certificates will be issued by TVETCDACC

MODULE I

ELECTRICAL INSTALLATION I

UNIT CODE: 0713 251 15A

TVETCDACC UNIT CODE: ENG/CU/ET/CR/01/3/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. Competencies required includes, preparation of list of tools equipment and materials, performing piping and laying cables, performing mounting of electrical components and terminating electrical installation.

Summary of Learning Outcomes

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

S/NO	Learning Outcome	Duration (Hours)
1.	Prepare list of tools, equipment and materials	10
2.	Perform piping and laying of cables	20
3.	Perform mounting of electrical components	40
4.	Terminate electrical installation	10
	TOTAL	**80**

Learning Outcomes, Content and Suggested Assessment Methods

Learning Outcome	Content	Suggested Assessment Methods
1. Prepare list of tools, equipment and materials	1.1 Introduction 1.2 Workshop communication: 1.2.1 Oral and Written 1.3 Values 1.3.1 Self-Awareness 1.3.2 Stress Management 1.3.3 Assertiveness 1.3.4 Drug and Substance abuse 1.3.5 Time Management	• Oral questioning • Written tests • Observation • Practical tests

Learning Outcome	Content	Suggested Assessment Methods
	1.4 Identification of tools and materials e.g. 1.4.1 Cutting tools 1.4.2 Measuring tools 1.4.3 Measuring equipment 1.4.4 Cables and conductors 1.4.5 Conduits 1.4.6 Trunking 1.4.7 Consumables 1.5 Types, application, care, maintenance and storage of: 1.5.1 Tools e.g. 1.5.1.1 Cable strippers 1.5.1.2 Pliers 1.5.1.3 Screw drivers 1.5.1.4 Hammers 1.5.2 Materials e.g. 1.5.2.1 Cables 1.5.2.2 Fittings 1.5.2.3 Accessories	
2. Perform piping and laying of cables	2.1 Safety procedures 2.2 Procedures for piping 2.3 Cables and cable joints 2.4 Surface wiring 2.4.1 Cables and accessories used in surface wiring 2.4.2 Factors to consider during surface wiring 2.4.2.1 Types and applications e.g. Conduits 2.4.2.2 Preparation of wiring systems; Marking out, cutting, bending, 2.5 Draw –in/Lay of cables routes 2.6 Cable Identification 2.7 IEE regulations 2.8 General Cleanliness 2.9 Tools and equipment storage	• Written tests • Observation • Oral questioning • Practical test
3. Perform mounting of electrical components	3.1 Electrical components e.g. 3.1.1 Junction boxes 3.1.2 Ceiling rose 3.1.3 Switches 3.1.4 Socket outlets	• Written tests • Oral questioning • Practical tests • Observation

Learning Outcome	Content	Suggested Assessment Methods
	3.1.5 Bulb holders 3.2 Component Symbols 3.3 Safety in electrical installation	
4. Terminate Electrical Installation	4.1 Importance of termination 4.2 Cable labelling 4.3 Tools used in cable termination e.g. 4.3.1 Strip Knife 4.4 IEE regulations 4.5 Disposal of waste materials 4.6 Book Keeping 4.7 Budgeting	• 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	B. Scaddan Electrical installation work J. Hyde Electrical installation Principles and Practices	5 pcs	1:5
2.	Installation manuals	IEEE regulation BS3939 NEMA regulations OSHA	5 pcs	1:5
3.	Charts	Single line diagram	1 pcs for each	1:25

		Circuit diagrams Colour codes		
4.	Power point presentations	For trainer's use	1	1:25
B	**Learning Facilities & infrastructure**			
1.	Lecture/theory room	50m^2	1	1:25
2.	Workshop	150m^2	1	1:25
3.	Laboratory	100m^2	1	1:25
4.	Site			
C	**Consumable materials**			
1.	Electrical wires	1.0mm^2(red, black green)	5 rolls	1:5
		1.5mm^2(red, black green)	5 rolls	1:5
2.	Insulation tapes		25 pcs	1:1
3.	Accessories	Switches, sockets, Junction boxes, Consumer units, Lamp holders, Patrice boxes, Circuit breakers, relays, transformers	25 pcs	1:1
4.	Pipes	PVC conduits, Metallic conduits	25 pcs	1:1
5.	Wood screws		50 pcs	1:1
D	**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.	Draw wire		25 pcs	1:1
7.	Try Square		25 pcs	1:1
8.	File		5 pcs	1:5
9.	Spirit level		25 pcs	1:1
10.	Assorted Screw driver		25 pcs	1:1
11.	Assorted hammers		25 pcs	1:1
12.	Crimping tools		5 pcs	1:5
13.	PPEs		25 pcs	1:1
14.	Multi-meters		5 pcs	1:5
15.	Clamp meters		5 pcs	1:5
16.	Earth resistance meter		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

ELECTRICAL AND ELECTRONIC EQUIPMENT AND APPLIANCE REPAIRS

UNIT CODE: 0714 251 16A

TVETCDACC UNIT CODE: ENG/CU/ET/CR/02/3/MA

Relationship to Occupational Standards

This unit addresses the unit of competency: Perform electrical and electronic equipment and appliance repairs

Duration of Unit: 80 hours

Unit Description

This unit covers competencies required to perform electrical and electronic equipment and appliances repair. Competencies include: preparing a list of maintenance tools, equipment and materials, inspecting and testing faulty components, performing maintenance activities and conducting tests on repaired equipment and assemble repaired equipment and appliance

Summary of Learning Outcomes

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

S/NO	Learning Outcome	Duration (Hours)
1.	Prepare a list of maintenance tools, equipment and materials	10
2.	Inspect and test electrical and electronic equipment and appliances	10
3.	Perform maintenance activities	40
4.	Perform tests on repaired equipment and appliances	10
5.	Assemble repaired equipment and appliance	10
	TOTAL	**80**

Learning Outcomes, Content and Suggested Assessment Method

Learning Outcome	Content	Suggested Assessment Methods
1. Prepare a list of maintenance tools,	1.1 Classification of Materials 1.2 Semi-Conductor Theory 1.3 Semi-Conductor Diode	• Written tests • Oral questioning • Practical tests

equipment and materials	1.4 Classification of tools and instruments e.g. 1.4.1.1 Analogue and digital instruments 1.4.1.2 Indicating tools and equipment 1.4.1.3 Measurement tools and equipment 1.4.1.4 Cutting tools and equipment 1.4.1.5 Tightening tools 1.5 Various specification range in electrical tools and instruments 1.6 Calibration of instruments 1.7 Care and Maintenance of tools and equipment's 1.8 Draw Electrical and Electronics Symbols 1.9 Materials in maintenance activities e.g. 1.9.1 Cables 1.9.2 PCBs	• Observation
2. Inspect and test faulty components	2.1 Disassembling of various equipment and appliances eg 2.1.1 Radio 2.1.2 Television 2.1.3 Refrigerators 2.1.4 Electric kettles 2.1.5 Instant showers 2.1.6 Air conditioning systems 2.1.7 Washing machines 2.1.8 Mobile phones 2.1.9 Iron boxes 2.1.10 Set top boxes 2.2 Sorting of screws during disassembling 2.3 Inspecting and testing faulty equipment and appliances 2.4 Types of tests on power supply system e.g. 2.4.1 Test for voltage input 2.4.2 Short circuit tests 2.4.3 Open circuit tests 2.5 Troubleshooting methods on various equipment and appliances 2.6 Safety during testing of power supply system 2.7 IEE regulation	• Observation • Oral questioning • Written tests

3. Perform maintenance activities	3.1 Repair/Replacement of faulty components 3.1.1 Maintenance activities e.g. 3.1.1.1 Cleaning 3.1.1.2 Tightening 3.1.1.3 Soldering 3.1.1.4 Assembling 3.1.2 Disposal of waste materials e.g. 3.1.2.1 Old batteries 3.1.2.2 Lugs and screws 3.1.2.3 Tapes 3.1.2.4 Cable sheaths 3.1.2.5 PCBs 3.1.2.6 Off cuts 3.2 EHS regulations 3.3 OSHA regulations	• Observation • Oral questioning • Practical tests • Written tests
4. Perform tests on repaired equipment and appliances	4.1 Visual inspection 4.2 Identification of test points 4.3 Types of tests 4.3.1 Continuity tests 4.3.2 Short circuit test 4.3.3 Operation tests 4.3.4 Open circuit test 4.4 Safe test procedures 4.5 IEE regulations 4.6 Source of information 4.6.1 Employee 4.6.2 Customer Feedback 4.6.3 Organization Documents	• Observation • Oral questioning • Practical tests • Written tests

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.	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 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.	10 pcs for each book	1:2.5
2.	Software	Assorted simulation software e.g., Circuit wizard.	25	1:1
3.	Audio visual presentations	Projector	1	1:25
B	**Learning Facilities & infrastructure**			
1.	Lecture/theory room	$60m^2$	1	1:25
2.	Workshop	$150m^2$	1	1:25
3.	Computer laboratory	$100m^2$	1	1:25
C	**Consumable materials**			
1.	Electronic components	Breadboards, Stripboards, Jumper wires, Assorted resistors, Assorted capacitors, Assorted MOSFETs, Assorted JFETs, 555 timers, Solder wire, LEDs, Assorted BJT transistors, LDRs, OPAMPs, thermistors, 12V DC motors	25 pcs	1:1
D	**Tools and Equipment**			
1.	Assorted tools and equipment	Side cutters, Side cutters, Pliers, Screw driver, Crimping tools, Mult-meter, Solder guns	25 pcs	1:1
2.	Assorted electrical gadgets	Solder gun, Heat sink, Hot air guns, function generator	25 pcs	1:1
3.	Assorted measuring instruments	Digital Oscilloscope,	5 for each category	1:5
4.	Digital Multimeter,			
5.	Digital functional generator		3 pcs	1:8

6.	Laser jet printer		2 pcs	1:13
7.	Power supply	Variable power supply, 5V Power adapters, 9V Power adapters, 12V Power adapters.	10 pcs	1:3
8.	Trainers kit	Analogue training kits, PWM kit	5 pcs	1:5
9.	PCB prototyping material	Copper board, ferrite chloride solution, see-through printing paper, HASL finishing PCB	25 for each category	1:1
10.	Drilling gun		3 pcs	1:8
11.	Work stations		25	1:1

ELECTRICAL INSTRUMENTATION

UNIT CODE: 0714 251 17A

TVETCDACC UNIT CODE: ENG/CU/ET/CR/03/3/MA

Relationship to Occupational Standards

This unit addresses the unit of competency: Apply Electrical Instrumentation

Duration of Unit: 80 hours

Unit Description

This unit covers competencies required to apply electrical instrumentation. Competencies include; demonstrating understanding of measurements, applying electrical instruments, measuring of electrical quantities and performing maintenance of electrical instruments.

Summary of Learning Outcomes

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

S/NO	Learning Outcome	Duration (Hours)
1.	Demonstrate understanding of measurements	10
2.	Apply electrical instruments	20
3.	Measure of electrical quantities	20
4.	Perform maintenance of electrical instruments	30
	TOTAL	**80**

Learning Outcomes, Content and Suggested Assessment Methods:

Learning Outcome	Content	Suggested Assessment Methods
1. Demonstrate understanding of electrical measurements	1.1 Units of electrical measurements and symbols 1.2 Conversions of Unit of measurements	• Written tests • Oral questioning • Practical tests • Observation

Learning Outcome	Content	Suggested Assessment Methods
2. Apply electrical instruments	2.1 Addition, subtraction, multiplication and division of positive and negative numbers 2.2 Classifications of instruments 2.2.1 Indicating instruments 2.2.2 Measuring instruments 2.3 Analogue Instruments 2.3.1 Voltmeter 2.3.2 Ohmmeter 2.3.3 Ammeter 2.3.4 Clamp ammeter 2.3.5 Megohmeter 2.3.6 Digital multimeter 2.3.7 Multimeter probes	• Observation • Oral questioning • Practical tests • Written tests
3. Measure electrical quantities	3.1 Resistance measurement 3.1.1 Methods resistance measurements 3.1.2 Resistor color coding 3.2 High resistance measurements 3.2.1 Hand-cranked megohmmeter 3.3 Voltage measurement 3.4 Current measurement 3.5 Insulation resistance measurement 3.6 OSHA regulations	• Observation • Oral questioning • Practical tests • Written tests
4. Perform maintenance of electrical instruments	4.1 Troubleshooting methods on electrical instruments 4.2 Maintenance activities 4.2.1 Repairs/replacing of components 4.2.2 Cleaning, soldering, tightening 4.2.2.1 Methods of soldering 4.2.3 Instrument configuration and calibration 4.3 Use of manufacturer's manuals during maintenance 4.4 Safety regulations 4.5 Waste material disposal	• Observation • Oral questioning • Practical tests • Written tests

Suggested Methods of Instruction

- Projects
- 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.	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	Indicators, sirens, insulation tape, cables	25 pcs	1:1
10.	Assorted dies	Moulds, star wheels, guide ways, worm wheels	5 for each category	1:5
D	**Tools and Equipment**			
11.	Assorted tools and equipment	Side cutters, Side cutters, Pliers, Screw driver, Crimping tools, Mult-meter, torque wrench	25 pcs	1:1
12.	PPEs	Safety boots, overall	25 pcs	1:1
13.	Work stations		25	1:1

MODULE II

ELECTRICAL INSTALLATION II

UNIT CODE: 0713 351 18A

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

Relationship to Occupational Standards

This unit addresses the unit of competency: Perform Electrical Installation

Duration of Unit: 90 hours

Unit Description

This unit specifies the competencies required for performing electrical installation. Competencies required includes, applying EHS standards, preparing working drawings, assembling tools, equipment and materials, performing electrical installation, terminating installation**,** inspecting and testing installation

Summary of Learning Outcomes

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

S/NO	Learning Outcome	Duration (Hours)
1.	Apply EHS Standards	10
2.	Prepare working drawings	10
3.	Assemble tools, equipment & materials	10
4.	Perform electrical installation	40
5.	Terminate Electrical installation	10
6.	Inspect and test installation	10
	TOTAL	**90**

Learning Outcomes, Content and Suggested Assessment Methods

Learning Outcome	Content	Suggested Assessment Methods
1. Apply EHS standards	1.1 Meaning of term PPE 1.2 Purpose of PPE 1.3 Types of PPE 1.4 Safe and correct handling, use, maintenance and storage of different types of PPE 1.5 Classes of fires and fire fighting equipment 1.6 First aid procedures 1.6.1 Rescuing electric shock victim 1.7 Methods of resuscitation	• Written tests • Oral questioning • Observation
2. Prepare working drawings	2.1 Meaning of working drawings 2.2 Types of Working drawings 2.3 Identification and care of drawing instruments and equipment 2.4 Identification of drawing paper sizes 2.5 Drawing various types of lines 2.6 Drawing title block 2.7 Drawing standard electrical symbols 2.8 Conversion of scales	• Observation • Oral questioning • Practical tests • Written tests
3. Assemble tools, equipment & materials	3.1 Classification of tools e.g. 3.1.1 Cutting tools e.g. ✓ Hacksaw ✓ Stripping knife ✓ Side cutter ✓ Pliers 3.1.2 Measuring tools e.g. ✓ Tape measure ✓ Try square ✓ Steel rule ✓ Spirit level 3.1.3 Fixing tools e.g. ✓ Hammers ✓ Screw drivers 3.1.4 Crimping tool 3.1.5 Equipment ✓ Multimeter ✓ Stock and die ✓ Vice ✓ Insulation resistance meter ✓ Earth resistance meter	• Observation • Oral questioning • Practical tests • Written tests

Learning Outcome	Content	Suggested Assessment Methods
	✓ Clamp meter ✓ Pipe bending machine 3.1.6 Others e.g. ✓ Draw wire ✓ Bending spring ✓ Drill 3.2 Use, care and maintenance of tools 3.3 Identification of materials e.g. o Cables o Consumer control unit o Switches, sockets, holders and other accessories o Conduits, trunking etc o Screws 3.4 Specification of tools, equipment and materials ✓ Tolerance/ range ✓ Make / model ✓ Size ✓ Class 3.5 Reuse and Disposal of materials 3.6 Bill of Quantities (BOQ) 3.7 List and assemble tools, equipment and materials 3.8 Inventory management ✓ Stock taking ✓ Record keeping	
4. Perform electrical installation	4.1 Single phase and three phase installation 4.1.1 Domestic Installation 4.2 Cables and cable joints 4.3 Wiring systems and accessories 4.3.1 Types and applications e.g. 4.3.1.1 Conduits 4.3.1.2 Cable trays 4.3.1.3 Cable ducts 4.3.2 Lighting circuits 4.3.2.1 One way, two way, intermediate 4.3.2.2 Looping in methods at ceiling rose, joint boxes, switches 4.4 Power circuits 4.4.1 Radial circuits, ring circuits	• Written tests • Observation • Oral questioning • Practical test

Learning Outcome	Content	Suggested Assessment Methods
	4.4.2 Water heating circuits 4.4.3 Electric cooker circuits 4.4.4 Call and alarm circuits 4.4.5 Bell circuits 4.4.6 Intruder alarm circuits 4.4.7 Fire alarm circuits 4.5 Cable labelling 4.6 Disposal of waste materials	
5. Terminate Electrical Installation	6.1 Importance of termination 6.2 Cable labelling 6.3 Cable lugging 6.4 Tools used in cable termination e.g. 6.4.1 Crimping tool 6.4.2 Strip Knife 6.5 IEE regulations 6.6 Disposal of waste materials	• Written tests • Oral questioning • Practical tests • Observation
6. Inspect and test electrical Installation	6.1 Types of tests e.g. 6.1.1 Earth continuity tests 6.1.2 Insulation tests 6.1.3 Short circuit tests 6.2 Earthing points in Electrical installation 6.2.1 Methods of earthing 6.2.2 Factors to consider in selecting an earthing method 6.2.3 Testing an earthing system 6.3 Testing tools e.g. 6.3.1 Multimeters 6.3.2 Insulation tester 6.3.3 Ohmmeter 6.4 Importance of testing 6.5 IEE regulations	• Written tests • Oral questioning • Practical tests • Observation

Suggested Methods of Instructions

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

- Discussions

List of 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 3. Electrical Theory for the Electrician" by Mike Holt 4. Electrical installation work by Brian Scaddan	5 pcs	1:5
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**			

S/No.	Category/Item	Description/ Specifications	Quantity	Recommended Ratio (Item: Trainee)
1.	Lecture/theory room	60m^2	1	1:25
2.	Workshop	150m^2	1	1:25
3.	Site			
C	**Consumable materials**			
5.	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
6.	Insulation tapes		25 pcs	1:1
7.	Accessories	Switches, sockets, Junction boxes, Consumer units, Lamp holders, Patrice boxes, Circuit breakers, energy meter, cut out, cooker unit, instant water heater switch,	25 pcs	1:1
8.	Conduits and trunkings	PVC conduits, Steel conduits, Mini trunking	25 pcs	1:1
	Tools and Equipment			
6.	Hacksaws		25 pcs	1:1

S/No.	Category/Item	Description/ Specifications	Quantity	Recommended Ratio (Item: Trainee)
7.	Striping knives		25 pcs	1:1
8.	Side cutters		25 pcs	1:1
9.	Pliers		25 pcs	1:1
10.	Tape measure		25 pcs	1:1
11.	Try Square		25 pcs	1:1
12.	Spirit level		25 pcs	1:1
13.	Assorted Screw driver		25 pcs	1:1
14.	Assorted hammers		25 pcs	1:1
15.	PPEs		25 pcs	1:1
16.	Multimeters		5 pcs	1:5
17.	Clamp meters		5 pcs	1:5
18.	Earth resistance meter		5 pcs	1:5
19.	Stocks & Dies		5 pcs	1:5
20.	Vices		5 pcs	1:5
21.	Pipe bending Machine		5 pcs	1:5
22.	Bending spring		5 pcs	1:5
23.	Drilling machines		5 pcs	1:5
24.	Work stations		25	1:1
25.	Installation boards		13 pcs	1:2

POWER SUPPLY SYSTEMS I

UNIT CODE: 0714 351 19A

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

Relationship to Occupational Standards

This unit addresses the unit of competency: Install power supply systems

Duration of Unit: 70 hours

Unit Description

This unit covers competencies required for installing power supply systems. Competencies include; identifying power supply system components, assembling tools, equipment and materials, installing power supply system, testing installed power supply system.

Summary of Learning Outcomes

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

S/NO	Learning Outcome	Duration (Hours)
1.	Identify power supply components	10
2.	Assemble tools, equipment and materials	10
3.	Install power supply system	40
4.	Test power supply system	10
	TOTAL	**70**

Learning Outcomes, Content and Suggested Assessment Methods

Learning Outcome	Content	Suggested Assessment Methods
1. Identify power supply components	1.1 P-N juction 1.2 Introduction to BJT 1.3 BJT configuration 1.4 Meaning of terms 1.5 Components of power supply e.g. 1.6 Transformer 1.7 Single phase rectifiers 1.8 Filters 1.9 Voltage regulators 1.10 Voltage divider	• Observation • Oral questioning

Learning Outcome	Content	Suggested Assessment Methods
	1.11 DC power converters 1.12 Protection components of a supply system 1.13 Fuses 1.14 Types of fuses 1.15 Varistor 1.16 Circuit breakers 1.17 Types of circuit breakers	
2. Assemble tools, equipment and materials	2.1 Classification of tools used in power supply system installation e.g. 2.1.1 Analogue and digital instruments 2.1.2 Indicating tools and equipment 2.1.3 Measurement tools and equipment 2.1.4 Cutting tools and equipment 2.1.5 Tightening tools 2.2 Printed circuit boards identification	• Written tests • Oral questioning • Practical tests • Observation
3. Install power supply system	3.1 Factors to consider in installation of power supply systems 3.2 Safety during power supply installation 3.3 Power supply component fixing techniques e.g. 3.3.1 Breadboard connections 3.4 Troubleshooting 3.5 Common faults in Electrical equipment's 3.6 Fault diagnosis procedure 3.7 Repair/Replace of components in Electrical equipment's	• Observation • Oral questioning • Practical tests • Written tests
4. Test power supply system	4.1 Visual inspection 4.2 Types of tests e.g. 4.2.1 Earth continuity tests 4.2.2 Insulation tests 4.2.3 Short circuit tests 4.3 Testing tools e.g. 4.3.1 Multimeters 4.3.2 Insulation tester 4.3.3 Ohmmeter 4.4 Importance of testing 4.5 IEE regulations	• Observation • Oral questioning • Practical tests • Written tests

Suggested Methods of Instructions

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

List of 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 3. Electrical Theory for the Electrician" by Mike Holt 4. Electrical installation work by Brian Scaddan	5 pcs	1:5
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**			
4.	Lecture/theory room	$60m^2$	1	1:25
5.	Workshop	$150m^2$	1	1:25
6.	Site			
C	**Consumable materials**			
9.	Insulation tapes		25 pcs	1:1
10.	Accessories	Stationery, Breadboards, Strip Board, Assorted Electronic components., UPS, Batteries, Battery Chargers, Assorted Cables, Assorted protective devices , Assorted solar system components	25 pcs	1:1
11.	Conduits and trunkings	PVC conduits, Mini trunking	25 pcs	1:1
	Tools and Equipment			
26.	Hacksaws		25 pcs	1:1
27.	Striping knives		25 pcs	1:1
28.	Side cutters		25 pcs	1:1
29.	Pliers		25 pcs	1:1
30.	Tape measure		25 pcs	1:1
31.	Try Square		25 pcs	1:1
32.	Spirit level		25 pcs	1:1
33.	Assorted Screw driver		25 pcs	1:1
34.	Assorted hammers		25 pcs	1:1
35.	PPEs		25 pcs	1:1

36.	Multimeters		5 pcs	1:5
37.	Clamp meters		5 pcs	1:5
38.	Earth resistance meter		5 pcs	1:5
39.	Soldering Gun		5 pcs	1:5
40.	Solder Suckers		5 pcs	1:5
41.	Assorted spanners and wrenches		5 pcs	1:5
42.	Oscilloscopes		5 pcs	1:5
43.	Bending spring		5 pcs	1:5
44.	Drilling machines		5 pcs	1:5
45.	Work stations		25	1:1
46.	Draw wire		5 pcs	1:5
47.	Installation boards		13 pcs	1:2

ELECTRICAL AND ELECTRONIC EQUIPMENT AND APPLIANCES MAINTENANCE

UNIT CODE: 0713 351 20A

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

Relationship to Occupational Standards

This unit addresses the unit of competency: Perform electrical and electronic equipment and appliance maintenance.

Duration of Unit: 70 hours

Unit Description

This unit covers competencies required to perform electrical and electronic equipment and appliance maintenance. Competencies include: assembling maintenance tools, equipment and materials, inspecting and testing faulty components, performing maintenance activities, performing tests on repaired equipment and appliances and assembling repaired equipment and appliances

Summary of Learning Outcomes

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

S/NO	Learning Outcome	Duration (Hours)
1.	Assemble maintenance tools, equipment and materials	10
2.	Inspect and test faulty components	10
3.	Perform maintenance activities	30
4.	Perform tests on repaired equipment and appliances	10
5.	Assemble repaired Equipment and Appliances	10
	TOTAL	**70**

Learning Outcomes, Content and Suggested Assessment Methods

Learning Outcome	Content	Suggested Assessment Methods
1. Assemble maintenance tools, equipment and materials	1.1 Classification of tools and instruments e.g. 1.1.1 Analogue and digital instruments 1.1.2 Indicating tools and equipment 1.1.3 Measurement tools and equipment 1.1.4 Cutting tools and equipment 1.1.5 Tightening tools 1.2 Various specification range in electrical tools and instruments 1.3 Calibration of instruments 1.4 Materials used in power supply installation e.g. 1.4.1 Cables 1.4.2 PCBs	• Written tests • Oral questioning • Practical tests • Observation
2. Inspect and test faulty components	2.1 Disassembling of various equipment and appliances eg 2.1.1 Radio 2.1.2 Television 2.1.3 Refrigerators 2.1.4 Electric kettles 2.1.5 Instant showers 2.1.6 Printers 2.1.7 Photocopiers 2.1.8 Microwaves 2.1.9 Air conditioning systems 2.1.10 Washing machines 2.1.11 Mobile phones 2.1.12 Iron boxes 2.1.13 Set top boxes 2.2 Sorting of screws during disassembling 2.3 Inspecting and testing faulty equipment and appliances 2.4 Types of tests on power supply system e.g. 2.4.1 Test for voltage input 2.4.2 Short circuit tests 2.4.3 Open circuit tests	• Observation • Oral questioning • Written tests

	2.5 Troubleshooting methods on various equipment and appliances 2.6 Safety during testing of power supply system 2.7 IEE regulation	
3. Perform maintenance activities	3.1 Repair/Replacement of faulty components 3.1.1 Maintenance activities e.g. 3.1.1.1 Cleaning 3.1.1.2 Tightening 3.1.1.3 Soldering 3.1.1.4 Assembling 3.2 Disposal of waste materials e.g. 3.2.1 Old batteries 3.2.2 Lugs and screws 3.2.3 Tapes 3.2.4 Cable sheaths 3.2.5 PCBs 3.2.6 Off cuts 3.3 EHS regulations 3.4 OSHA regulations	• Observation • Oral questioning • Practical tests • Written tests
4. Perform tests on repaired equipment and appliances	4.1 Visual inspection 4.2 Identification of test points 4.3 Types of tests 4.3.1 Continuity tests 4.3.2 Short circuit test 4.3.3 Open circuit test 4.4 Safe test procedures 4.5 IEE regulations	• Observation • Oral questioning • Practical tests • Written tests
5. Assemble repaired equipment and appliance	5.1 Tightening of screws 5.2 Connectors 5.2.1 Types of connectors 5.3 Use of cable ties, silicon glue, super glue, insulating tapes 5.4 Mounting of cooling components	• Observation • Oral questioning • Practical tests • Written tests

Suggested Methods of Instructions

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

List of 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 3. Electrical Theory for the Electrician" by Mike Holt 4. Electrical installation work by Brian Scaddan	5 pcs	1:5
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**			
7.	Lecture/theory room	$60m^2$	1	1:25
8.	Workshop	$150m^2$	1	1:25
9.	Site			

S/No.	Category/Item	Description/ Specifications	Quantity	Recommended Ratio (Item: Trainee)
C	**Consumable materials**			
12.	Insulation tapes		25 pcs	1:1
13.	Accessories	Stationery, Breadboards, Strip Board, Assorted Electronic components., UPS, Batteries, Battery Chargers, Assorted Cables, Assorted protective devices , Assorted solar system components	25 pcs	1:1
14.	Conduits and trunkings	PVC conduits, Mini trunking	25 pcs	1:1
	Tools and Equipment			
48.	Hacksaws		25 pcs	1:1
49.	Striping knives		25 pcs	1:1
50.	Side cutters		25 pcs	1:1
51.	Pliers		25 pcs	1:1
52.	Tape measure		25 pcs	1:1
53.	Try Square		25 pcs	1:1
54.	Spirit level		25 pcs	1:1
55.	Assorted Screw driver		25 pcs	1:1
56.	Assorted hammers		25 pcs	1:1
57.	PPEs		25 pcs	1:1
58.	Multimeters		5 pcs	1:5
59.	Clamp meters		5 pcs	1:5
60.	Earth resistance meter		5 pcs	1:5

S/No.	Category/Item	Description/ Specifications	Quantity	Recommended Ratio (Item: Trainee)
61.	Soldering Gun		5 pcs	1:5
62.	Solder Suckers		5 pcs	1:5
63.	Assorted spanners and wrenches		5 pcs	1:5
64.	Oscilloscopes		5 pcs	1:5
65.	Bending spring		5 pcs	1:5
66.	Drilling machines		5 pcs	1:5
67.	Stock and die		5 pcs	1:5
68.	Vice		5 pcs	1:5
69.	Work stations		25	1:1
70.	Draw wire		5 pcs	1:5
71.	Installation boards		13 pcs	1:2
72.	Bearing pullers		1 pc	1:25

MODULE III

DIGITAL LITERACY

ISCED UNIT CODE: 0611 551 01A
TVET CDACC UNIT CODE: ENG/CU/ET/BC/01/5/MA

Relationship to Occupational Standards
This unit addresses the Unit of Competency: Apply Digital Literacy

Duration of Unit: 40 Hours

Unit Description
This unit covers the competencies required to demonstrate digital literacy. It involves operating computer devices, solving tasks using the Office suite, accessing online/offline data and information, performing online communication and collaboration, applying cybersecurity skills and performing jobs online. It also involves applying job entry techniques.

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	**40**

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 1.3 Classification of computers 1.4 Components of a computer	• Observation • Portfolio of Evidence • Project • Written assessment • Practical assessment

Learning Outcome	Content	Suggested Assessment Methods
	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 Classification of computer software 1.7 Operating system functions 1.8 Procedure for turning/off a computer 1.9 Mouse use techniques 1.10 Keyboard Parts and Use Techniques 1.11 Desktop Customization 1.12 File and Files Management using an operating system 1.13 Computer Internet Connection Options 1.13.1. Mobile Networks/Data Plans 1.13.2. Wireless Hotspots 1.13.3. Cabled (Ethernet/Fiber) 1.13.4. Dial-Up	• Oral assessment

Learning Outcome	Content	Suggested Assessment Methods
	1.14 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 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	• Observation • Portfolio of Evidence • Project • Written assessment • Practical assessment • Oral assessment

Learning Outcome	Content	Suggested Assessment Methods
	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 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	

Learning Outcome	Content	Suggested Assessment Methods
	2.15.3 Sorting data 2.15.4 Filtering data 2.15.5 Visual representation using charts 2.15.6 Worksheet printing 2.16 Electronic Presentations 2.17Meaning and Importance of electronic presentations 2.18Examples of Presentation Software 2.19Using the electronic presentation application 2.19.1 Parts of the PowerPoint screen (slide navigation pane, slide pane, notes, the ribbon, quick access toolbar, and scroll bars). 2.19.2 Open and close presentations 2.19.3 Creating Slides (Insert new slides, duplicate, or reuse slides.) 2.19.4 Text Management (insert, delete, copy, cut and paste, drag and drop, format, and use spell check). 2.19.5 Use magnification/zoom tools 2.19.6 Apply or change a theme. 2.19.7 Save a presentations 2.19.8 Switch between open presentations 2.20Developing a presentation 2.20.1 Presentation views 2.20.2 Slides	

Learning Outcome	Content	Suggested Assessment Methods
	2.20.3 Master slide 2.21Text 2.21.1 Editing text 2.21.2 Formatting 2.21.3 Tables 2.22Charts 2.22.1 Using charts 2.22.2 Organization charts 2.23Graphical objects 2.23.1 Insert, manipulate 2.23.2 Drawings 2.24Prepare outputs 2.24.1 Applying slide effects and transitions 2.25Check and deliver 2.25.1 Spell check a presentation 2.25.2 Slide orientation 2.25.3 Slide shows, navigation 2.26 Print presentations (slides and handouts)	
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 News Group	• Observation • Portfolio of Evidence • Project • Written assessment • Practical assessment • Oral assessment

Learning Outcome	Content	Suggested Assessment Methods
	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) 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	• Observation • Portfolio of Evidence • Project • Written assessment • Practical assessment • Oral assessment •

Learning Outcome	Content	Suggested Assessment Methods
	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 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	• Observation • Portfolio of Evidence • Project • Written assessment • Practical assessment • Oral assessment

Learning Outcome	Content	Suggested Assessment Methods
	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	
6. Perform online jobs	6.1 Introduction to online working 6.2 Types of online Jobs 6.3 Online job platforms 6.3.1 Remotask 6.3.2 Data annotation tech 6.3.3 Cloud worker 6.3.4 Upwork 6.3.5 Oneforma 6.3.6 Appen 6.4 Online account and profile management 6.5 Identifying online jobs/job bidding 6.6 Online digital identity 6.7 Executing online tasks	• Observation • Oral assessment • Portfolio of evidence • Third party report • Written assessment

Learning Outcome	Content	Suggested Assessment Methods
	6.8 Management of online payment accounts.	
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 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	• Observation • Oral assessment • Portfolio of evidence • Written assessment

Learning Outcome	Content	Suggested Assessment Methods
	7.6.7 Honesty 7.7 Generally knowledgeable in current affairs and technical area	

Suggested Methods Instruction

- Practical
- Projects
- Demonstrations
- Group discussions
- Direct instruction

Recommended Resources for 25 Trainees

S/No.	Category/Item	Description/ Specifications	Quantity	Recommended Ratio (Item: Trainee)
A	**Learning Materials**			
1)	Power point presentations	For trainer's use	1	1:25
2)	Sample CVs	For trainee's use	5	1:5
3)	Sample job applications	For trainee's use	5	1:5
B	**Learning Facilities & infrastructure**			
4)	Lecture/theory room		1	1:25
5)	Computers with OS (Windows/Linux/Mac), Microsoft Office, Google Workspace, Antivirus	For trainee's use	25	1:1
6)	Internet connection	For trainees and trainer's use	1 connection	1:25
7)	Whiteboard	For trainer's use	1	1:25
8)	Smartboard/Smart TV (Where applicable)	For trainer's use	1	1:25
C	**Consumable materials**			
9)	Printing papers	For trainer and trainee use	Varies	Varies
10)	Assorted whiteboard markers	For trainer's use	Varies	Varies
D	**Tools and Equipment**			
11)	Printers	For trainer's use	2	1:12

12)	External storage media	For trainer and trainee use	Varies	1:1 or 1:5 depending on need
13)	Projector	For trainer's use	1	1:25

COMMUNICATION SKILLS

ISCED UNIT CODE:0031 541 02A
TVET CDACC UNIT CODE: ENG/CU/ET/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 encompasses the skills necessary for effective communication. It includes the utilization of various communication methods, such as written, non-verbal, oral, and group communication techniques.

Summary of Learning Outcomes

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

S/No	Learning 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		**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 1.4.Factors to consider when selecting a channel of communication	• Practical assessment • Observation • Portfolio of Evidence • Oral questions • Written assessment • Third party report

	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	• Practical assessment • Observation • Portfolio of Evidence • Oral questions • Written assessment • Third party report
3. Apply non-verbal communication skills	3.1 Utilize body language and Gestures 3.2 Apply body posture 3.3 Apply workplace dressing code	• Practical assessment • Observation • Portfolio of Evidence • Oral questions • Written assessment • 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	• Practical assessment • Observation • Portfolio of Evidence • Oral questions • Written assessment • Third party report
5. Apply group discussion skills	1.1 Establishing rapport 1.2 Facilitating resolution of issues	• Practical assessment • Observation

	1.3 Developing action plans 1.4 Group organization techniques 1.5 Turn-taking techniques 1.6 Conflict resolution techniques 1.7 Team-work	• Portfolio of Evidence • Oral questions • Written assessment • Third party report

Suggested Methods of Instruction

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

Recommended Resources for 25 trainees

S/no.	Category/item	Description/specification	Quantity	Recommended ratio(item: trainee)
A.	**Learning materials**			
1.	Case studies	Published case studies	5	1:5
2.	Business plan templates	Standard business plan templates	5	1:5
3.	Video clips	Digital types	25	1:25
4.	Newspapers and Handouts	Well reputed news papers	5	1:5
5.	Business Journals	Well reputed journals	5	1:5
B.	**Learning facilities and infrastructure**			
1.	Lecture/theory room	$72m^2$	1	1:25
2.	Whiteboard	4 feet by 8 feet	1	1:25
3.	Projector	LCD High resolution	1	1:25
4.	Computers	RAM: 8GB	25	1:25

5.	Printers	Ink Jet	2	1:13
6.	Smart TV	LCD	1	1:25
7.	Internet connection	Adequate speed		1:25
C.	**Consumable materials**			
1.	Stationary materials	Pens, pencils, papers	Enough for 25	1:25
2.	Assorted whiteboard markers	Non-permanent	Enough for 25	1:25

ELECTRICAL PRINCIPLES I

ISCED UNIT CODE: 0714 441 05A
TVET CDACC UNIT CODE: ENG/CU/ET/CC/01/5/MA

UNIT DURATION: 100 HOURS

Relationship to Occupational Standards

This unit addresses the Unit of Competency: Apply electrical principles

UNIT DESCRIPTION

This unit describes competences required to apply electrical principles in their work. It involves applying Electrical quantities, using cells and batteries, applying magnetism and electromagnetism, applying Electrostatics principles, apply concepts of D.C circuit theory and performing electrical measurements.

Summary of Learning Outcomes

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

S/NO	Learning Outcome	Duration (Hours)
1.	Applying Electrical quantities	10
2.	Using cells and batteries	10
3.	Apply concepts of D.C circuit theory	20
4.	Applying magnetism and electromagnetism	20
5.	Applying Electrostatics principles	20
6.	Apply AC circuits	10
7.	Performing electrical measurements	20
TOTAL		**100**

Learning Outcomes, Content and Suggested Assessment Methods

Learning Outcome	Content	Suggested Assessment Methods
1. Applying Electrical quantities	1.1 The meaning of SI unit 1.2 SI unit of various types of Electrical parameters 1.3 Ohm's law 1.4 Calculations involving various Electrical parameters e.g. Power, Current, Voltage, Resistance 1.5 Instruments used in measuring various types of Electrical parameters	• Practical • Project • Third party report • Portfolio of evidence • Written tests • Oral questioning

2. Using cells and batteries	2.1 Sources of electricity 2.2 electrolysis and its applications 2.3 Simple cells 2.4 Primary and secondary cells 2.5 Types of cells and batteries 2.5.1 Dry cells 2.5.2 Leclanché 2.5.3 Mercury 2.5.4 Lead-acid 2.5.5 Alkaline 2.5.6 Lithium 2.6 E.m.f and internal resistance of cells 2.7 Maintenance of batteries 2.8 Applications of batteries	• Practical • Project • Third party report • Portfolio of evidence • Written tests • Oral questioning
3. Apply magnetism and electromagnetism concepts	1.1 Magnetic and non-magnetic materials 1.2 Concepts of magnetic fields and field distribution 1.3 Concepts of electromagnetism 1.4 Laws of electromagnetic induction 1.5 Concepts of self and mutual induction	• Practical • Project • Third party report • Portfolio of evidence • Written tests • Oral questioning
4. Apply Electrostatics principles	1.1 Electrostatics quantities 1.2 Types of capacitors 1.3 Concept of charge and electrostatic field 1.4 Capacitors in series and parallel 1.5 Measurement of capacitance 1.6 Application of Capacitors 1.7 Testing of capacitor	• Practical • Project • Third party report • Portfolio of evidence • Written tests • Oral questioning
5. Apply concepts of D.C circuit theory	1.1 |Resistance and resistivity 1.2 Parallel and series circuits 1.3 Basic electrical laws 1.3.1 Ohms law 1.3.2 Kirchhoff's theorem	• Practical • Project • Third party report • Portfolio of evidence • Written tests • Oral questioning

6. Apply A.C circuit	6.1.AC fundamentals 6.2.Calculation involving passive elements in AC circuits 6.3.Power triangle 6.4.Calculations involving power	• Practical • Project • Third party report • Portfolio of evidence • Written tests • Oral questioning
7. Perform electrical measurements	7.1 Types of transducers 7.2 Types of electrical instruments 7.3 Measurements of electrical quantities using Instruments 7.4 Calculations involving electrical instruments 7.5 Instrumental/systematic errors 7.6 Calculations involving systematic errors	• Practical • Project • Third party report • Portfolio of evidence • Written tests • Oral questioning

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	J. Bird Electrical and Electronic Principles V.K. Mehta & R. Mehta Basic Electrical Engineering	5 pcs	1:5
2.	Installation manuals	Electronic components datasheets	5 pcs	1:5
3.	Charts	Circuit diagrams Colour codes	1 pcs for each	1:25

4.	Scientific Calculators		25	1:1
5.	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.	Laboratory	$100m^2$	1	1:25
9.	Computer laboratory	$100m^2$	1	1:25
C	**Consumable materials**			
10.	Connector wires	Jumper wires,	5 pkts	1:5
11.	Insulation tapes		25 pcs	1:1
12.	Circuit boards	Bread board, copper strip boards	25 pcs	1:1
13.	Assorted electronic components	Resistors, diodes, capacitors, transistors, ICs, Transformers, Inductors, Batteries	25 pcs	1:1
14.	Soldering wires		5 rolls	1:5
D	**Tools and Equipment**			
15.	Striping knives		25 pcs	1:1
16.	Side cutters		25 pcs	1:1
17.	Pliers		25 pcs	1:1
18.	Assorted Screw driver		25 pcs	1:1
19.	Crimping tools		5 pcs	1:5
20.	PPEs		25 pcs	1:1
21.	Multimeters		5 pcs	1:5
22.	Oscilloscope		5 pcs	1:5
23.	Function generator		5 pcs	1:5
24.	Spectrum analyser		5 pcs	1:5
25.	Variable power supply		5 pcs	1:5
26.	Solder guns		25 pcs	1:1

27.	Hot air gun		5 pcs	1:5
28.	Work stations		25	1:1

TECHNICAL DRAWING

ISCED UNIT CODE: 0732 441 06A

TVET CDACC UNIT CODE: ENG/CU/ET/CC/02/5/MA

UNIT DURATION: 100 HOURS

Relationship to Occupational Standards

This unit addresses the unit of competency: Prepare technical drawings

UNIT DESCRIPTION

This unit covers competences required to prepare technical drawings. Competences include preparing drawing equipment and materials, producing plane geometry drawings, producing pictorial and orthographic drawings of components, managing basic operations in AutoCAD, develop drawings in AutoCAD and producing electrical drawings.

Summary of Learning Outcomes

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

S/NO	Learning Outcome	Duration (Hours)
1.	Prepare drawing equipment and materials	10
2.	Produce plane geometry drawings	10
3.	Produce pictorial and orthographic drawings of components	20
4.	Manage basic operations in AutoCAD	20
5.	Develop Drawings in AutoCAD	20
6.	Produce electrical drawings	20
TOTAL		**100**

Learning Outcomes, Content and Suggested Assessment Methods:

Learning Outcome	Content	Suggested Assessment Methods
1. Prepare drawing equipment and materials	1.1 Identification and care of drawing equipment 1.1.1Drawing boards 1.1.2T and set squares	• Practical • Project • Third party report • Portfolio of evidence

Learning Outcome	Content	Suggested Assessment Methods
	1.1.3Drawing set 1.2 Identification and care of drawing materials 1.2.1Drawing papers 1.2.2Pencils 1.2.3Erasers 1.2.4Masking tapes 1.2.5 Paper clips 1.3 Reference to manufacturer's instructions and work place procedures on use and maintenance of drawing equipment and materials	• Written tests • Oral questioning
2. Produce plane geometry drawings	2.1 Types of lines in drawings 2.2 Freehand printing of letters 2.3 Borderlines and title blocks 2.4 Construction of different angles 2.5 Measurement of different angles 2.6 Bisection of different angles and lines 2.7 Construction of geometric figures 2.7.1Circles 2.7.2Triangles 2.7.3Rectangles 2.7.4Parallelogram 2.7.5Polygons 2.7.6Pyramids 2.7.7Conic sections 2.7.8Prisms 2.8 Patterns development e.g cones, pyramids, prisms, cylinders	• Practical • Project • Third party report • Portfolio of evidence • Written tests • Oral questioning

Learning Outcome	Content	Suggested Assessment Methods
	2.9 Different types of Tangents 2.9.1Exterior tangents to a circle 2.9.2Interior tangents to a circle 2.10 Standard drawing conventions	
3. Produce pictorial and orthographic drawings of components	3.1 Meaning of pictorial and orthographic drawings 3.2 Meaning of symbols and abbreviations 3.3 Free hand sketching of different types of geometric forms, tools and equipment 3.4 Drawing and interpretation of orthographic elevations 3.5 Drawing objects in isometric view 3.6 Drawing objects in oblique view	• Practical • Project • Third party report • Portfolio of evidence • Written tests • Oral questioning
4. Manage basic operations in AutoCAD	4.1 Identification of Key features of CAD software 4.2 AutoCAD visual reference commands 4.3 AutoCAD ribbon tools 4.4 AutoCAD status bar tools 4.5 AutoCAD navigation commands 4.6 AutoCAD drawing work 4.7 Saving of AutoCAD drawing files in proper format	• Practical • Demonstration • Projects • Written tests • Oral test
5. Develop Drawings in AutoCAD	5.1 Setting up of Drawing interface. 5.2 Creating drawing Layouts 5.3 Creation of 2D drawings 5.4 Editing/modification of 2D drawings 5.5 Saving AutoCAD drawings 5.6 AutoCAD 2D drawing work	• Practical • Demonstration • Projects • Written tests • Oral test
6. Produce electrical drawings	6.1 Electrical symbols and abbreviations 6.2 Meaning of electrical drawings 6.3 Drawing of electrical diagrams e.g. block, schematic, circuit, line and wiring	• Observation • Oral questioning • Practical tests

Learning Outcome	Content	Suggested Assessment Methods
	6.4 Drawing of ***Electrical and Electronic drawings*** using an appropriate CAD software 6.5 Simulation of Electrical and electronic drawings 6.6 Installation of Electrical components in a building plan using AutoCAD	

Suggested Methods of Delivery

- Projects
- Demonstration by trainer
- Practice by the trainee
- Discussions

Recommended Resources for 25 trainees

S/No.	Category/Item	Description/ Specifications	Quantity	Recommended Ratio (Item: Trainee)
A	**Learning Materials**			
1.	Textbooks	K.Morling Geometric and Engineering drawing	5 pcs	1:5
2.	Drawing instruments	T-squares, set squares, drawing sets, Masking tapes	25	1:1
3.	Power point presentations	For trainer's use	1	1:25

B	**Learning Facilities & infrastructure**			
4.	Lecture/theory room	$50m^2$	1	1:25
5.	Drawing tables		25	1:1

ENGINEERING MATHEMATICS I

ISCED UNIT CODE: 0541 441 07A

TVET CDACC UNIT CODE: ENG/CU/ET/CC/03/5/MA

UNIT DURATION: 120 HOURS

Relationship to Occupational Standards

This unit addresses the Unit of Competency: Apply engineering mathematics 1

Unit Description

This unit describes the competencies required to apply a wide range of engineering technician mathematics. Competencies include: applying number systems, applying algebra, applying trigonometry and hyperbolic functions, performing coordinates geometry, carrying out binomial expansions applying calculus, applying statistics and probability, applying matrices, applying vector theory and applying complex numbers.

Summary of Learning Outcomes

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

S/NO	Learning Outcome	Duration (Hours)
1.	Apply number systems	5
2.	Apply algebra	10
3.	Apply Trigonometry and Hyperbolic functions	15
4.	Perform coordinates geometry	10
5.	Carry out binomial expansions	20
6	Apply Calculus	10
7	Apply Statistics and probability	20
8	Apply matrices	10
9	Apply Vector Theory	10

10	Apply Complex Numbers	10
TOTAL		**120**

Learning Outcomes, Content and Suggested Assessment Methods

Learning Outcome	**Content**	**Suggested Assessment Methods**
1. Apply number systems	1.1 Types of numbers 1.1.1 Rounding off numbers to the nearest tens, 1.1.2 hundreds, thousands, millions and billions 1.1.3 Whole numbers 1.1.4 Odd numbers 1.1.5 Even numbers 1.1.6 Prime number 1.1.7 Ratio and proportions 1.2 Percentages 1.2.1 Word problems involving natural 1.2.2 Numbers 1.3 Factors 1.3.1 Factors of composite numbers 1.3.2 Prime factors 1.3.3 Factors in power form 1.4 Divisibility Test 1.4.1 GCD 1.4.2 Application of GCD/HCF to real life situations 1.5 LCM 1.5.1 Multiples of a number 1.5.2 LCM of a set of numbers	• Written assessment • Practical assessment • Oral Questioning

	1.5.3 Application of LCM in real life situations 1.6 Integers 1.6.1 The number line 1.6.2 Operation on integers 1.6.3 Order of operations 1.6.4 Application to real life situation 1.7 Fractions 1.7.1 Proper, improper fractions and mixed numbers 1.7.2 Conversion of improper fractions to mixed numbers and vice versa 1.7.3 Comparing fractions 1.7.4 Operations on fractions 1.7.5 Order of operations on fractions 1.7.6 Word problems involving fractions in real life situations 1.8 Decimals 1.8.1 Fractions and decimals 1.8.2 Recurring decimals 1.8.3 Recurring decimals and fractions 1.8.4 Decimal places 1.8.5 Standard form 1.8.6 Operations on decimals 1.8.7 Order of operations 1.8.8 Real life problems involving decimals 1.9 Arithmetic operation 1.9.1 Addition 1.9.2 Subtraction 1.9.3 Multiplication	

	1.9.4Division 1.10 Squares and square roots 1.10.1 Squares by multiplication 1.10.2 Square roots by factorization 1.10.3 Squares and Square roots using Calculators	
2. Apply algebra	2.1 Indices and logarithms 2.1.1 Indices (powers) and base 2.1.2 Laws of indices (including positive 2.1.3 integers, negative integers and fractional 2.1.4 indices) 2.1.5 Powers of 10 and common logarithms 2.1.6 Common logarithms; 2.1.7 characteristics 2.1.8 mantissa 2.1.9 Logarithm tables 2.1.10 Application of common logarithms in 2.1.11 multiplication, division and finding 2.1.12 roots 2.2 Algebra 2.2.1 Algebraic expressions including algebraic fractions 2.2.2 Simplification of algebraic expressions 2.2.3 Factorization by grouping 2.2.4 Removal of brackets	• Written assessment • Practical assessment • Oral Questioning

	2.2.5 Substitution and evaluation 2.2.6 Problem solving in real situation 2.3 Simultaneous Equation 2.4 Solve simultaneous equation by; 2.4.1 Elimination method 2.4.2 Substitution method 2.4.3 Graphical method 2.4.4 Solve real life problems 2.5 Quadratic expressions and equations 2.5.1 Expansion of algebraic expressions 2.5.2 The three quadratic identities 2.5.3 Using the three quadratic identities 2.5.4 Factorization of quadratic expressions 2.5.5 Solutions of quadratic equations by factor method 2.5.6 Formation and solution of quadratic equations	
3. Apply trigonometry and hyperbolic functions	3.1 Importance of trigonometry in engineering. 3.2 Trigonometric Ratios and Functions 3.2.1 Definitions of sine, cosine, tangent, cosecant, secant, and cotangent. 3.2.2 Unit circle and angle measurement 3.2.2.1 Degrees and radians 3.2.2.2 Graphs of trigonometric functions. 3.3 Trigonometric Identities 3.3.1 Fundamental identities 3.3.1.1 Pythagorean 3.3.1.2 Reciprocal 3.3.1.3 Quotient identities	• • Written assessment • Oral assessment • Practical • Project • Third party report • Portfolio of evidence •

	3.3.2 Co-function identities and even-odd properties. 3.3.3 Sum and difference formulas, double-angle, and half-angle formulas. 3.4 Solving Trigonometric Equations 3.4.1 Basic Trigonometric Equations 3.4.1.1 Solving equations involving basic trigonometric functions. 3.4.1.2 Using identities to simplify and solve equations. 3.4.2 Inverse Trigonometric Functions 3.4.2.1 Definition and properties. 3.4.2.2 Solving equations using inverse trigonometric functions. 3.4.3 Applications of Trigonometric Equations 3.4.3.1 Engineering problems involving periodic functions and waveforms. 3.4.3.2 Harmonic motion and oscillations in mechanical systems. 3.5 Trigonometry in Triangles 3.5.1 Right-Angle Triangles 3.5.1.1 Solving for sides and angles using trigonometric ratios. 3.5.1.2 Applications in engineering problems such as inclined planes and forces. 3.5.2 Non-Right-Angle Triangles 3.5.2.1 Law of Sines and Law of Cosines. 3.5.2.2 Solving oblique triangles. 3.5.2.3 Applications in engineering fields of structural analysis and navigation. 3.6 Introduction to Hyperbolic Functions	

	3.6.1 Definitions of hyperbolic sine, cosine, tangent, and their reciprocals. 3.6.2 Graphs and properties of hyperbolic functions. 3.7 Hyperbolic Identities 3.7.1 Fundamental identities 3.7.1.1 Pythagorean-like identities 3.7.2 Sum and difference formulas, double-angle, and half-angle formulas. 3.8 Solving Hyperbolic Equations 3.8.1 Basic Hyperbolic Equations 3.8.1.1 Solving equations involving basic hyperbolic functions. 3.8.1.2 Using identities to simplify and solve equations. 3.8.2 Inverse Hyperbolic Functions 3.8.2.1 Definition and properties. 3.8.2.2 Solving equations using inverse hyperbolic functions. 3.9 Applications of Hyperbolic Functions in Engineering	
4. Perform coordinates geometry	4.1 Polar equations 4.1.1 Definition of polar coordinates 4.1.2 Definition and examples of polar equations. 4.1.3 Representing curves using polar equations. 4.2 Cartesian equation 4.2.1 Definition of Cartesian coordinates. 4.2.2 Definition of a point in cartesian coordinates 4.2.3 Relationship between Cartesian and polar coordinates. 4.2.4 Definition and examples of Cartesian equations.	• Written assessment • Oral assessment • Practical • Project • Third party report • Portfolio of evidence

	4.2.5 Representing lines, circles, parabolas, ellipses, and hyperbolas using Cartesian equations. 4.2.6 Conversion Between Polar and Cartesian Equations. 4.3 Graphs of polar equations 4.3.1 Plotting Polar Equations 4.3.1.1 Definition of a point in polar coordinates 4.3.1.2 Steps to graph polar equations. 4.3.1.3 Using symmetry and periodicity in polar graphs. 4.3.2 Analyzing Polar Graphs 4.3.2.1 Identifying key features intercepts, maxima, minima 4.3.3 Applications in engineering 4.4 Normal and tangents 4.4.1 Tangents to Curves 4.4.1.1 Definition of a tangent line. 4.4.1.2 Finding the slope of a tangent to a curve at a given point. 4.4.2 Normals to Curves 4.4.2.1 Definition of a normal line. 4.4.2.2 Finding the equation of a normal to a curve at a given point. 4.4.3 Tangents and Normals in Polar Coordinates 4.4.3.1 Techniques for finding tangents and normals to curves defined by polar equations. 4.5 Loci 4.5.1 Introduction to Loci 4.5.1.1 Definition of Locus 4.5.1.2 Understanding the concept of a locus.	

	4.5.1.3 Importance of loci in engineering. 4.5.2 Locus in Relation to a Circle 4.5.2.1 Equations and properties of loci relative to circles. 4.5.2.2 Common loci problems involving circles 4.5.3 Applications in Engineering 4.5.3.1 Using loci to solve engineering problems: robotic arm movement 4.5.3.2 Analyzing Loci of Points: tracing the path of a point on a rotating arm 4.5.3.3 Using loci to optimize mechanical systems: designing cams, robotic path planning.	
5. Carry out binomial expansion	5.1 Basic concepts of binomial theorem 5.1.1 Binomial expressions and notation. 5.1.2 Factorials and their use in binomial coefficients. 5.1.3 Binomial Coefficients 5.1.3.1 Definition and calculation using combinations (nCr). 5.1.3.2 Pascal's Triangle as a tool for finding binomial coefficients. 5.2 Binomial Expansion 5.2.1 General form of the binomial expansion expression 5.2.2 Binomial Expansion of $(a+b)^n$ where $n = 2,3,4\ldots$ 5.2.3 Special cases 5.2.3.1 When $(1+x)^n$ 5.2.3.2 Negative and fractional binomial expansions using the binomial series 5.3 Applications of Binomial Expansion 5.3.1 Simplifying algebraic expressions using binomial expansion.	• • Written assessment • Oral assessment • Practical • Project • Third party report • Portfolio of evidence

	5.3.2 Solving polynomial equations. 5.4 Engineering Applications 5.5 Estimating values in engineering calculations.	
6. Apply Calculus	6.1 Introduction to calculus 6.2 Functional notation 6.3 The gradient of a curve 6.4 Differentiation from first principles 6.5 Differentiation of y = axn by the general rule 6.6 Differentiation of sine and cosine functions 6.7 Differentiation of eax and ln ax 6.8 Methods of differentiation 6.8.1 Differentiation of common functions 6.8.2 Differentiation of a product 6.8.3 Differentiation of a quotient 6.8.4 Function of a function 6.8.5 Successive differentiation 6.9 Some applications of differentiation 6.9.1 Rates of change 6.9.2 Velocity and acceleration 6.9.3 Turning points 6.10 Practical problems involving 6.11 Tangents and normal 6.12 Small changes 6.13 Logarithmic differentiation 6.14 Introduction to logarithmic differentiation 6.14.1 Laws of logarithms	• Written assessment • Practical assessment • Oral Questioning

	6.14.2 Differentiation of logarithmic functions 6.14.3 Differentiation of further logarithmic functions 6.14.4 Differentiation of [f (x)] 6.15 Integral Calculus 6.16 Standard integration 6.17 The process of integration 6.18 The general solution of integrals of the form axn 6.19 Definite integrals 6.20 Integration using algebraic substitutions 6.21 Algebraic substitutions algebraic substitutions 6.22 Further worked problems on integration using algebraic substitutions 6.23 Change of limits 6.24 Integration using trigonometric substitutions 6.25 Integration using partial fractions 6.26 The t = tan θ substitution 6.27 Integration by parts 6.28 Numerical integration 6.29 The trapezoidal rule 6.30 The mid-ordinate rule 6.31 Simpson's rule	
7. Apply statistics and probability	.1 Measures of central tendency mean, mode and median .2 Measures of dispersion .3 Variance and standard deviation .4 Definition of probability	• Written assessment

	.5 Laws of probability .6 Expectation variance and SD .7 Calculations involving discrete and continuous random variables. .8 Types of distributions 7.8.1 Binomial 7.8.2 Poisson 7.8.3 Normal 7.1 Mean, variance and SD of probability distributions 7.2 Application of probability distributions	• Oral assessment • Practical • Project • Third party report • Portfolio of evidence
8. Apply matrices I	8.1 Matrix 8.2 Order of a matrix 8.3 Square matrix 8.4 Compatibility in addition and 8.5 Multiplication of matrices 8.6 Multiplication of a matrix by a scalar Matrix multiplication 8.7 Identity matrix 8.8 Determinant of a 2 x 2 matrix 8.9 Inverse of a 2 x 2 matrix and 8.10 Singular matrix 8.11 Solutions of simultaneous equations in two unknowns by 8.12 Matrix method Crammer rule	• Written assessment • Practical assessment • Oral Questioning
9. Apply vector theorem	9.1 Vectors and scalar in two and three dimensions 9.1.1 Operations on vectors: Addition and subtraction 9.2 Position vectors 9.3 Resolution of vectors 9.4 Scalar and vector product 9.5 Gradient,	• Practical • Project • Written tests • Oral questioning

	9.6 Curl 9.7 Divergence	
10. Apply complex numbers	a. Argand diagrams b. Complex numbers operations c. De Moivre's theorem	• Practical • Project • Written tests • Oral questioning

Suggested Methods of Instruction

1. Practical
2. Demonstrations
3. Group discussion
4. Direct instructions

Recommended Resources for 25 Trainees

S/No.	Category/Item	Description/ Specifications	Quantity	Recommended Ratio (Item: Trainee)
A	**Learning Materials**			
1.	Textbooks	Engineering Mathematics by John bird 8th edition	5 pcs	1:5
2.		Engineering Mathematics by A.K stround 8th edition	5 pcs	1:5

3.		SMP	25	1:1
B	**Learning Facilities & infrastructure**			
1	Lecture/theory room	50 m^2	1	1:25
C	**Consumable materials**			
1.	Charts	Manila papers		
2.	marker pens	Erasable		
D	**Tools and Equipment**			
1.	Calculators	Scientific	25 pcs	1:1

POWER SUPPLY SYSTEMS II

ISCED UNIT CODE: 0714 451 21A

UNIT CODE: ENG/CU/ET/CR/01/5/B

Relationship to Occupational Standards
This unit addresses the unit of competency: Install power supply systems

UNIT DURATION: 100 HOURS

Unit Description
This unit covers competencies required for installing power supply system. Competencies includes; designing Power Supply Circuits, assembling Power Supply Prototypes, optimizing Power Supply Performance and repairing Power Supply Systems.s

Summary of Learning Outcomes
By the end of this unit of learning the trainee will be able to:

S/NO	Learning Outcome	Duration (Hours)
1.	Design Power Supply Circuits	30
2.	Assemble Power Supply Prototypes	30
3.	Optimize Power Supply Performance	20
4.	Repair Power Supply Systems	20
TOTAL		**100**

Learning Outcomes, Content and Suggested Assessment Methods

Learning Outcome	Content	Suggested Assessment Methods
1. Design Power Supply Circuits	1.1 Meaning of terms 1.1.1 Factors to consider when designing power supply system. 1.2 Topology Selection 1.2.1 Efficiency vs. load analysis (linear vs. switching) 1.2.2 Topology trade-offs: Buck/Boost/Flyback for industrial vs. consumer apps 1.3 Component Calculation 1.3.1 Capacitor/inductor sizing per IEEE 1818 (ripple <5%)	• Observation • Oral questioning • Written tests • Practical tests

Learning Outcome	Content	Suggested Assessment Methods
	1.3.2 Feedback loop stability criteria (phase margin >45°) 1.4 PCB Design 1.4.1 High-current trace width calculations (IPC-2221) 1.4.2 Thermal via arrays for >10A applications 1.5 Noise isolation techniques: 1.5.1 Split ground planes 1.5.2 Guard rings for sensitive analog 1.6 Power Distribution 1.6.1 Star grounding vs. chassis grounding (IEEE 1100) 1.6.2 RFI shielding methods for >100kHz noise 1.7 SMPS/UPS Configuration 1.7.1 Online UPS battery sizing (IEC 62040) 1.7.2 Synchronous rectification for >90% efficiency 1.8 Simulation & Validation 1.8.1 LTspice/PSIM models per IEEE 1666 1.8.2 Worst-case scenario testing (line/load transients) 1.9 Protection Circuits 1.9.1 UVLO/OVP thresholds 1.9.2 Crowbar circuits for >50V systems 1.10 Transient Management 1.10.1 Inrush current limiting: NTC vs. active FET 1.10.2 TVS diode selection for IEC 61000-4-5 compliance	
2. Assemble Power Supply Prototypes	2.1 Component Assembly 2.1.1 Safety Protocols: 2.1.2 use of grounded workstations, wrist straps (ANSI/ESD S20.20)	• Observation • Oral questioning • Practical tests • Written tests

Learning Outcome	Content	Suggested Assessment Methods
	2.1.3 Handling guidelines for moisture-sensitive components (IPC/JEDEC J-STD-033) 2.1.4 Soldering Techniques 2.2 Input/Output Testing 2.2.1 IEC 61000-4-11 Compliance: 2.2.1.1 Voltage dip/sag testing 2.2.1.2 Surge immunity 2.2.2 Performance Metrics: 2.2.2.1 Load regulation 2.2.2.2 Efficiency measurements 2.3 Stability Diagnostics 2.3.1 Loop stability testing (phase/gain margin via network analyzer) 2.3.2 Identifying parasitic oscillations (>20MHz) 2.3.3 Oscilloscope probing techniques (1X/10X, ground loops) 2.3.4 Spectrum analyzer settings (RBW, VBW for conducted noise) 2.4 EMI Mitigation 2.4.1 Conducted EMI (CISPR 32): 2.4.1.1 LISN measurements (150kHz–30MHz) 2.4.1.2 Filter design (common-mode chokes, X/Y capacitors) 2.4.2 • Radiated EMI 2.4.3 Near-field probing techniques 2.4.4 Shielding effectiveness validation 2.5 Compliance Validation 2.5.1 IEC/EN 62368 (Safety) 2.5.2 Creepage/clearance measurements 2.5.3 Fault condition testing (short-circuit, overload) 2.5.4 CISPR 32 (EMC) 2.5.5 Radiated emissions (30MHz–6GHz) 2.5.6 Harmonic current emissions (IEC 61000-3-2)	

Learning Outcome	Content	Suggested Assessment Methods
3. Optimize Power Supply Performance	3.1 Efficiency Enhancement 3.1.1 Synchronous rectification (MOSFET vs. diode) 3.1.2 Soft-switching techniques (ZVS/ZCS) per IEEE 1662 3.1.3 Loss analysis (conduction/switching) 3.2 Standby Power Reduction 3.2.1 80 Plus certification requirements (Titanium/Platinum) 3.2.2 Burst-mode operation optimization 3.2.3 Auxiliary supply design (e.g., flyback for <100mW) 3.3 Power Factor Correction (PFC) 3.3.1 Active PFC topologies (boost, totem-pole) 3.3.2 THD limits per IEC 61000-3-2 3.3.3 Control loop tuning (average current mode) 3.4 Stress Testing 3.4.1 Load step testing (10-90% in <100µs) 3.4.2 Thermal cycling (-40°C to +85°C) per IEC 60068 3.5 Design Upgrades 3.5.1 Component derating (capacitors/MOSFETs) 3.5.2 Cost vs. reliability trade-offs 3.5.3 MTBF calculations	• Observation • Oral questioning • Practical tests • Written tests
4. Repair Power Supply Systems	4.1 Failure Diagnosis 4.1.1 Capacitor aging (ESR increase) 4.1.2 MOSFET avalanche breakdown 4.1.3 Optocoupler degradation 4.2 Fault Tracing 4.2.1 Schematic navigation per IPC-7711 4.2.2 Waveform analysis (switching nodes, gate drives)	•

Learning Outcome	Content	Suggested Assessment Methods
	4.3 Component Replacement 4.3.1 Optocoupler recalibration (CTR measurement) 4.3.2 Feedback loop stability verification 4.4 Thermal Management 4.4.1 IR thermometer use 4.4.2 Heatsink design 4.5 Documentation 4.5.1 Report format 4.5.2 Calibration records	

Suggested Methods of Instruction

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

List of Recommended Resources for 25 trainees

S/No.	Category/Item	Description/ Specifications	Quantity	Recommended Ratio (Item: Trainee)
A	**Learning Materials**			
5.	Textbooks	5. B. Scaddan Electrical installation work 6. J. Hyde Electrical Installation Principles and Practices	5 pcs	1:5

		7. Electrical Theory for the Electrician" by Mike Holt 8. Electrical installation work by Brian Scaddan		
6.	Installation manuals	IEEE regulation BS3939 NEMA regulations OSHA	5 pcs	1:5
7.	Charts	Single line diagram Circuit diagrams Colour codes	1 pcs for each	1:25
8.	Power point presentations	For trainer's use	1	1:25
B	**Learning Facilities & infrastructure**			
10.	Lecture/theory room	$60m^2$	1	1:25
11.	Workshop	$150m^2$	1	1:25
12.	Site			
C	**Consumable materials**			
15.	Insulation tapes		25 pcs	1:1
16.	Accessories	Stationery, Breadboards, Strip Board, Assorted Electronic components., UPS, Batteries, Battery Chargers, Assorted Cables, Assorted protective devices , Assorted solar system components	25 pcs	1:1

17.	Conduits and trunkings	PVC conduits, Mini trunking	25 pcs	1:1
	Tools and Equipment			
73.	Hacksaws		25 pcs	1:1
74.	Striping knives		25 pcs	1:1
75.	Side cutters		25 pcs	1:1
76.	Pliers		25 pcs	1:1
77.	Tape measure		25 pcs	1:1
78.	Try Square		25 pcs	1:1
79.	Spirit level		25 pcs	1:1
80.	Assorted Screw driver		25 pcs	1:1
81.	Assorted hammers		25 pcs	1:1
82.	PPEs		25 pcs	1:1
83.	Multimeters		5 pcs	1:5
84.	Clamp meters		5 pcs	1:5
85.	Earth resistance meter		5 pcs	1:5
86.	Soldering Gun		5 pcs	1:5
87.	Solder Suckers		5 pcs	1:5
88.	Assorted spanners and wrenches		5 pcs	1:5
89.	Oscilloscopes		5 pcs	1:5
90.	Bending spring		5 pcs	1:5
91.	Drilling machines		5 pcs	1:5
92.	Work stations		25	1:1

93.	Draw wire		5 pcs	1:5
94.	Installation boards		13 pcs	1:2

Installation instruments

- Continuity tester (ohmmeter)
- Insulation resistance tester
- Earth loop impedance tester
- Test lamp
- CRO
- Multimeter
- Computer

Materials and supplies

- Stationery
- Test Certificate
- PCB
- Design softwares

Reference materials

- Manufacturers' manuals
- Relevant catalogues
- IEE regulations
- OSHA regulations

MODULE IV

WORK ETHICS AND PRACTICES

ISCED UNIT CODE: 0417 441 03A
TVET CDACC UNIT CODE: ENG/CU/ET/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 competencies required to demonstrate employability skills. It involves the ability to: conduct self-management, promote ethical work practices and values, promote teamwork, manage workplace conflicts, maintain professional and personal development, apply problem-solving, and promote customer care.

Summary of Learning Outcomes

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

S/No	Learning Outcomes	Duration (Hours)
1.	Apply self-management skills	10
2.	Promote ethical work practices and values	4
3.	Promote team work	10
4	Maintain professional and personal development	10
5	Apply problem solving skills	4
6	Promote customer care	2
	Total	**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	● Observation ● Portfolio of evidence ● Project

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	• Practical • Written assessment • Oral assessment
2. Promote ethical work 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	• Portfolio of evidence • Project • Practical • Observation • Written assessment • Oral assessment
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 3.7.1 Leading a team 3.7.2 Team performance and evaluation 3.7.3 Conflicts and conflict resolution	• Observation • Written assessment • Oral assessment • Portfolio of evidence • Project • Practical

Learning Outcome	Content	Suggested Assessment Methods
	3.7.4 Gender and diversity mainstreaming 3.7.5 Developing Healthy workplace relationships 3.7.6 Adaptability and flexibility 3.7.7 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	● Project ● Practical ● Observation ● Written assessment ● Oral assessment ● 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 5.5 Creative thinking and critical thinking process in development of innovative and practical solutions	● Observation ● Project ● Portfolio of evidence ● Practical ● Written assessment ● Oral assessment
6. Promote customer care	6.1 Identifying customer needs	● Observation ● Project

Learning Outcome	Content	Suggested Assessment Methods
	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	• Practical • Portfolio of evidence • Written assessment • Oral assessment

Suggested Methods of Instruction

- Practical
- Projects
- Demonstrations
- Group discussions
- Direct instruction

Recommended Resources for 25 Trainees

S/No.	Category/Item	Description/ Specifications	Quantity	Recommended Ratio (Item: Trainee)
A	**Learning Materials**			
1)	Power point presentations	For trainer's use	1	1:25
2)	Charts	For trainees and Trainer's use	6-10	1:5 pr 1:10
3)	Video clips	For trainees and Trainer's use	Varies	Varies
4)	Audio tapes	For trainees and Trainer's use	Varies	Varies
B	**Learning Facilities & infrastructure**			
5)	Lecture/theory room	For Trainer/trainee's use	1	1:25
6)	Computers	For trainee's use	25	1:1
7)	Radio sets	For trainee's use	3-5	1:5 or 1:10
8)	TV sets	For trainee's use	3-5	1:5 or 1:10
C	**Consumable materials**			

9)	Stationery	For trainees and trainer's use	Varies	Varies
D	**Tools and Equipment**			
10)	LCD projectors	For trainer's use	1	1:25

ENTREPRENEURIAL SKILLS

ISCED UNIT CODE: 0413 541 04A

TVET CDACC UNIT CODE: ENG/CU/ET/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 demonstrate an understanding of entrepreneurship. It involves demonstrating an understanding of financial literacy, applying entrepreneurial concepts, identifying entrepreneurship opportunities, applying business legal aspects, and developing business innovative strategies and business plans.

Summary of Learning Outcomes

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

S/No	Learning Outcomes	Duration (Hours)
1.	Apply financial literacy skills	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	**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	• Practical • Portfolio of evidence • Project • Observation • Written assessment

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	• Oral assessment • Third party reports • Interviews
2.Apply 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	• Observation • Project • Written assessment • Oral assessment • Third party report
3.Identify Entrepreneurship Opportunities	3.1 Sources of business ideas 3.2 Factors to consider when evaluating business opportunity 3.3 Business life cycle	• Observation • Project • Written assessment • Oral assessment • Third party report
4.Apply Business Legal Aspects	4.1 Forms of business ownership 4.2 Business registration and	• Observation • Project

Learning Outcome	Content	Suggested Assessment Methods
	licensing processing 4.3 Types of contracts and agreements 4.4 Employment laws 4.5 Taxation laws	• Written assessment • Oral assessment • Third party report
5.Innovate Business Strategies	5.1 Creativity in business 5.2 Innovative business strategies 5.3 Entrepreneurial Linkages 5.4 ICT in business growth and development	• Observation • Project • Written assessment • Oral assessment • Third party report
6.Develop Business Plan	6.1 Business description 6.2 Marketing plan 6.3 Organizational/Management 6.4 plan 6.5 Production/operation plan 6.6 Financial plan 6.7 Executive summary 6.8 Business plan presentation 6.9 Business idea incubation	• Observation • Written assessment • Project • Oral assessment • Third party report

Suggested Methods of Instruction

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

Recommended Resources for 25 trainees

S/no.	Category/item	Description/specification	Quantity	Recommended ratio(item: trainee)
A. Learning materials				

1.	Report writing templates	Digital report template	5	1:5
2.	Flashcards	Educational flash cards	5	1:5
3.	Flip charts	Educational flip charts	5	1:5
B.	**Learning facilities and infrastructure**			
1.	Lecture/theory room	$72m^2$	1	1:25
2.	Whiteboard	4 feet by 8 feet	1	1:25
3.	Projector	LCD High resolution	1	1:25
4.	Computers	RAM: 8GB	25	1:25
5.	Printers	Ink Jet	2	1:13
C.	**Consumable materials**			
1.	Printing Papers	A4	Enough for 25	1:25
2.	Assorted whiteboard markers	Non-permanent	Enough for 25	1:25
D.	**Tools and equipment**			
1.	Mobile phones	Functioning smart phone	Enough for 25	1:25

ANALOGUE ELECTRONICS

ISCED UNIT CODE: 0714 441 08A

TVET CDACC UNIT CODE: ENG/CU/ET/CC/04/5/MA

UNIT DURATION: 80 HOURS

Relationship to Occupational Standards

This unit addresses the Unit of Competency: Apply analogue electronics one.

UNIT DESCRIPTION

This unit describes the competencies required to apply analogue electronics. These competencies include; applying semiconductor theory, applying semiconductor diodes, applying understanding of transistors, applying special semiconductor devices, performing rectification, applying amplifiers, use of oscillators and application of opto-electronics.

Summary of Learning Outcomes

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

S/NO	Learning Outcome	Duration (Hours)
1.	Apply semiconductor theory	5
2.	Apply semiconductor diode	10
3.	Apply transistors	15
4.	Apply special semiconductor devices	10
5.	Perform rectification	10
6.	Apply amplifiers	10
7.	Use oscillators	10
8.	Apply opto-electronics	10
TOTAL		**80**

Learning Outcomes, Content and Suggested Assessment Methods

Learning Outcome	Content	Suggested Assessment Methods
1. Understand semiconductor theory	1.1 Atomic structure 1.1.1. Structure of the Atom 1.1.2. Electron Configuration 1.1.3. Ions and Charge Carriers 1.2 Types of materials 1.2.1. Insulators	1 Practical test 2 Project 3 Third Party Report 4 Portfolio of evidence

Learning Outcome	Content	Suggested Assessment Methods
	1.2.2. Conductors 1.2.3. Semiconductors 1.2.4. Semiconductor materials 1.3 Types of semiconductors materials 1.3.1. Intrinsic semiconductors 1.3.2. Extrinsic semiconductors 1.3.2.1. n-type extrinsic semiconductor 1.3.2.2. p-type extrinsic semiconductor 1.4 The pn junction 1.4.1. Properties of pn junction 1.4.2. Current flow in a forward biased pn junction 1.4.3. Current flow in a reverse biased pn junction 1.4.4. V-I characteristics of a pn junction	5 Written test 6 Oral questioning
2. Apply semiconductor diodes.	2.1 Introduction to the crystal diode 2.2 Characteristics of the crystal diode 2.2.1. Resistance of a crystal diode 2.2.2. Equivalent circuit of the crystal diode 2.3 Biasing of the crystal diode 2.3.1 Foreward biasing 2.3.2 Reverse biasing 2.4 Limitations in the operating conditions of a crystal diode 2.4.1 forward current rating 2.4.2 PIV 2.4.3 power rating 2.5 Special purpose diodes 2.5.1 LED 2.5.2 Photodiode 2.5.3 Optoisolator 2.5.4 Tunnel diode 2.5.5 Varactor diode 2.5.6 Schockley diode 2.6 Application of semiconductor diodes	1 Practical test 2 Third Party Report 3 Portfolio of evidence 4 Written test 5 Oral questioning

Learning Outcome	Content	Suggested Assessment Methods
3. Apply transistors.	3.1 Bipolar junction transistors (BJTs) 3.1.1 Types and construction of BJT transistors 3.1.2 Operation of NPN and PNP transistors 3.1.3 Characteristics of BJTs, i.e., V-I, and gain 3.2 BJT configurations 3.2.1 Common emitter 3.2.2 Common base 3.2.3 Common collector 3.3 Characteristics of BJT connections 3.4 BJT transistor load line analysis 3.4.1 DC load line 3.4.2 AC load line 3.5 BJT transistor biasing methods 3.5.1 Key terms in transistor biasing (faithful amplification, variation of transistor parameters, stabilisation) 3.5.2 Base resistor, emitter bias, collector feedback, voltage divider biasing techniques 3.6 Field Effect Transistors (FETs) – JFET & MOSFET 3.7 P and N channels of FETs 3.8 Operation of FETs 3.9 Characteristics of FETs 3.10 Biasing techniques of FETs 3.11 Application of FETs	1 Practical test 2 Third Party Report 3 Portfolio of evidence 4 Written test 5 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	1 Practical test 2 Third Party Report 3 Portfolio of evidence 4 Written test 5 Oral questioning

Learning Outcome	Content	Suggested Assessment Methods
	4.3 Schematic symbols of special semiconductor devices 4.4 Application of special semiconductor devices	
5. Perform rectification.	5.1 Types of rectifiers 5.1.1 Half wave rectifiers 5.1.2 Full wave rectifiers (center-tap and bridge) 5.2 Classes of rectifiers 5.2.1 Uncontrolled Rectifier 5.2.2 Controlled Rectifier 5.2.3 Half-Controlled Rectifier 5.2.4 Fully-Controlled Rectifier 5.3 Application of rectifiers 5.4 Types of converters 5.4.1 AC to DC converter (rectifier) 5.4.2 DC to AC Converter (Inverter) 5.4.3 DC to DC Converter 5.4.4 AC to AC Converter 5.5 Application of converters	1 Practical test 2 Third Party Report 3 Portfolio of evidence 4 Written test 5 Oral questioning
6. Apply amplifiers.	6.1 Classification of amplifiers based on;Stages 6.1.2 Coupling method 6.1.3 Frequency 6.2 Types of amplifiers 6.2.1 RC coupled amplifiers 6.2.2 Power amplifiers 6.2.3 Tuned amplifiers 6.3 Feedback 6.3.1 Principle of feedback 6.3.2 Positive feedback 6.3.3 Negative feedback	1 Practical test 2 Third Party Report 3 Portfolio of evidence 4 Written test Oral questioning

Learning Outcome	Content	Suggested Assessment Methods
	6.4 Operational amplifiers (OPAMPs) 6.4.1 Construction of opamps 6.4.2 Characteristics of the ideal and practical opamps 6.4.3 Opamp configurations 6.4.3.1 Inverting Amplifier 6.4.3.2 Non-Inverting Amplifier 6.4.3.3 Voltage Follower (Buffer) 6.4.3.4 Summing Amplifier 6.4.3.5 Differential Amplifier 6.4.3.6 Instrumentation Amplifier 6.4.3.7 Integrator 6.4.3.8 Differentiator 6.4.3.9 Comparator 6.4.3.10 Schmitt Trigger 6.5 Application of Amplifiers	
7. Use oscillators.	1.1 Sinusoidal oscillation 1.2 Types of sinusoidal oscillations 1.2.1 Damped oscillations 1.2.2 Undamped oscillations 1.3 Components of transistor oscillators 1.4 Essential conditions for oscillations 1.5 Types of oscillators Colpitts 1.5.1 Hartley 1.5.2 Phase shift oscillator 1.5.3 Crystal oscillator 1.6 Applications of oscillators 1.7 Wave shaping and multivibrator circuits 1.8 Types of multivibrators 1.8.1 Astable 1.8.2 Monostable 1.8.3 Bistable 1.9 Passive filters 1.9.1 High pass 1.9.2 Low pass 1.9.3 Band pass 1.10 Clippers and clampers	1 Practical test 2 Third Party Report 3 Portfolio of evidence 4 Written test Oral questioning

Learning Outcome	Content	Suggested Assessment Methods
	Applications of wave shaping and multivibrator circuits	
8. Apply opto-electronics	1.11 Opto-electronic devices 1.11.1 LEDs 1.11.2 OLED 1.11.3 LASER diode 1.11.4 Photo transistors 1.11.5 Photo diodes 1.11.6 Optocoupler 1.11.7 LASCR 1.12 Liquid crystal displays 1.12.1 Dynamic scattering LCDs 1.12.2 Field effect scattering LCDs 1.12.3 LASERs and MASERs 1.12.4 Applications of optoelectronics	1 Practical test 2 Third Party Report 3 Portfolio of evidence 4 Written test Oral questioning

Suggested Methods of Instruction

- Practical
- Project
- Group discussions
- Demonstration
- Visit to manufacturing and processing industries
- On-job-training
- Charts and Audio-visual presentations

Recommended Resources for 25 Trainees

S/No.	Category/Item	Description/ Specifications	Quantity	Recommended Ratio (Item: Trainee)
A	**Learning Materials**			
1.	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).	10 pcs for each book	1:2.5

		A textbook of electrical technology (1st multicolour ed., Multicolour illustrative 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.		
2.	Software	Assorted simulation software e.g., Circuit wizard.	25	1:1
3.	Audio visual presentations	Projector	1	1:25
B	**Learning Facilities & infrastructure**			
4.	Lecture/theory room	$60m^2$	1	1:25
5.	Workshop	$150m^2$	1	1:25
6.	Computer laboratory	$100m^2$	1	1:25
C	**Consumable materials**			
7.	Electronic components	Breadboards, Stripboards, Jumper wires, Assorted resistors, Assorted capacitors, Assorted MOSFETs, Assorted JFETs, 555 timers, Solder wire, LEDs, Assorted BJT transistors, LDRs, OPAMPs, thermistors, 12V DC motors	25 pcs	1:1
D	**Tools and Equipment**			

8.	Assorted tools and equipment	Side cutters, Side cutters, Pliers, Screw driver, Crimping tools, Mult-meter, Solder guns	25 pcs	1:1
9.	Assorted electrical gadgets	Solder gun, Heat sink, Hot air guns, function generator	25 pcs	1:1
10.	Assorted measuring instruments	Digital Oscilloscope,	5 for each category	1:5
11.	Digital Multimeter,			
12.	Digital functional generator		3 pcs	1:8
13.	Laser jet printer		2 pcs	1:13
14.	Power supply	Variable power supply, 5V Power adapters, 9V Power adapters, 12V Power adapters.	10 pcs	1:3
15.	Trainers kit	Analogue training kits, PWM kit	5 pcs	1:5
16.	PCB prototyping material	Copper board, ferrite chloride solution, see-through printing paper, HASL finishing PCB	25 for each category	1:1
17.	Drilling gun		3 pcs	1:8
18.	Work stations		25	1:1

DIGITAL ELECTRONICS

ISCED UNIT CODE: 0714 441 09A
TVET CDACC UNIT CODE: ENG/CU/ET/CC/05/5/MA

UNIT DURATION: 60 Hours

Relationship to Occupational Standards
This unit addresses the Unit of Competency: Apply Digital Electronics

Unit Description
This unit describes competences required to apply digital electronics. Competences include applying knowledge of number systems, applying knowledge of binary code and applying logic gates, Boolean algebra concepts, applying knowledge of digital logic circuits, applying knowledge of converters (ADC and DAC) and managing computer memories.

Summary of Learning Outcomes
By the end of this unit of learning the trainee will be able to:

S/NO	Learning Outcome	Duration (Hours)
1.	Apply knowledge of number systems	10
2.	Apply knowledge of binary codes	10
3.	Apply Logic gates and Boolean algebra concepts	10
4.	Apply knowledge of digital logic circuits	10
5.	Apply knowledge of advance digital logic and converter circuits	10
6.	Manage computer memories	10
TOTAL		**60**

Learning Outcomes, Content and Suggested Assessment Methods

Learning Outcome	Content	Suggested Assessment Methods
1. Apply knowledge of number systems	1.1 Numbers systems e.g. 1.1.1 Decimal 1.1.2 Octal 1.1.3 Hexadecimal 1.1.4 Binary	1 Observation 2 Written test 3 Practical 4 Demonstration

	1.2 Number system representation 1.3 Conversion of number systems 1.4 Perform 1's and 2's complement	5 Oral questioning 6 Third party report
2. Apply knowledge of binary codes	1.1 BCD (Binary Coded Decimal) 1.2 Gray Code 1.3 Excess 3 code	1 Observation 2 Written test 3 Practical 4 Demonstration 5 Oral questioning 6 Third party report
3. Apply Logic gates and Boolean algebra concepts	3.1 Basic logic gates 3.2 Universal logic gates operation 3.3 Special purpose gates 3.4 laws of Boolean algebra 3.5 Logic expressions simplification 3.6 K-MAPS	1 Observation 2 Written test 3 Practical 4 Demonstration 5 Oral questioning 6 Third party report
4. Apply knowledge of digital logic circuits	4.1 Combinational logic circuits design and minimization 4.2 Logic families. 4.2.1 Bipolar Families 4.2.2 MOS Families 4.2.3 Hybrid Family 4.3 Sequential logic circuits 4.4 Flip flops	1 Observation 2 Written test 3 Practical 4 Demonstration 5 Oral questioning Third party report
5. Apply knowledge of advance digital logic and converter circuits	5.1 Counters 5.2 Data handling devices 5.2.1 Decoders 5.2.2 Encoders 5.2.3 Multiplexers 5.2.4 Demultiplexers 5.2.5 Shift registers 5.3 Arithmetic circuits 5.4 Digital converters (ADC)(DAC)	1 Observation 2 Written test 3 Practical 4 Demonstration 5 Oral questioning Third party report
6. Manage computer memories	6.1 VVF Introduction to Computer Memory systems 6.2 Types of memory devices 6.2.1 RAMs	1 Observation 2 Written test 3 Practical 4 Demonstration

	6.2.2 ROMs 6.2.3 EEPROM 6.2.4 EPROM 6.3 Memory organization. 6.4 Memory expansion	5 Oral questioning Third party report

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**			
1.	Reference books	Digital Electronics: Principles, Devices and Applications By Anil K. Maini	5 pcs	1:5
2.	Installation manuals	Assorted Systems component Manufacturer's manuals and data sheets Instrumentation Handbooks	5 pcs	1:5
3.	Charts	Assorted Circuit diagrams charts	1 pcs for each	1:25
4.	Software	Assorted simulation software e.g Deeds,	25	1:1
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.	Assorted electronics components	ICs, resistors, capacitors	25 pcs	1:1
D	**Tools and Equipment**			
10.	Assorted tools and equipment	Side cutters, Side cutters, Pliers, Screw driver,Multi-meter, Oscilloscope, Solder guns, breadboards	25 pcs	1:1
11.	PPEs	Safety boots, overall	25 pcs	1:1
12.	Function generator		5 pcs	1:5
13.	Variable power supply		5 pcs	1:5
14.	Trainers kit	Assorted logic gate, combinational circuits trainer kits with component Manufacturer's manuals and data sheets	5 pcs	1:5
15.	Hot air gun		5 pcs	1:5
16.	Work stations		25	1:1

ELECTRICAL PRINCIPLES II

ISCED UNIT CODE: 0713 441 10A

TVET CDACC UNIT CODE: ENG/CU/ET/CC/06/5/MA

UNIT DURATION: 60 HOURS

Relationship to Occupational Standards

This unit addresses the Unit of Competency: Apply electrical principles

UNIT DESCRIPTION

This unit describes competences required to apply electrical principles in their work. It involves apply basic electrical machines, apply three phase power supply, apply transients in dc circuits.

Summary of Learning Outcomes

By the end of the unit the trainee should be able to:

S/NO	Learning Outcome	Duration (Hour)
1.	Apply electrical machines	20
2.	Apply three phase power supply	20
3.	Apply transients in DC Circuits	20
TOTAL		**60**

Learning Outcomes, Content and Suggested Assessment Methods

Learning Outcome	**Content**	**Suggested Assessment Methods**
1. Apply electrical machines	1.1 Electrical machines identification 1.2 electrical machines operations 1.2.1 DC motors 1.2.2 DC generators	• Practical • Project • Third party report • Portfolio of evidence

	1.2.3 AC single phase motors 1.2.4 AC three phase machines: Induction, Synchronous 1.2.5 Transformer 1.3 Derivation of generator e.m.f equation 1.4 Electrical machine control 1.5 Calculations involving electrical machines 1.6 Applications of electrical machines	• Written tests • Oral questioning
2. Apply three phase power supply	2.1 Principles of three phase power generation 2.2 Connections of three phase power supply 2.2.1 Star and delta connection 2.3 Calculations involving three phase power supply connections 2.4 Measurements of three phase power supply 2.4.1 One wattmeter method 2.4.2 Two wattmeter method 2.4.3 Three wattmeter method	• Practical • Project • Third party report • Portfolio of evidence • Written tests • Oral questioning
3. Apply transients in Electrical DC Circuits	3.1 Derivation of growth and decay equations in R-L and R-C circuits. 3.1.1 Sketching of Growth and decay curves in R-L and R-C circuits 3.1.2 Calculations involving Growth and	• Practical • Project • Third party report • Portfolio of evidence • Written tests • Oral questioning

	decay in R-L and R-C circuits based on the time constants. 3.2 Application of the effect of time constant in switching inductive and capacitive loads 3.3 Analysis of Passive and active filters	

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**			
6.	Textbooks	J. Bird Electrical and Electronic Principles V.K. Mehta & R. Mehta Basic	5 pcs	1:5

		Electrical Engineering		
7.	Installation manuals	Electronic components datasheets	5 pcs	1:5
8.	Charts	Circuit diagrams Colour codes	1 pcs for each	1:25
9.	Scientific Calculators		25	1:1
10.	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
C	**Consumable materials**			
1.	Connector wires	Jumper wires,	5 pkts	1:5
2.	Insulation tapes		25 pcs	1:1
3.	Circuit boards	Bread board, copper strip boards	25 pcs	1:1
4.	Assorted electronic components	Resistors, diodes, capacitors, transistors, ICs,	25 pcs	1:1

		Transformers, Inductors, Batteries		
5.	Soldering wires		5 rolls	1:5
D	**Tools and Equipment**			
1. 1.	Striping knives		25 pcs	1:1
2. 2.	Side cutters		25 pcs	1:1
3. 3.	Pliers		25 pcs	1:1
4.	Assorted Screw driver		25 pcs	1:1
5.	Crimping tools		5 pcs	1:5
6.	PPEs		25 pcs	1:1
7.	Multimeters		5 pcs	1:5
8.	Oscilloscope		5 pcs	1:5
9.	Function generator		5 pcs	1:5
10.	Spectrum analyser		5 pcs	1:5
11.	Variable power supply		5 pcs	1:5
12.	Solder guns		25 pcs	1:1
13.	Hot air gun		5 pcs	1:5
14.	Work stations		25	1:1

ELECTRICAL INSTRUMENTATION II

UNIT CODE: 0713 451 22A

UNIT CODE: ENG/CU/ET/CR/02/5/MA

Relationship to Occupational Standards

This unit addresses the unit of competency: Apply Electrical Instrumentation

Duration of Unit: 100 hours

Unit Description

This unit covers competencies required to apply electrical instrumentation. Competencies include; demonstrating understanding of measurements, applying analogue instruments, applying electromechanical instruments, applying digital instruments, measuring of electrical and physical quantities, applying waveform analyzing instruments, applying sensors, transducers and calibrating instruments

Summary of Learning Outcomes

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

S/NO	Learning Outcome	Duration (Hours)
1.	Apply analogue instruments	10
2.	Apply electromechanical instruments	10
3.	Apply digital instruments	10
4.	Measure electrical and physical quantities	20
5.	Apply waveform analysing instruments	20
6.	Apply sensors and transducers	20
7.	Calibrate instruments	10
	TOTAL	**100**

Learning Outcomes, Content and Suggested Assessment Methods:

Learning Outcome	Content	Suggested Assessment Methods

1. Apply analogue instruments	• Meaning of terms
	• Analogue Instruments
	  • Voltmeter
	  • Transistor voltmeter circuit
	  • Voltmeter range changing
	  • Difference amplifier voltmeter
	  • Op amp amplifier Voltmeter
	  • Voltage to current converter
	  • Ohmeter
	  • Series ohmmeter circuit
	  • Shunt ohmmeter circuit
	  • Linear ohmmeter
	  • Ammeter
	  • Ammeter circuit
	  • Analogue electronic multimeter
	  • Multimeter probes
	  • High voltage probes
	  • High current probes
	  • Radio Frequency Probes
	• Calculation of errors
	• Statistical methods of analyzing errors
	  • Arithmetic mean value
	  • Deviation
		• Observation
		• Oral questioning
		• Practical tests
		• Written tests

Learning Outcome	Content	Suggested Assessment Methods
	• Standard deviation	

2. Apply electromechanical instruments	• Meaning of terms
	• Permanent magnet moving coil and moving iron instruments
	  • Deflection instrument fundamentals
	  • PMC construction
	  • Torque equation and scale
	  • Deflecting torque
	  • Controlling torque
	  • Damping torque
	• Galvanometer
	  • Function
	  • DC and AC galvanometer
	  • Sensitivity
	  • Use of a galvanometer as null meter of null detector
	  • Types of galvanometers
	  • Ballistic galvanometer
	  • Vibration galvanometer
	• DC and AC Ammeters and Voltmeters
	  • Ammeter circuit
	  • Shunt resistance
	  • Swamping resistance
	  • Ammeter scale
		• Observation
		• Oral questioning
		• Practical tests
		• Written tests

Learning Outcome	Content	Suggested Assessment Methods
	• Multirange ammeters • Rectifier ammeter • Voltmeter circuit • Swamping resistance • Multirange voltmeter • Rectifier voltmeter • Classifications • Moving iron type • Attraction type • Repulsion type • Moving coil type • DC permanent magnet type • Electrodynamic (dynamometer) type • Hot wire type • AC induction type • Split type • Shaded pole • Electrostatic type voltmeter • Wattmeter • Types of wattmeter • Dynamometer type • AC Induction type • DC Electrostatic type • Energy meters	

Learning Outcome	Content	Suggested Assessment Methods

3. Apply digital instruments	• Meaning of terms
	• Logic gates circuits e.g.
	  • AND gates
	  • OR gates
	  • NAND gates
	• Flipflops circuits
	• Digital displays e.g.
	  • Light emitting diode displays
	  • Liquid crystal displays
	• Digital counting e.g.
	  • Scale-of-16 bit counter
	  • Decade counter
	  • Scale-of-2000 bit counter
	  • Digital frequency division
	  • Seven-segment display
	• Digital voltmeter
	• Digital multimeter
	• Digital Cathode ray oscilloscope
	• Analogue-to-digital converters
	  • Methods of analogue to digital conversion
	• Digital-to-analogue converters
	  • Methods of digital to analogue conversion
	• Calculations involving accuracy and resolution in digital instruments
		• Observation
		• Oral questioning
		• Practical tests
		• Written tests

4. Measure electrical and physical quantities	• Meaning of terms
	• Methods resistance measurements
	  • Voltmeter and ammeter methods
	  • Substitution method
	  • Wheatstone bridge
		• Observation
		• Oral questioning
		• Practical tests
		• Written tests

Learning Outcome	Content	Suggested Assessment Methods

	• Low resistance measurement
	  • Kelvin bridge
	  • Four terminal resistors
	  • Low resistance linear Ohmmeter
	  • Micro-ohmmeter
	• High resistance measurements
	  • Voltmeter and ammeter methods
	  • Guard wire and guard ring
	  • Wheatstone bridge measurement of high resistance
	  • Hand-cranked megohmmeter
	• Measurement of inductance and capacitance
	• RC and RL equivalent circuits
	  • Inductor and capacitor equivalent circuit
	  • Q factor of an inductor
	  • D factor of a capacitor
	  • AC bridge theory
	  • Circuit and balance equations
	• Capacitance bridges
	• Inductance bridges
	• Multifunction impedance bridge
	• Analogue and digital R-C-L meter
	• Measurement of physical quantities e.g.
	  • Temperature	

Learning Outcome	Content	Suggested Assessment Methods
	• Humidity • Noise	

5. Apply waveform analyzing instruments	• Meaning of terms
	• Cathode ray tube
	  • Parts of a cathode ray tube
	• Cathode ray oscilloscope
	  • Operation of a CRO
	  • Classifications of CROs
	  • Triggered sweep type
	  • Recurrent sweep type
	• Dual trace, dual beam, sampling, digital readout CROs
	• Oscilloscope controls
	• Application of CROs
	• Logic analyzers
	• Spectrum analyzers
		• Observation
		• Oral questioning
		• Practical tests
		• Written tests

6. Apply sensors and transducers	• Meaning of terms
	  • Sensors
	  • Transducers
	• Types of sensors and transducers e.g.
	  • Resistance type
	  • Inductance type
	  • Capacitance type
	• Classification of transducers
	  • Active transducers
	  • Passive transducers
	• Signal processing
	  • Analogue signal processing
	  • Continuous time signal processing
	  • Discrete time signal processing
		• Observation
		• Oral questioning
		• Practical tests
		• Written tests

Learning Outcome	Content	Suggested Assessment Methods
	• Digital signal processing • Nonlinear signal processing • Statistical signal processing • Applications of signal processing • Data presentation displays • LED displays • LCD displays	
7. Calibrate instruments	• Meaning of calibration • Comparison methods • DC voltmeter calibration • DC ammeter calibration • Ohmmeter calibration • Wattmeter calibration • Digital multimeters as standard instruments • Calibration instruments • Precision voltage source • Voltage calibrator • Potentiometers • Basic potentiometers • Potentiometers with switched resistors • Potentiometer calibration methods • DC ammeter calibration • DC voltage calibration	• Observation • Oral questioning • Practical tests • Written tests

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**			
5.	Textbooks	B. Scaddan Electrical installation work J. Hyde Electrical installation Principles and Practices	5 pcs	1:5
6.	Installation manuals	IEEE regulation BS3939 NEMA regulations OSHA	5 pcs	1:5
7.	Charts	Single line diagram Circuit diagrams Colour codes	1 pcs for each	1:25
8.	Power point presentations	For trainer's use	1	1:25
B	**Learning Facilities & infrastructure**			
18.	Lecture/theory room	$50m^2$	1	1:25
19.	Workshop	$150m^2$	1	1:25
20.	Laboratory	$100m^2$	1	1:25
21.	Site			
C	**Consumable materials**			
95	Electrical wires	$1.0mm^2$(red, black green)	5 rolls	1:5
		$1.5mm^2$(red, black green)	5 rolls	1:5

96	Insulation tapes		25 pcs	1:1
97	Accessories	Switches, sockets, Junction boxes, Consumer units, Lamp holders, Patrice boxes, Circuit breakers, relays, transformers	25 pcs	1:1
98	Pipes	PVC conduits, Metallic conduits	25 pcs	1:1
99	Wood screws		50 pcs	1:1
D	**Tools and Equipment**			
21.	Hacksaws		25 pcs	1:1
22.	Striping knives		25 pcs	1:1
23.	Side cutters		25 pcs	1:1
24.	Pliers		25 pcs	1:1
25.	Tape measure		25 pcs	1:1
26.	Draw wire		25 pcs	1:1
27.	Try Square		25 pcs	1:1
28.	File		5 pcs	1:5
29.	Spirit level		25 pcs	1:1
30.	Assorted Screw driver		25 pcs	1:1
31.	Assorted hammers		25 pcs	1:1
32.	Crimping tools		5 pcs	1:5
33.	PPEs		25 pcs	1:1
34.	Multi-meters		5 pcs	1:5
35.	Clamp meters		5 pcs	1:5

36.	Earth resistance meter		5 pcs	1:5
37.	Bending spring		5 pcs	1:5
38.	Drilling machines		5 pcs	1:5
39.	Work stations		25	1:1
40.	Installation boards		13 pcs	1:2

SECURITY SYSTEMS INSTALLATION

ISCED UNIT CODE: 0713 451 23A

TVET CDACC UNIT CODE: ENG/CU/ET/CR/03/5/MA

UNIT DURATION: 100 HOURS

Relationship to Occupational Standards

This unit addresses the unit of competency: Install security systems

UNIT DESCRIPTION

This unit covers competences required in performing security system installation**.** Competences include applying health and safety measures, installing security systems, testing security system installation and maintaining security system installations.

Summary of Learning Outcomes

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

S/NO	Learning Outcome	Duration (Hours)
1.	Apply health and safety measures	5
2.	Install security Systems	65
3.	Test security system installation	10
4.	Maintain security system installation	20
TOTAL		**100**

Learning Outcomes, Content and Suggested Assessment Methods:

Learning Outcome	Content	Suggested Assessment Methods
1. Apply health and safety measures	**<u>Theory Content</u>** 1.1 Health and Safety Measure 1.1.1 Relevant clauses in appropriate Acts e.g. 1.1.2 Occupational safety and health act (OSHA) 1.1.3 Work injury benefits act (WIBA)	1 Practical 2 Project 3 Third party report 4 Portfolio of evidence 5 Written tests

Learning Outcome	Content	Suggested Assessment Methods
	1.1.4 Safety Regulations and procedures 1.2 Work site preparation 1.3 Security systems installation tools 1.3.1 Fixing tools 1.3.2 Measuring tools 1.3.3 Termination tools e.g crimping tool 1.3.4 Cutting tools 1.4 Electrical measuring instruments 1.4.1 Multimeter 1.4.2 Earth resistance meter 1.4.3 Cable testers 1.5 Marking piping and fixing tools e.g scribers, pliers 1.6 Importance of marking	Oral questioning
2. Install Security Systems	2.1 Types of cables in security system 2.2 Factors to consider in security system cable laying 2.3 Segregation in cable laying 2.3.1 Importance segregations 2.4 Security system installation 2.5 CCTV system 2.5.1 Identification of materials and components 2.5.1.1 Cables 2.5.1.2 Conduits, trunking etc 2.5.1.3 CCTV system components 2.5.1.4 Backup system (data and power) 2.6 Specification of tools, equipment and materials 2.6.1 Tolerance/ range 2.6.2 Make / model 2.6.3 Size	1 Practical 2 Project 3 Third party report 4 Portfolio of evidence 5 Written tests 6 Oral questioning

Learning Outcome	Content	Suggested Assessment Methods
	2.6.4 Class 2.7 Wiring CCTV system 2.7.1 Schematic diagram 2.7.2 Wiring diagram 2.8 Alarm systems 2.8.1 Fire alarm 2.8.2 Burglar alarm 2.9 Identification of materials and components 2.9.1 Cables 2.9.2 Conduits, trunking etc 2.9.3 Alarm system components 2.9.4 Backup system(power) 2.10 Specification of tools, equipment and materials 2.10.1 Tolerance/range 2.10.2 Make/model 2.10.3 Size 2.10.4 Class 2.11 Wiring Bell and alarm alarm system 2.11.1 Bell transformers Indicator board 2.11.2 Bell bushes 2.11.3 Bell relays 2.11.4 Control panel 2.11.5 Sounders 2.11.6 Buzzers 2.11.7 Bell 2.11.8 Hooters 2.11.9 Sirens 2.11.10 Electrical power supply installation 2.11.11 240VAC supply 2.11.12 12VAC supply 2.11.13 Bell and alarm components installation	

Learning Outcome	Content	Suggested Assessment Methods
	2.11.14Schematic diagram 2.11.15Wiring diagram 2.12 Electric fence 2.13 identification of materials and components 2.13.1 Cables 2.13.2 Conduits, trunking etc 2.13.3 Electric fence components 2.13.4 Backup system(power) 2.14 Specification of tools, equipment and materials 2.14.1 Tolerance/ range 2.14.2 Make / model 2.14.3 Size 2.14.4 Class 2.15 Wiring electric fence system 2.15.1 Schematic diagram 2.15.2 Wiring diagram 2.16 Insulation classes of enclosures e.g. 2.16.1 IP 44 (Ingress protection) 2.16.2 IP 55 2.16.3 IP 65 2.16.4 IP 66 2.16.5 IP 67 2.17 Cable labelling 2.18 Cable termination 2.18.1 Importance of termination 2.19 Tools used in cable termination e.g. 2.19.1 Strip Knife 2.20 Security system integration with other components 2.21 Housekeeping practices **<u>Practical content</u>**	

Learning Outcome	Content	Suggested Assessment Methods
	2.22 Install security system 2.23 CCTV system 2.24 Alarm systems 2.25 Electric fence system 2.26 Coding/configuring security system 2.27 Proper disposal of waste material **Practical content** 2.28 Install security system 2.29 Coding security system 2.30 Proper disposal of waste material	
3. Test security system installation	**Theory content** 6.1 Visual inspection 6.2 Types of tests in security system e.g. 6.2.1 Insulation test 6.2.2 Short circuit test 6.2.3 Continuity test 6.2.4 Arming and disarming tests 6.2.5 Physical inspection of the system 6.3 Test results documentation 6.4 Security system commissioning **Practical content** 6.5 Test performance of system as per design specifications	1 Practical 2 Project 3 Third party report 4 Portfolio of evidence 5 Written tests 6 Oral questioning
7. Maintain security system installation	**Theory content** 7.1 Maintenance schedule preparation	1 Practical 2 Project 3 Third party report

Learning Outcome	Content	Suggested Assessment Methods
	7.2 System maintenance check list preparation 7.3 Maintenance tools and equipment selection 7.4 Inspection and tests 7.5 Faults diagnosis 7.6 Faults rectification 7.7 Maintenance reports documentation **Practical Content** 7.8 Perform security system installation maintenance as per IEEE regulations 7.9 Inspection and tests 7.10 Faults diagnosis 7.11 Faults rectification 7.12 Maintenance reports documentation	4 Portfolio of evidence 5 Written tests 6 Oral questioning

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	B. Scaddan Electrical installation work	5 pcs	1:5

		J. Hyde Electrical installation Principles and Practices		
2.	Installation manuals	Equipment manuals Control panel manuals	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**			
6.	Lecture/theory room	$60m^2$	1	1:25
7.	Workshop	$150m^2$	1	1:25
8.	Site			
C	**Consumable materials**			
9.	Assorted Electrical cables		5 rolls	1:5
10.	Insulation tapes		25 pcs	1:1
11.	Accessories	Switches, sockets, Junction boxes, Consumer units, Patrice boxes, Circuit breakers	25 pcs	1:1
12.	Assorted CCTV components	Cameras, Digital video recorder, power supply unit, TFT monitors,	5 pcs	1:5
13.	Security system components	Alarm panels, magnetic sensors, vibration sensors, motion detectors	5 pcs	1:5

14.	Fire Alarm system components	Addressable control panel, fire and heat detectors, call points, buzzers	5 pcs	1:5
15.	Electric fence components	Energizer, Insulators, wires, support	5 pcs	1:5
16.	Pipes and trunkings	PVC conduits, Steel conduits, Mini trunking	25 pcs	1:1
D	**Tools and Equipment**			
17.	Hacksaws		25 pcs	1:1
18.	Striping knives		25 pcs	1:1
19.	Side cutters		25 pcs	1:1
20.	Pliers		25 pcs	1:1
21.	Tape measure		25 pcs	1:1
22.	Try Square		25 pcs	1:1
23.	Spirit level		25 pcs	1:1
24.	Assorted Screw driver		25 pcs	1:1
25.	Assorted hammers		25 pcs	1:1
26.	Crimping tools		5 pcs	1:5
27.	PPEs		25 pcs	1:1
28.	Multimeters		5 pcs	1:5
29.	Clamp meters		5 pcs	1:5
30.	Earth resistance meter		5 pcs	1:5
31.	Stocks & Dies		5 pcs	1:5
32.	Vices		5 pcs	1:5
33.	Wire fasteners		5 pcs	1:5
34.	Oscilloscope		5 pcs	1:5
35.	Pipe bending Machine		5 pcs	1:5
36.	Bending spring		5 pcs	1:5
37.	Drilling machines		5 pcs	1:5

38.	Work stations		25	1:1
39.	Installation boards		13 pcs	1:2

MODULE V

ENGINEERING MATHEMATICS II

ISCED UNIT CODE: 0541 541 11A

TVET CDACC UNIT CODE: ENG/CU/ET/CC/01/6/MA

Unit duration: 100 hours.

Relationship to Occupational Standards

This unit addresses the unit of competency: Apply Engineering mathematics

Unit Description: This unit describes the competencies required by a technician in order to apply technician mathematics. It enables the learner to; apply Power Series, solve Partial differential equations, ordinary differential Equations, apply Laplace transforms apply Fourier Series, apply multiple Integrals, apply complex variables, apply numerical methods and apply matrices II

Summary of Learning Outcomes

By the end of the unit the trainee should be able to:

S/NO	Learning Outcome	Duration (Hour)
1.	Apply Power Series	10
2.	Solve Partial differential equations	10
3.	Ordinary differential Equations	10
4.	Apply Laplace transforms	10
5.	Apply Fourier Series	20
6.	Apply multiple Integrals	10
7.	Apply Complex Variables	10
8.	Apply numerical methods	10
9.	Apply matrices II	10
TOTAL		**100**

Learning Outcomes, Content and Suggested Assessment Methods

Learning Outcome	Content	Suggested Assessment Methods
1. Apply Power Series	1.1 Meaning of the term power series 1.2 Taylor's theorem 1.3 Deduction of Maclaurin's theorem to obtain power series	• Written assessment • Oral assessment • Practical • Project

	1.4 Application of Taylor's theorem and Maclaurin's theorems in numerical work	• Third party report • Portfolio of evidence
2. Solve Partial differential equations	2.1 Definition of partial derivatives 2.1.1 Derivation of a function of two or more variables 2.1.2 Application of partial derivatives 2.1.3 Stationary points of functions of two variables.	• Written assessment • Oral assessment • Practical • Project • Third party report • Portfolio of evidence
3. Ordinary differential Equations	3.1 Formation and solution of 1st and 2nd order differential equations 3.1.1 1st order variable separable 3.1.2 1st order homogeneous 3.1.3 1st order linear 3.2 2nd order by the determination of coefficients. 3.3 D-operator method 3.3.1 Simultaneous differential Equations 3.3.2 Series Method 3.4 Applications of differential equations	• Written assessment • Oral assessment • Practical • Project • Third party report • Portfolio of evidence
4. Apply Laplace transforms	4.1 Definition of Laplace transform of a function 4.1.1 Derivation of Laplace transforms of simple functions 4.1.2 Laplace transforms of elementary functions 4.1.3 Inference of linearity properties 4.1.4 Use of list of standard transforms 4.2 Properties of Laplace transforms 4.2.1 Derivation of Laplace transforms of $F(t) = e^{at}$ 4.2.2 Statement of initial and final value theorems 4.2.3 Derivation of the Laplace transforms of the first and second derivatives from definition 4.3 Determination of the inverse Laplace transform of simple transforms	• Written assessment • Oral assessment • Practical • Project • Third party report • Portfolio of evidence

	4.3.1 Definition of inverse Laplace transform 4.3.2 Determination of inverse Laplace transforms of simple forms 4.3.3 Determination of partial fractions for expressions up to degree three in the denominator 4.4 Determination of inverse Laplace transforms of partial fractions and a list of standards 4.5 Differential equations and simultaneous equations with constant coefficients and given initial conditions 4.6 Application of theorem for the Laplace transforms 4.7 Evaluations of Laplace transform using a small stock of transform key pair 4.8 Application of Laplace transforms to impulse response problems	
5. Apply Fourier series	5.1 Definition of Fourier series for a function 5.1.1 Determination of Fourier series for period 2π to T 5.2 Determination of Fourier series of non-periodic functions 5.3 Determination of the Fourier series for non-periodic functions over a given range 5.4 Determination of the Fourier series for odd and even functions and half-range series	• Written assessment • Oral assessment • Practical • Project • Third party report • Portfolio of evidence
6. Apply multiple integrals	6.1 Definition of double and triple integrals 6.2 Using double integrals to find areas and volumes. 6.3 Apply double and triple integrals in polar, cylindrical and spherical coordinates. 6.4 Use of triple integrals in solving problems.	• Written assessment • Oral assessment • Practical • Project • Third party report • Portfolio of evidence •
7. Apply matrices II	7.1 Definition of Eigen values and Eigen Vectors (Eigen values, Eigenvectors,	• Written assessment Oral assessment • Practical

	characteristics polynomials, distinct Eigen values, Normalized Eigen Vectors) 7.2 Calculation of Eigen values and Eigen Vectors 7.3 Explanation of function of matrices (similarity transformation and properties, exponential and meaning, logarithms of matrices) 7.4 Definition of Jordan form of a matrix 7.5 State transition matrix (properties of continuous time transition matrix for a linear time varying system)	• Project • Third party report • Portfolio of evidence
8. Apply complex variables	8.1 Functions of complex variable 8.1.1 Derivatives of analytic functions 8.2 Define analytic (regular) functions 8.3 Cauchy Riemann equation	• Written assessment • Oral assessment • Practical • Project • Third party report • Portfolio of evidence
9. Apply numerical methods	9.1 Define numerical methods 9.1.1 Application of iterative methods to solve equations 9.2 Definition of interpolation and extrapolation 9.3 Application of interpolation and extrapolation	• Written assessment • Oral assessment • Practical • Project • Third party report • Portfolio of evidence

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**			
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	25 pcs	1:1

		DirectX 11 compliant (DirectX 12 recommended)		
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	

ELECTRICAL PRINCIPLES III

ISCED UNIT CODE: 0713 541 12A

TVET CDACC UNIT CODE: ENG/CU/ET/CC/02/6/MA

UNIT DURATION: 100 HOURS

Relationship to Occupational Standards

This unit addresses the Unit of Competency: Apply electrical principles

UNIT DESCRIPTION

This unit describes competences required to apply electrical principles in their work. It involves conduct system earthing and protection, apply illumination principles, apply two port networks and apply electromagnetic field.

Summary of Learning Outcomes

By the end of the unit the trainee should be able to:

S/NO	Learning Outcome	Duration (Hours)
1.	Conduct System Earthing and protection	20
2.	Apply illumination principles	30
3.	Apply Two Port networks	20
4.	Apply Electromagnetic field	30
TOTAL		**100**

Learning Outcomes, Content and Suggested Assessment Methods

Learning Outcome	Content	Suggested Assessment Methods
Conduct system earthing and protection	1.1 Application of System and equipment protection principles 1.1.1 Protection zones	• Practical • Project • Third party report

	1.1.2 Protection systems 1.2 Perform Protection system design 1.2.1 Protection system Drawings 1.2.2 Protection system Device sizing 1.2.3 Protection system Location 1.3 Design Earthing systems 1.3.1 TT 1.3.2 TNC 1.3.3 TNCS 1.3.4 IT 1.3.5 TNS 1.4 Perform Test on an earthing system 1.4.1 Earth resistance test 1.4.2 Earth loop impedance test 1.5 Identification of various types of lightning strikes based on Benjamin Franklin 1.6 Perform Lightning system design 1.6.1 Lightning arrestors 1.6.2 Lightning design drawing 1.6.3 Size of lightning system	• Portfolio of evidence • Written tests • Oral questioning
pply illumination principles	2.1 Application of Laws of lighting 2.2 Calculations on Light requirements as laws of lighting	• Practical • Project • Third party report

	2.3 Selection of Electric luminaires 2.4 Design of lighting schemes	• Portfolio of evidence • Written tests • Oral questioning
3. Use two port networks	1.1 Analysis of basic passive networks based on black box technique 1.2 Determination of characteristic impedance 1.3 Derivation of ABCD constants 1.4 Application of cascaded networks as per network parameters. 1.5 Types of transmission lines and their applications	• Practical • Project • Third party report • Portfolio of evidence • Written tests • Oral questioning
4. Apply electromagnetic field theory	4.1 Identification of Electromagnetic radiation sources as per EN 300386 v1.6.1 4.2 Identification of detectors of Electromagnetic radiations as per EN 300386 v1.6 4.3 Application of electromagnetic waves as per EN 300386 v1.6.1 4.4 Identification of electromagnetics Laws based on Maxwell's equation. 4.5 Calculations of 4.6 Electromagnetic wave parameters based on Maxwell's equation. 4.6.1 Wavelength 4.6.2 Velocity 4.6.3 Frequency	• Practical • Project • Third party report • Portfolio of evidence • Written tests • Oral questioning

	4.7 Behaviours and effects of Electromagnetic waves 4.8 Identification of electrostatics terms. 4.9 Identification of Magneto statics terms 4.10 Identification of Electrodynamics laws 4.11 Identification of Energy conservation theorem as per the Internal energy 4.12 Calculation of Electromagnetic Energy flow as per the Maxwell's equations. 4.13 Calculation of Energy flow in an antenna as per the E-H propagation.	

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**			
11.	Textbooks	J. Bird Electrical and Electronic Principles V.K. Mehta & R. Mehta Basic Electrical Engineering	5 pcs	1:5
12.	Installation manuals	Electronic components datasheets	5 pcs	1:5
13.	Charts	Circuit diagrams Colour codes	1 pcs for each	1:25
14.	Scientific Calculators		25	1:1
15.	Power point presentations	For trainer's use	1	1:25
B	**Learning Facilities & infrastructure**			
1.	Lecture/theory room	$60m^2$	1	1:25
6.	Workshop	$150m^2$	1	1:25
C	**Consumable materials**			
1.	Connector wires	Jumper wires,	5 pkts	1:5

2.	Insulation tapes		25 pcs	1:1
7.	Circuit boards	Bread board, copper strip boards	25 pcs	1:1
8.	Assorted electronic components	Resistors, diodes, capacitors, transistors, ICs, Transformers, Inductors, Batteries	25 pcs	1:1
9.	Soldering wires		5 rolls	1:5
D	**Tools and Equipment**			
15.	Striping knives		25 pcs	1:1
16.	Side cutters		25 pcs	1:1
17.	Pliers		25 pcs	1:1
18.	Assorted Screw driver		25 pcs	1:1
19.	Crimping tools		5 pcs	1:5
20.	PPEs		25 pcs	1:1
21.	Multimeters		5 pcs	1:5
22.	Oscilloscope		5 pcs	1:5
23.	Function generator		5 pcs	1:5

24.	Spectrum analyser		5 pcs	1:5
25.	Variable power supply		5 pcs	1:5
26.	Solder guns		25 pcs	1:1
27.	Hot air gun		5 pcs	1:5
28.	Work stations		25	1:1

ELECTRICAL INSTALLATION III

ISCED UNIT CODE: 0713 551 24A
TVET CDACC UNIT CODE: ENG/CU/ET/CR/01/6/MA

UNIT DURATION: 100 HOURS

Relationship to Occupational Standards
This unit addresses the unit of competency: Perform Electrical Installation

Unit Description
This unit describes competences required for performing electrical installation. Competences include conducting site survey, designing installation, performing system sizing, preparation of working drawings, planning for logistics, preparation of installation work plan, establishment of installation team, preparation of work site, performing installation, terminating installation, inspecting and testing installation and finally preparation of tenders and service contracts.

Summary of Learning Outcomes

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

S/NO	Learning Outcome	Duration (Hours)
1.	Conduct site survey	5
2.	Perform system sizing	10
3.	Design electrical installation	10
4.	Prepare working drawings	10
5.	Plan for logistics	5
6.	Prepare installation work plan	10
7.	Establish installation team	5
8.	Prepare work site	5
9.	Perform electrical installation	10
10.	Terminate electrical installation	10
11.	Inspect and test electrical installation	10
12.	Prepare tenders and service contract	10
TOTAL		**100**

Learning Outcomes, Content and Suggested Assessment Methods

Learning Outcome	Content	Suggested Assessment Methods
1. Conduct site survey	1.1 Type of installation 1.1.1 Domestic installations 1.1.2 Industrial installations 1.1.3 Commercial installations 1.2 Type of building e.g. 1.2.1 Permanent building 1.2.2 Semi-permanent buildings 1.3 Utilities available 1.3.1 Water 1.3.2 Electricity 1.3.3 Communication 1.3.4 Installation conditions e.g. temperature, humidity, moisture 1.4 Taking measurements on site 1.4.1 Length e.g. conduits size 1.4.2 Total area 1.4.3 Temperature 1.4.4 Humidity 1.5 Preparation of site survey report	• Written tests • Observation • Oral questioning • Practical tests
2. Perform system sizing	2.1 Introduction to standards 2.1.1 IEE regulations. 2.2.1 Kenya bureau of standards (KEBS) 2.3.1 British standards 2.4.1 KPLC by-laws 2.5.1 ERC regulations 2.6.1 County by-laws 2.7.1 National Construction Authority (NCA) 2.2 Reference to relevant IEE regulations eg ▪ EPRA 2.3 Load Estimation e.g. 2.3.1 Factor of simultaneity (Ks) 2.3.2 Factor of utilization (Ku) 2.4 Determining cable: 2.4.1 Types	• Written tests • Observation • Oral questioning

Learning Outcome	Content	Suggested Assessment Methods
	2.4.2 Ratings 2.4.3 Sizes 2.4.4 Insulation type 2.5 Protective devices 2.5.1 Types 2.5.2 Ratings 2.6 Reference to relevant regulations	
3. Design Electrical Installation	3.1 Meaning of terms 3.2 Types of wiring systems 3.3 Factors to consider in designing electrical installation e.g. 3.3.1 Load size 3.3.2 Structure 3.3.3 Clients need 3.4 Types of supply 3.4.1 DC , AC Single phase and three phase	• Written tests • Observation • Oral questioning
4. Prepare working drawing	4.1 Working drawings 4.1.1Meaning of working drawings 4.2 Drawing of electrical diagrams 4.2.1.1 Block 4.2.1.2 Circuits 4.2.1.3 Schematic 4.2.1.4 Wiring 4.2.1.5 Line 4.3 Reading and Interpretation of architectural drawings 4.4 Reading and Interpretation of electrical drawings 4.5 Use of Computer Aided Design (CAD) applications e.g. AutoCAD	• Observation • Oral questioning • Practical tests • Written tests
5. Plan for logistics	5.1 Transport for: 5.1.1 Materials and their safety 5.1.2 PersonnelStorage of materials on site 5.2 Site security 5.3 Human resource	• Written tests • Oral questioning

Learning Outcome	Content	Suggested Assessment Methods
	5.4 Skills required 5.5 Communication 5.1.1 Purpose 5.1.2 Modes	
6. Prepare installation work plan	6.1 Identification of scope of installation work 6.2 Identify installation team 6.3 Meaning of terms 6.4 Preparation of work schedules 6.4.1 Bar charts 6.4.2 Gantt charts 6.4.3 Critical path networks 6.5 Raise the necessary permit and licences 6.6 Permit to work 1.6.1 Types of permit e.g. Gate pass, Name tags 1.6.2 Sources and application procedures in acquiring the permits 6.7 Classes of EPRA licences C2, C1, B, A2, A1	• Written tests • Oral questioning • Observation
7. Establish installation team	7.1 Team building 7.2 Team members familiarization 7.3 Collaboration 7.4 Task distribution 7.5 Communication protocol	• Written tests • Oral questioning
8. Prepare work site	8.1 Identification of hazards and safety requirements for the site 8.2 Reference to relevant regulations e.g. 8.2.1 Occupational Safety and Health Act (OSHA) 8.2.2 County by-laws 8.3 Utilities 9.3.1 Access roads 9.3.2 Water 9.3.3 Electricity	• Written tests • Oral questioning

Learning Outcome	Content	Suggested Assessment Methods
9. Perform electrical installation	9.1 Meaning of terms 9.2 Single phase and three phase installation 9.2.1 Domestic Installation 9.2.2 Industrial Installation 9.2.3 Commercial Installation ➢ Phase/load balancing 9.3 Cables and cable joints 9.4 Wiring systems and accessories 9.4.1 Meaning of terms 9.4.2 Types and applications e.g. 9.4.3 Conduits 9.4.4 Cable trays 9.4.5 Cable ducts 9.4.6 Trunkings 9.5 Preparation of wiring systems 9.5.1 Marking out, cutting, bending, threading, chiselling, trenching 9.5.2 Draw –in/Lay of cables routes 9.5.3 Cable Identification 9.6 Installation of final circuits 9.6.1 Lighting circuits 9.6.1.1 One way, two way, intermediate 9.6.1.2 Dimmer switches 9.6.1.3 Looping in methods at ceiling rose, joint boxes, switches 9.6.2 Power circuits 9.6.2.1 Radial circuits, 9.6.2.2 Ring circuits 9.6.3 Water heating circuits 9.6.4 Electric cooker circuits 9.6.5 Call and alarm circuits 9.6.5.1 Bell circuits 9.6.5.2 Intruder alarm circuits 9.6.5.3 Fire alarm circuits 9.7 EHS standards	• Written tests • Observation • Oral questioning • Practical test

Learning Outcome	Content	Suggested Assessment Methods
10. Terminate Electrical installation	10.1 Meaning of Terms 10.2 Importance of termination 10.3 Types of terminations 10.4 Cable labeling 10.5 Cable lugging 10.6 Tools used in cable termination e.g. 10.6.1 Crimping tool 10.6.2 Strip Knife	• Written tests • Oral questioning • Practical tests • Observation
11. Inspect and test Electrical installation	11.1 Meaning of terms 11.2 Types of tests e.g. 11.2.1 Earth continuity tests 11.2.2 Ring circuit test 11.2.3 Insulation tests 11.2.4 Short circuit tests 11.2.5 Open circuit test 11.3 Testing tools e.g. 11.3.1 Multimeter 11.3.2 Insulation tester 11.3.3 Ohmmeter 11.4 Importance of installation testing 11.5 IEE regulations	• Written tests • Oral questioning • Observation
12. Prepare tenders and service contracts	12.1 Sources of law 12.2 Law of tort 12.3 Laws of contract and tendering 12.4 Types and forms of contract 12.5 Types of tenders 12.6 Tender estimation and costing 12.7 Statutory documents in contracts and tendering	• Written tests • Observation • Oral questioning

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**			
13	Textbooks	B. Scaddan Electrical installation work J. Hyde Electrical Installation Principles and Practices	5 pcs	1:5
14	Installation manuals	IEEE regulation BS3939 NEMA regulations OSHA	5 pcs	1:5
15	Charts	Single line diagram Circuit diagrams Colour codes	1 pcs for each	1:25
16	Power point presentations	For trainer's use	1	1:25
B	**Learning Facilities & infrastructure**			
1.	Lecture/theory room	$60m^2$	1	1:25
1.	Workshop	$150m^2$	1	1:25
2.	Laboratory	$100m^2$	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
2	Accessories	Switches, sockets, Junction boxes, Consumer units, Lamp holders, Patrice boxes, Circuit breakers	25 pcs	1:1
3	Pipes and trunkings	PVC conduits, Steel conduits, Mini trunking	25 pcs	1:1
D	**Tools and Equipment**			
4.	Hacksaws		25 pcs	1:1
5.	Striping knives		25 pcs	1:1
6.	Side cutters		25 pcs	1:1
7.	Pliers		25 pcs	1:1
8.	Tape measure		25 pcs	1:1
9.	Try Square		25 pcs	1:1
10.	Spirit level		25 pcs	1:1
11.	Assorted Screw driver		25 pcs	1:1
12.	Assorted hammers		25 pcs	1:1
13.	Crimping tools		5 pcs	1:5
14.	PPEs		25 pcs	1:1
15.	Multimeters	s	5 pcs	1:5
16.	Clamp meters		5 pcs	1:5
17.	Earth resistance meter		5 pcs	1:5
18.	Stocks & Dies		5 pcs	1:5
19.	Vices		5 pcs	1:5
20.	Oscilloscope		5 pcs	1:5
21.	Pipe bending Machine		5 pcs	1:5

22	Bending spring		5 pcs	1:5
23	Drilling machines		5 pcs	1:5
24	Work stations		25	1:1
25	Installation boards		13 pcs	1:2

ELECTRICAL MACHINE CONTROL SYSTEMS

ISCED UNIT CODE: 0713 551 25A

UNIT CODE: ENG/CU/ET/CR/02/6/B

UNIT DURATION: 200 HOURS

Relationship to Occupational Standards

This unit addresses the unit of competency: Install electrical machine control systems

Unit Description

This unit covers competencies required to install electrical machine control system. Competencies include; conducting site survey, designing electrical machine control system, assembling tools, equipment and materials, mounting electrical and electronic components, wiring electrical and electronic components, terminating wiring of electrical and electronic components, configuring and testing the installed electrical machine control system, commissioning and documenting installation report.

Summary of Learning Outcomes

By the end of the unit the trainee should be able to:

S/NO	Learning Outcome	Duration (Hours)
1.	Conduct site survey	10
2.	Design electrical machine control system	30
3.	Assemble tools, equipment and materials	10
4.	Mount electrical and electronic components	30
5.	Perform wiring of electrical and electronic components	40
6.	Terminate system wiring	20
7.	Configure and test control system	40
8.	Commission the system and document installation report	20

TOTAL	200

Learning Outcomes, Content and Suggested Assessment Methods

Learning Outcome	Content	Suggested Assessment Methods
1. Conduct site survey	1.1. Utilities available 1.1.1. Water 1.1.2. Electricity 1.1.3. Communication 1.2. Installation conditions 1.2.1. Temperature, 1.2.2. Humidity, 1.2.3. Dust 1.3. Taking measurements on site 1.3.1. Length e.g. conduits size 1.3.2. Total area 1.3.3. Temperature 1.4. Types of industrial layouts 1.4.1. Process layout 1.4.2. Product layout 1.4.3. Hybrid layout 1.4.4. Fixed position layout 1.4.5. Site survey report preparation	• Observation • Oral questioning • Written tests • Practical tests
2. Design electrical machine control system	1.5. Meaning of terms 1.6. Types of control system. 1.7. Open loop control system 1.8. Closed loop control system 1.9. Logic control 1.10. ON-OFF control 1.11. Linear control 1.11.1. Proportional control 1.11.2. PID control 1.12. Components of a control system 1.12.1. Input signal 1.12.2. Sensing elements 1.12.3. Process being controlled 1.12.4. Controllers 1.12.5. Output	• Observation • Oral questioning • Written tests • Practical tests

Learning Outcome	Content	Suggested Assessment Methods
	1.13. Control system modeling 1.14. Calculations involving system modeling 1.15. Control system methodologies 1.15.1. Single input, single output (SISO) 1.15.2. Multiple input, multiple output (MIMO) 1.16. Control system strategies 1.16.1. Adaptive control 1.16.2. Optimal control 1.16.3. Intelligent control 1.16.4. Robust control 1.16.5. Stochastic control 1.16.6. Hierarchical control 1.17. Use of machine manufacturer's manuals	
3. Assemble tools, equipment and materials	1.18. Identification of tools and materials e.g. 1.18.1. Cutting tools 1.18.2. Measuring tools 1.18.3. Measuring equipment 1.18.4. Cables and conductors 1.18.5. Crimping tool 1.18.6. Conduits 1.18.7. Trunking 1.18.8. Consumables eg 1.18.8.1. Cable strippers 1.18.8.2. Pliers 1.18.8.3. Screw drivers 1.18.8.4. Hammers 1.18.8.5. Chisels 1.18.8.6. Allen keys 1.18.8.7. Electrician knives 1.18.8.8. Crimping tools 1.18.8.9. Bending springs 1.18.8.10. Steel tapes	• Observation • Oral questioning • Practical tests • Written tests

Learning Outcome	Content	Suggested Assessment Methods
	1.18.8.11. Draw wires 1.18.8.12. Hack saws 1.18.8.13. Drills 1.18.9. Equipment e.g. 1.18.9.1. Multimeters 1.18.9.2. Computer 1.18.10. Materials e.g. 1.18.10.1. Cables 1.18.10.2. Fittings 1.18.10.3. Accessories 1.19. Assemble tools, equipment and materials 1.20. Inventory management	
4. Mount electrical and electronic components	1.21. Meaning of terms 1.22. Components of control system eg 1.22.1. Sensors 1.22.2. Actuators 1.22.3. Limit switches 1.22.4. Push buttons 1.22.5. Logic gates 1.22.6. Microcontrollers 1.22.7. PLC 1.22.8. SCADA 1.22.9. Din rail 1.22.10. Control panels 1.22.11. Transmitters 1.22.12. Timers 1.22.13. Counters 1.22.14. VSDs 1.22.15. Contactors 1.22.16. Relays 1.23. Interpreting the control design 1.23.1. Design symbols 1.23.2. Terminations 1.23.3. Drawings 1.23.4. Types of enclosures	1. Written tests 2. Oral questioning 3. Practical tests 4. Observation

Learning Outcome	Content	Suggested Assessment Methods
5. Perform wiring of electrical and electronic components	1.24. Meaning of terms 1.25. Motor control circuits 1.25.1. Motor starters 1.25.2. Interlocking 1.26. Cable sizes, ratings, color coding and marking 1.27. Type of wiring systems e.g. 1.27.1. Surface wiring 1.27.2. Batten wiring 1.27.3. Conduit wiring 1.27.4. Concealed wiring 1.28. Types of cables e.g. 1.28.1. Armored cables 1.28.2. Twisted cables 1.28.3. Stranded cables 1.28.4. Shielded cables 1.28.5. Coaxial cables 1.29. IEE regulations	• Observation • Oral questioning • Practical tests • Written tests
6. Terminate system wiring	1.30. Meaning of terms 1.31. Factors determining type of termination 1.31.1. Voltage 1.31.2. Current 1.31.3. Overhead or underground 1.31.4. Outdoor or indoor 1.31.5. Type of connectors 1.32. Methods of wiring termination e.g. 1.32.1. Crimp connections 1.32.2. Soldered connections 1.32.3. Compression termination 1.32.4. Wire wrapping connection 1.32.5. Direct connection 1.32.6. Loop or eye connection 1.33. Cable joints 1.33.1. Types of cable joints e.g. 1.33.1.1. Straight through joint	• Oral questioning • Observation • Written tests • Practical tests

Learning Outcome	Content	Suggested Assessment Methods
	1.33.1.2. Y and T type joint 1.33.1.3. Pot end joints 1.33.1.4. Indoor and outdoor 1.34. OSHA regulations 1.35. IEE regulations	
7. Configure and test control system	1.36. Meaning of terms 1.37. Configuration of inputs and output 1.38. Test instruments 1.39. Visual inspection of the system 1.40. Types of tests on control system 1.40.1. Test for input supply 1.40.2. Short circuit tests 1.40.3. Open circuit tests 1.41. Safety during testing power supply system 1.42. IEE regulation 1.43. Use manufacturer's manuals in testing system components 1.44. Test running the machine control system	1. Oral questioning 2. Observation 3. Written tests 4. Practical tests
8. Commission the system and document installation report	1.45. User training 1.46. Preparation of system's standard operating procedures and manuals 1.47. Issuing of completion certificates 1.48. Preparation of installation reports 1.49. haring and documentation of installation reports 1.50. Commissioning of control system	1. Oral questioning 2. Observation 3. Written tests 4. Practical tests

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		5 pcs	1:5
14.	Synchronous Motors		5 pcs	1:5
15.	Single Phase motors		5 pcs	1:5
16.	Electric Generator		5 pcs	1:5
17.	DC motors		5 pcs	1:5
18.	Hacksaws		25 pcs	1:1
19.	Striping knives		25 pcs	1:1
20.	Side cutters		25 pcs	1:1
21.	Pliers		25 pcs	1:1
22.	Tape measure		25 pcs	1:1
23.	Try Square		25 pcs	1:1

24.	Spirit level		25 pcs	1:1
25.	Assorted Screw driver		25 pcs	1:1
26.	Assorted hammers		25 pcs	1:1
27.	Crimping tools		5 pcs	1:5
28.	PPEs		25 pcs	1:1
29.	Multimeters		5 pcs	1:5
30.	Clamp meters		5 pcs	1:5
31.	Earth resistance meter		5 pcs	1:5
32.	Stocks & Dies		5 pcs	1:5
33.	Vices		5 pcs	1:5
34.	Oscilloscope		5 pcs	1:5
35.	Pipe bending Machine		5 pcs	1:5
36.	Bending spring		5 pcs	1:5
37.	Drilling machines		5 pcs	1:5
38.	Work stations		25	1:1
39.	Installation boards		13 pcs	1:2

MODULE VI

RESEARCH METHODS

ISCED UNIT CODE: 0111 541 13A

TVET CDACC UNIT CODE: ENG/CU/ET/CC/03/6/MA

UNIT DURATION: 80 HOURS

Relationship to Occupational Standards

This unit addresses the Unit of Competency: Apply Research Methods

Unit Description

This unit covers the competencies required to apply research methods. Competencies include; identifying research problem, conducting literature review, developing research methodology, analyzing collected data and preparing research report.

Summary of Learning Outcomes

By the end of the unit the trainee should be able to:

S/NO	Learning Outcome	Duration (Hours)
9.	Identify research problem	10
10.	Conduct literature review	10
11.	Develop Research Methodology	20
12.	Analyse collected data	20
13.	Prepare research report	20
TOTAL		**80**

Learning Outcomes, Content and Suggested Assessment Methods

Learning Outcome	Content	Suggested Assessment Methods
1. Identify research problem	1.1 Methods of identifying research problem 1.2 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	• Practical • Demonstration • Projects • Written tests • Oral test
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	• Practical • Demonstration • Projects • Written tests • Oral test
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 3.4 Research proposal and budget preparation	• Practical • Demonstration • Projects • Written tests • Oral test

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 4.5.1 Data visualization tools 4.5.2 Presentation software	• Practical • Demonstration • Projects • Written tests • Oral test
5. Prepare research report	13.1 Discussion of research findings 13.2 Drawing of conclusions based on findings 13.3 Recommendations 13.4 Referencing systems 13.4.1 APA 13.4.2 MLA 13.4.3 Havard 13.4.4 IEEE 13.5 Appendices 13.6 Research report presentation	• Practical • Demonstration • Projects • Written tests • Oral test

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 and Dr. Meenu Mishra Pandey	5 pcs	1:5
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**			
1.	Lecture/theory room	60m^2	1	1:25
2.	Computer laboratory	100m^2	1	1:25
3.	Research Centre	100m^2	1	1:25
C	**Consumable materials**			
1.	Field research materials	Sampling supplies i.e. soil, bags, notebook, battery and fuel	25 pcs	1:1
2.	Social research materials	Surveys and questionnaires	25 pcs	1:1
3.	Laboratory research materials	Chemical reagents, glassware and plastic ware	25	1:5
D	**Tools and Equipment**			
1.	Assorted research and data collection tools and equipment	Camera, Digital storage device, computer,	25 pcs	1:1

ELECTRICAL PROJECT SUPERVISION

ISCED UNIT CODE: 0713 551 14A

TVET CDACC UNIT CODE: ENG/CU/ET/CC/04/6/MA

UNIT DURATION: 60 HOURS

Relationship to Occupational Standards

This unit addresses the unit of competency: Supervise Electrical Project

UNIT DESCRIPTION

This unit covers competences required to manage an electrical project. Competences include preparing work schedule, preparing safety work plan, leading project teams, supervising materials tools and equipment, monitoring project implementation and commissioning electrical project.

Summary of Learning Outcomes

By the end of the unit the trainee should be able to:

S/NO	Learning Outcome	Duration (Hours)
1.	Prepare work schedule	10
2.	Prepare safety work plan	10
3.	Lead project teams	10
4.	Supervise materials tools and equipment	10
5.	Monitor project implementation	10
6.	Commission electrical project	10
TOTAL		**60**

Learning Outcomes, Content and Suggested Assessment Methods

Learning Outcome	Content	Suggested Assessment Methods
1. Prepare work schedule	1.1 Determination of scope of work 1.1.1 Meaning of terms 1.1.2 Project work planning 1.1.3 Elements of project work planning 1.1.4 Factors to consider in project planning 1.1.5 Project objectives 1.1.6 Project lifecycle 1.2 Identification of project work resources 1.2.1 Finance 1.2.2 Personnel 1.2.3 Consultancy 1.2.4 Materials 1.2.5 Tools 1.2.6 Storage facilities 1.2.7 Buildings 1.3 Identification of project work tasks 1.3.1 Objectives 1.3.2 Activities 1.3.3 Timeframe 1.3.4 Performance indicators	• Practical demonstration • Projects • Written tests • Oral test

Learning Outcome	Content	Suggested Assessment Methods
	1.3.5 Resource required 1.3.6 Outputs 1.3.7 Resource allocation 1.4 Identification of project logistics 1.4.1 Budget 1.4.2 Finance 1.4.3 Resource loading and scheduling 1.4.4 Resource constrains and tradeoff 1.4.5 Resource monitoring and control 1.4.6 Progress reports 1.4.7 Transportation and delivery 1.5 Develop a project organization structure 1.5.1 Top management 1.5.2 Supervisors 1.5.3 Workers 1.5.4 Suppliers 1.5.5 Financiers 1.6 Develop project policies 1.6.1 Cost control policy 1.6.2 Communication policy	

Learning Outcome	Content	Suggested Assessment Methods
	1.6.3 Compliance and legal policy 1.6.4 Ethics and integrity policy 1.6.5 Risk management policy 1.6.6 Safety policy 1.6.7 Quality assurances policy 1.6.8 Environmental policy 1.6.9 Procurement and vender management policy 1.7 Determine project time span 1.7.1 Gantt charts 1.7.2 Work breakdown structure (WBS) 1.7.3 Network diagrams: critical path analysis, program evaluation and review technique (PERT) 1.7.4 Task sequencing 1.8 Project crashing	
2. Prepare safety work plan	2.1 Meaning of terms 2.2 Identification of risks are 2.2.1 Understanding risks in electrical projects 2.2.2 Operational risks 2.2.3 Short term strategic risks 2.2.4 Long term strategic risks 2.3 Conduct risk analysis 2.3.1 EHS Standards 2.3.2 SWOT analysis	• Practical demonstration • Projects • Written tests • Oral test

Learning Outcome	Content	Suggested Assessment Methods
	2.4 Determine risk mitigation plans 2.4.1 Design and technical risks mitigation 2.4.2 Procurement and supply chain mitigation 2.4.3 Operational risks mitigation 2.4.4 Safety risk mitigation 2.4.5 Regulatory and risk mitigation 2.4.6 Financial risk mitigation 2.4.7 Scheduling and time mitigation 2.4.8 Environmental risk mitigation 2.4.9 Communication risk mitigation 2.5 Continuous monitoring and review	
3. Lead project team	3.1 Identification of project team 3.1.1 Project manager 3.1.2 Lead engineer 3.1.3 Construction manager 3.1.4 Procurement manager 3.1.5 Quality control manager 3.2 Develop Job descriptions of the team 3.2.1 Recruitment of staff 3.2.2 Qualifications 3.2.3 Competencies 3.2.4 Experience 3.3 Communicate Objectives of the project 3.3.1 Project policy 3.3.2 Communication channels 3.3.3 Importance of objectives 3.4 Delegate the project activities 3.4.1 Performance contracts 3.4.2 Effective delegation	• Practical demonstration • Projects • Written tests • Oral test

Learning Outcome	Content	Suggested Assessment Methods
	3.4.3 Concept of authority, responsibility and accountability 3.4.4 Importance of delegations 3.4.5 Challenges 3.5 Adherence to OSHA and EHS 3.5.1 Monitoring and evaluation 3.5.2 Importance of safety and healthy practices 3.6 Training of project team 3.6.1 Types of trainings 3.6.2 Administrative trainings 3.6.3 Financial management 3.6.4 Communication 3.6.5 Safety 3.7 Direct teams on the expected output 3.7.1 Results oriented management (ROM) 3.8 Results agreement management (RAM)	
4. Supervise Materials, tools, and equipment.	4.1 Identification of tools, materials and equipment 4.1.1 Types of electrical tools, materials and equipment 4.1.2 Quality aspect 4.1.3 Condition of tools 4.2 Perform auditing of tools, materials and equipment 4.2.1 Audit criteria 4.2.2 Importance of auditing 4.2.3 Types of audits 4.2.4 Disposal Act 4.3 Develop tools, material and equipment inventory system 4.3.1 Resources 4.3.2 Types of inventory systems 4.3.3 Responsibility	• Practical demonstration • Projects • Written tests • Oral test

Learning Outcome	Content	Suggested Assessment Methods
	4.4 Classification of tools, materials and equipment 4.4.1 Types of classifications 4.4.2 Importance of tool classification 4.4.3 Responsibility 4.4.4 Functionality and operation 4.5 Maintenance of tools, materials and equipment 4.5.1 EHS standards 4.5.2 Maintenance schedules 4.5.3 Maintenance trainings 4.5.4 Importance of maintenance 4.5.5 Types of tools, equipment and material maintenance	
5. Monitor project implementation	5.1 Meaning of terms 5.2 Preparation of monitoring tools 5.2.1 Importance of monitoring 5.2.2 Types of monitoring 5.2.3 Schedules 5.2.4 Resources 5.2.5 Gantt charts 5.3 Monitoring project activities 5.3.1 Responsibilities 5.3.2 Schedules of monitoring 5.3.3 Reallocation of duties and resources 5.3.4 Report writing 5.4 Assessment of quality of work 5.4.1 Assessment methods 5.4.2 Lead person 5.4.3 Importance of quality assessment 5.4.4 Quality policy 5.4.5 Consultancy services 5.5 Planning for short range action 5.6 Evaluation of project progress	• Practical demonstration • Projects • Written tests • Oral test

Learning Outcome	Content	Suggested Assessment Methods
	5.7 Preparing monitoring reports	
6. Commission electrical project	6.1 Constitute a commissioning panel 6.1.1 Leaders and guests 6.2 Develop a program with requirements 6.2.1 Commissioning procedure 6.2.2 End-user training 6.2.3 Completion certificate 6.2.4 Handover documents 6.2.5 User manuals 6.2.6 Post commissioning support 6.3 Adherence to safety procedures 6.3.1 OSHA standards. 6.3.2 Conduct functionality tests 6.4 Preparation of documents 6.4.1 Issuance of certificates 6.4.2 Work commencement certificate 6.4.3 Test certificates 6.4.4 Inspection certificate 6.4.5 Completion certificate 6.5 Prepare report and share with relevant parties 6.5.1 Report writing 6.5.2 Organization procedures 6.6 Conduct end-user training 6.7 Project handover	• Practical demonstration • Projects • Written tests • Oral test

Suggested Methods of Instruction

1. Practical
2. Project

3. Demonstration
4. Direct instruction

List of Recommended Resources for 25 trainees

S/No.	Item	Specifications	Quantity	Recommended Ratio (Item: Trainee)
A	**Learning Materials**			
1.	Textbooks	R. Tricker Electrical project management B. Scaddan Electrical installation work J. Hyde Electrical Installation Principles and Practices	5 pcs	1:5
2.	Charts	Critical path Chart	1 pcs each	1:25
3.	Power point presentations	For trainer's use	1	1:25
B	**Learning Facilities & infrastructure**			
1.	Lecture/theory room	$60m^2$	1	1:25

INDUSTRIAL AUTOMATION

ISCED UNIT CODE: 0714 551 26A

UNIT CODE: ENG/CU/ET/CR/03/6/MA

DURATION OF UNIT: 200 HOURS

Relationship to Occupational Standards

This unit addresses the unit of competency: Perform industrial automation

Unit Description

This unit covers competencies required to perform industrial automation. Competencies includes; install industrial sensors and transducers, install automation components and hardware, install machine systems, install robots and robotic systems and install programming software

Summary of Learning Outcomes

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

S/NO	Learning Outcome	Duration (Hours)
1.	Install industrial sensors and transducers	30
2.	Install automation components and hardware	40
3.	Install machine systems	40
4.	Install robots and robotic systems	40
5.	Install programming software	50
TOTAL		**200**

Learning Outcomes, Content and Suggested Assessment Methods

Learning Outcome	Content	Suggested Assessment Methods
1. Install industrial sensors and transducers	1.1 Meaning of terms 1.2.1 Sensors 1.2.2 Transducers 1.2 Types of sensors and transducers e.g. 1.2.1 Resistance type 1.2.2 Inductance type	• Written tests • Oral questioning • Observation • Practical tests

Learning Outcome	Content	Suggested Assessment Methods
	1.2.3 Capacitance type 1.3 Classification of transducers 1.4 Types of actuators 1.2.1 Pneumatic actuators 1.2.2 Hydraulic actuators 1.2.3 Electric actuators 1.5 Meaning of signal conditioning 1.6 Processes in signal conditioning 1.7 Operational amplifiers 1.8 Applications of operational amplifiers 1.9 Filters 1.10 Attenuators 1.11 EHS standards 1.12 IEE regulations	
2. Install automation components and hardware	2.1 Meaning of terms 2.2 Controllers 2.2.1 Process modeling 2.2.2 Transfer functions 2.2.3 Open loop and closed loop controls 2.3 Applications of controllers 2.3.1 Proportional controllers 2.3.2 Integral controllers 2.3.3 PID controllers 2.3.4 Feedback and feed forward control 2.3.5 Cascade/selective control 2.4 Industrial computers 2.4.1 Industrial computer hardware and software 2.4.2 Memory and memory addressing 2.4.3 Signal conditioning 2.4.4 Computer interfacing 2.4.5 Computer networking 2.4.6 PLC and SCADA 2.4.7 Distributed Control Systems 2.4.8 Components of DCS	• Observation • Oral questioning • Practical tests • Written tests

Learning Outcome	Content	Suggested Assessment Methods
	2.4.9 DCS configuration 2.4.10 Application of DCS 2.5 Programmable Logic Controllers 2.5.1 Hardware 2.5.2 Internal architecture 2.5.3 Input/output devices and their applications 2.5.4 Number systems 2.5.5 PLC data 2.6 Input and output processing 2.6.1 Signal conditioning 2.6.2 Remote connections 2.6.3 Networks 2.6.4 Input/output addresses 2.7 Ladder and functioning block diagrams 2.7.1 Ladder diagrams 2.7.2 Logic functions 2.7.3 Latching 2.7.4 Multiple outputs 2.7.5 Entering programs 2.7.6 Function blocks 2.8 IL, SFC and ST programming methods 2.8.1 Instruction lists 2.8.2 Sequential function charts 2.8.3 Structured text 2.9 Internal relay 2.9.1 Ladder programs 2.9.2 Battery-backed relays 2.9.3 One-shot operation 2.9.4 Set and reset 2.9.5 Master control relay 2.10 Subroutine and interrupts 2.10.1 Subroutine 2.10.2 Interrupt 2.11Data handling	

Learning Outcome	Content	Suggested Assessment Methods
	2.11.1 Registers and bits 2.11.2 Shift registers 2.11.3 Flip flops 2.11.4 Ladder programs 2.11.5 Data handling 2.11.6 Arithmetic functions 2.11.7 Closed loop control 2.12Components 2.12.1 Timers 2.12.2 Counters 2.13Programs 2.13.1 Program development 2.13.2 Temperature control 2.13.3 Valve sequencing 2.13.4 Conveyor belt control 2.13.5 Control of a process 2.13.6 Human machine Interfaces 2.13.7 Programming human machine interfaces 2.14Encoders and resolvers 2.14.1 Application of encoders and resolvers 2.15Output devices 2.15.1 LED 2.15.2 LCD screen 2.15.3 Monitors 2.15.4 Buzzers 2.15.5 Pilot lights 2.15.6 Solenoid valves 2.16Barcodes, RFIDS, Inductive IDS 2.16.1 Types 2.16.2 Components 2.16.3 Application 2.17Power control devices eg 2.17.1 Power diodes 2.17.2 Thyristors 2.17.3 Diacs	

Learning Outcome	Content	Suggested Assessment Methods
	2.17.4 Triacs 2.17.5 Triodes 2.17.6 Transistors 2.17.7 Snubbers 2.18Wiring and termination of cables 2.19Distribution block 2.20Transformers in automation systems 2.20.1 Pulse transformer 2.20.2 Variable frequency transformer 2.20.3 Radio frequency transformer 2.20.4 Instrument transformer 2.20.5 Resolver and synchro transformer 2.20.6 Piezzoelectric transformer 2.20.7 Intermediate frequency transformer 2.21 Power supply 2.21.1 Components 2.21.2 Applications 2.22Motors 2.22.1 Servomotors and stepper motors 2.22.2 Variable frequency drives 2.22.3 Servomechanisms 2.22.4 Types of servomechanisms 2.23Enclosures 2.23.1 Types of enclosures 2.24Insulation classes 2.25IEE regulations 2.26OSHA regulations 2.27NEMA regulations	
3. Install machine systems	3.1 Meaning of terms 3.2 Conveyors 3.2.1 Types of conveyors eg 3.2.2 Belt conveyor	1 Oral questioning 2 Practical tests 3 Observation 4 Written tests

Learning Outcome	Content	Suggested Assessment Methods
	3.2.3 Roller conveyors 3.2.4 Chain and mat conveyors 3.2.5 Rubber conveyors 3.2.6 Vibrating conveyors 3.2.7 Pneumatic conveyors 3.2.8 Conveyor accessories 3.3 Indexers and synchronous machines 3.3.1 Rotary cam indexers 3.3.2 Synchronous chassis pallet 3.3.3 Walking beams 3.3.4 Pick and place 3.4 Part feeders 3.4.1 Vibratory bowls and feeders 3.4.2 Step and rotary feeders 3.4.3 Escapements and parts handling	
4. Install robots and robotic systems	4.1 Meaning of terms 4.2 Components of a robot 4.3 Robot configuration 4.3.1 Articulated robots 4.3.2 Selective Compliant Assembly Robot Arm (SCARA robots) 4.3.3 Cartesian Robots 4.4 Parallel robots 4.5 Robot coordinate systems	1 Oral questioning 2 Practical tests 3 Observation 4 Written tests
5. Install programming software	5.1 Meaning of terms 5.2 PLC software brands eg Siemens 5.2.1 ABB 5.2.2 Schneider 5.2.3 Allen-Bradley 5.2.4 Rockwell 5.2.5 Berckoff 5.2.6 Mitsubishi 5.2.7 Omron	1 Practical tests 2 Oral questioning 3 Observation 4 Written tests

Learning Outcome	Content	Suggested Assessment Methods
	5.3 Programming concepts 5.4 Programming methodologies 5.5 Programming languages 5.6 Programming PLC, DCS, embedded systems, robot controller 5.7 Factors to consider in program development 5.8 Piping and instrumentation diagrams 5.9 Use of CAD in developing piping and instrumentation diagrams 5.10 Analysis softwares eg 5.10.1 Matlab 5.10.2 Labview 5.10.3 Multisim 5.11 Supervisory Control and data acquisition (SCADA)	

Suggested Methods of Instruction

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

Recommended Resources for 25 trainees

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

1.	Textbooks	S.K.B Pearson Control Systems Theory and Application. Fundamentals of automation and industrial control systems by Ayman Aly El Naggar. Fundamentals of Industrial Automation by Dobrivojie Popovic and Vijay P.	5 pcs	1:5
2.	Installation manuals	Electrical machine manuals Siemens PLC manual	5 pcs	1:5
3.	Charts	Single line diagram Motor starting circuits Circuit diagrams Colour codes	1 pcs for each	1:25
4.	Software	PLC SCADA Arduino IDEC language		
5.	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
C	**Consumable materials**			
1.	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
2.	Cables	USB, Ethernet, UART, 4-20mA current loop cable	5 pcs	1:5
3.	Insulation tapes		25 pcs	1:1
4.	Accessories	Sensors, Actuators, Limit switches, Push buttons, Timers, Relays, input/output modules, keyboard	25 pcs	1:1
5.	Pipes and trunkings	PVC conduits, Mini trunking	25 pcs	1:1
D	**Tools and Equipment**			
1.	PLC module		5	1:5
2.	Microcontroller tool kit		5	1:5

3.	Hacksaws		25 pcs	1:1
4.	Striping knives		25 pcs	1:1
5.	Side cutters		25 pcs	1:1
6.	Pliers		25 pcs	1:1
7.	Tape measure		25 pcs	1:1
8.	Try Square		25 pcs	1:1
9.	Spirit level		25 pcs	1:1
10.	Assorted Screw driver		25 pcs	1:1
11.	Assorted hammers		25 pcs	1:1
12.	Crimping tools		5 pcs	1:5
13.	PPEs		25 pcs	1:1
14.	Multimeter		5 pcs	1:5
15.	Clamp meters		5 pcs	1:5
16.	Earth resistance meter		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

AUTOMATION AND RADIO FREQUENCY SYSTEMS MAINTENANCE

ISCED UNIT CODE: 0714 551 26A

UNIT CODE: ENG/CU/ET/CR/04/6/MA

DURATION OF UNIT: 140 HOURS

Relationship to Occupational Standards

This unit addresses the unit of competency: Maintain automation and radio frequency systems

Unit Description

This unit covers competencies required to perform automation and radio frequency systems maintenance. Competencies includes: preparing maintenance schedule, inspecting and testing automation and radio frequency system, equipment and materials, performing maintenance activities, conducting tests on maintained system and documenting maintenance records

Summary of Learning Outcomes

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

S/NO	Learning Outcome	Duration (Hours)
1.	Prepare maintenance schedule	10
2.	Inspect and test automation and radio frequency system	20
3.	Prepare a list of maintenance tools, equipment and materials	10
4.	Perform maintenance activities	50
5.	Conduct system tests	30
6.	Document maintenance records	20
TOTAL		**140**

Learning Outcomes, Content and Suggested Assessment Methods

Learning Outcome	Content	Suggested Assessment Methods
1. Prepare maintenance schedule	1.1 Maintenance Concepts 1.1.1 Definition of maintenance 1.1.2 Importance of scheduling 1.2 Maintenance Types 1.4.1 Periodic service procedures 1.4.2 Preventive maintenance strategies 1.4.3 Breakdown response protocols 1.3 Documentation 1.2.1 Maintenance checklist components 1.2.2 Work plan structure 1.2.3 Service manual interpretation 1.4 Personnel 1.3.1 Roles and responsibilities 1.3.2 Qualification requirements	• Written tests • Oral questioning • Practical tests • Observation
2. Inspect and test automation and radio frequency system	2.1 RF Components 2.1.1 Active components 2.2.1.1 Transmitter 2.2.1.2 Receivers 2.2.1.3 Antenna 2.2.1.4 Modulators and demodulators 2.2.1.5 Radio frequency amplifiers 2.2.1.6 Oscillators 2.2.1.7 Mixers 2.2.1.8 Data converters 2.2.1.9 Phase locked looped circuit 2.2.1.10 RF transistor amplifiers 2.2.1.11 Noise and noise figures 2.1.2 Passive components 2.2.2.1 Resistors 2.2.2.2 Capacitors 2.2.2.3 Inductors 2.2.2.4 Crystals 2.2.2.5 Transformers 2.2 Automation Components 2.2.1 Sensors 2.2.2 Transducers	• Observation • Oral questioning • Written tests

	2.2.3 Actuators 2.2.4 Attenuators 2.2.5 Operational amplifiers 2.2.6 Controllers 2.2.7 PLC 2.2.8 Industrial computers 2.3 Automation system isolation points e.g. 2.3.1 Circuit breakers 2.3.2 Fuses 2.3.3 Isolators 2.4 Fault Analysis 2.4.1 Short circuit characteristics 2.4.2 Open circuit identification 2.4.3 Grounding fault symptoms 2.5 Testing Procedures 2.5.1 Continuity testing methods 2.5.2 Signal integrity verification 2.5.3 Isolation point checks 2.6 Recording test findings	
3. Perform maintenance activities	3.1 Component Service 3.1.1 Disassembly techniques 3.1.2 Cleaning procedures 3.1.3 Reassembly protocols 3.2 Repair Methods 3.2.1 Through-hole component replacement 3.2.2 Surface-mount device handling 3.2.3 Connector refurbishment 3.3 Connector Refurbishment 3.3.1 SMA/BNC contact polishing techniques 3.3.2 Insertion loss measurement after service 3.3.3 Thread engagement verification 3.4 Waste Management 3.4.1 PCB disposal methods 3.4.2 Battery recycling 3.4.3 Compliance with OSHA/EHS	• Observation • Oral questioning • Practical tests • Written tests
4. Conduct system tests	4.1 Test Types 4.1.1 Continuity verification 4.1.2 Power output measurement 4.1.3 Frequency stability checks	• Observation • Oral questioning • Practical tests

	4.2 Procedures 4.2.1 Safe test initiation 4.2.2 Result recording format 4.2.3 System recertification 4.3 Compliance 4.3.1 IEEE standards application 4.3.2 Power quality parameters 4.3.3 Spectral density analysis	• Written tests
5. Document maintenance records	5.1 Report Writing 5.1.1 Required sections 5.1.2 Technical terminology 5.1.3 Findings presentation 5.2 Documentation Types 5.2.1 Maintenance logs 5.2.2 Replacement recordS 5.2.3 Performance trends 5.3 Quality Systems 5.3.1 Non-conformance reporting 5.3.2 Version control 5.3.3 Stakeholder distribution	• Observation • Oral questioning • Practical tests • Written tests

Suggested Methods of Instruction

- Practical
- Project
- Demonstration
- Direct instruction
- Group Discussion

Recommended Resources for 25 trainees

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

6.	Textbooks	S.K.B Pearson Control Systems Theory and Application. Fundamentals of automation and industrial control systems by Ayman Aly El Naggar. Fundamentals of Industrial Automation by Dobrivojie Popovic and Vijay P.	5 pcs	1:5
7.	Installation manuals	Electrical machine manuals Siemens PLC manual	5 pcs	1:5
8.	Charts	Single line diagram Motor starting circuits Circuit diagrams Colour codes	1 pcs for each	1:25
9.	Software	PLC SCADA Arduino IDEC language		
10.	Power point presentations	For trainer's use	1	1:25
B	**Learning Facilities & infrastructure**			

3.	Lecture/theory room	$60m^2$	1	1:25
4.	Workshop	$150m^2$	1	1:25
C	**Consumable materials**			
6.	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
7.	Cables	USB, Ethernet, UART, 4-20mA current loop cable	5 pcs	1:5
8.	Insulation tapes		25 pcs	1:1
9.	Accessories	Sensors, Actuators, Limit switches, Push buttons, Timers, Relays, input/output modules, keyboard	25 pcs	1:1
10.	Pipes and trunkings	PVC conduits, Mini trunking	25 pcs	1:1
D	**Tools and Equipment**			
21.	PLC module		5	1:5
22.	Microcontroller tool kit		5	1:5

23.	Hacksaws		25 pcs	1:1
24.	Striping knives		25 pcs	1:1
25.	Side cutters		25 pcs	1:1
26.	Pliers		25 pcs	1:1
27.	Tape measure		25 pcs	1:1
28.	Try Square		25 pcs	1:1
29.	Spirit level		25 pcs	1:1
30.	Assorted Screw driver		25 pcs	1:1
31.	Assorted hammers		25 pcs	1:1
32.	Crimping tools		5 pcs	1:5
33.	PPEs		25 pcs	1:1
34.	Multimeter		5 pcs	1:5
35.	Clamp meters		5 pcs	1:5
36.	Earth resistance meter		5 pcs	1:5
37.	Bending spring		5 pcs	1:5
38.	Drilling machines		5 pcs	1:5
39.	Work stations		25	1:1
40.	Installation boards		13 pcs	1:2