

CORE UNITS
ELECTRICAL SYSTEMS AUTOMATION

ISCED UNIT CODE: 0714 551 36A

TVET CDACC UNIT CODE: ENG/CU/EI/CR/02/6/MA

UNIT DURATION: 160 HOURS

Relationship to Occupational Standards

This unit addresses the unit of competency: Automate Electrical systems

Unit Description

This unit covers competences required in automating electrical systems. Competences include; designing automation system, installing automation components, programming automation system, commissioning automation system, monitoring automation system and maintaining automation system.

Summary of Learning Outcomes

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

S/NO	Learning Outcome	Duration (Hours)
1.	Design automation system	20
2.	Install automation components	40
3.	Program automation system	50
4.	Commission Automation System	20
5.	Monitor automation system	10
6.	Maintain automation system	10
TOTAL		160

Learning Outcomes, Content and Suggested Assessment Methods

Learning Outcome	Content	Suggested Assessment Methods

Learning Outcome	Content	Suggested Assessment Methods
1. Design Automation system	1.1 Identifying the need for automation 1.1.1 Meaning of Automation system 1.1.2 Factors considered in choosing automation 1.1.3 Factors to consider in designing automation system 1.2 System analysis conducted 1.2.1 Functionality assessment 1.2.2 Methodology of system analysis 1.2.3 Determining set parameters e.g. performance criteria, constrains and expected outcomes 1.2.4 Recording of findings 1.3 Determining automation technology. 1.3.1 Types of automation technologies 1.3.1.1 PLC 1.3.1.2 Microcontroller 1.3.1.3 SCADA systems 1.3.1.4 Human Machine Interface 1.4 Developing system design plan 1.4.1 Types of system designs 1.4.2 Procedures of developing system plans 1.4.3 Tools 1.4.4 Drawings 1.5 Carry out Modelling, simulation and prototyping 1.5.1 Developing automation models and prototypes 1.5.2 Prototyping techniques 1.5.3 Conduct simulations 1.6 Preparation of BOQ 1.6.1 Understanding BOQ 1.7 Quantities and cost of materials	• Practical • Projects • Third party report • Portfolio of evidence • Written tests • Oral questioning

Learning Outcome	Content	Suggested Assessment Methods
2. Install automation components	2.1 Safety procedures for installing automation components and systems 2.1.1 Relevant clauses in appropriate Acts e.g. WIBA 2.1.2 Environment management and coordination Act (EMCA) 2.1.3 Relevant regulations: 2.1.4 IET regulations 2.1.5 Causes of accidents 2.1.6 Types of PPE handling, use, maintenance and storage of different types of PPE 2.1.7 Classes of fires and firefighting equipment 2.1.8 First aid procedures 2.2 Assembling tools, materials and equipment 2.2.1 Tools e.g. 2.2.1.1 Cable strippers 2.2.1.2 Pliers 2.2.1.3 Screw drivers 2.2.1.4 Hammers 2.2.1.5 Chisels 2.2.1.6 Electrician knives 2.2.1.7 Crimping tools 2.2.1.8 Bending springs 2.2.1.9 Steel tapes 2.2.1.10 Hack saws 2.2.1.11 Drills 2.2.2 Equipment e.g. 2.2.2.1 Stock and die 2.2.2.2 Vice 2.3 Materials e.g. 2.3.1 PCB 2.3.2 Breadboards 2.3.3 Networking cables 2.4 Installation of conduits, trunks, enclosures and support systems 2.4.1 IET regulations 2.4.2 Automation layout 2.4.3 Laying of cable routes	• Practical • Projects • Third party report • Portfolio of evidence • Written tests • Oral questioning

Learning Outcome	Content	Suggested Assessment Methods
	2.5 Installation of automation components 2.5.1 IET regulations on automation 2.5.2 Industrial sensors 2.5.3 Types of actuators 2.5.4 Machines starters 2.5.5 PLC 2.5.6 Microcontroller 2.5.7 Scada systems 2.5.8 Human Machine Interface 2.6 Installing cables and conductors 2.6.1 Types of cables 2.6.2 Cable sizes 2.6.3 Right choice of cables 2.7 Cable lugging, glanding and termination 2.7.1 Meaning of terminologies 2.7.2 Types of cable joints, cable lugs 2.8 Cable labelling 2.8.1 Cables are labelled as per IET standards. 2.9 Performing Electrical Tests 2.9.1 IET regulations 2.9.2 Continuity tests 2.9.3 Insulation resistance test 2.10 Polarity test	
3. Program automation system	3.1 Meaning of programming in automation 3.2 Developing PLC programs 3.2.1 Types of PLC programming languages 3.2.1.1 Ladder diagram 3.2.1.2 Instruction List 3.2.1.3 Functional Block diagram 3.3 Developing Microcontroller programs 3.3.1 Types of programming languages 3.3.1.1 C/C++	• Practical • Projects • Third party report • Portfolio of evidence • Written tests • Oral questioning

Learning Outcome	Content	Suggested Assessment Methods
	3.3.1.2 Python 3.4 Configuration of components and their parameters 3.5 Testing and debugging of the program 3.6 Uploading program to automation systems. 3.6.1 Procedure of uploading and downloading 3.7 Configuring control parameters of automation system	
4. Commission automation system	4.1 Conducting unit test 4.1.1 Meaning of unit test 4.1.2 Regulations/standards - OEMS, IEE and KEBS standards. 4.1.3 Testing parameters 4.1.4 Procedure of unit testing 4.2 Conducting functional tests 4.2.1 Meaning of functional test 4.2.2 Testing parameters 4.2.3 Procedure of functional testing 4.3 Conducting system integration tests 4.3.1 Meaning of system integration tests 4.3.2 Regulations/standards - OEMS. 4.3.3 Testing parameters 4.3.4 Procedure of testing 4.4 Maintaining documentation 4.4.1 Purpose of documentation 4.4.2 Types of documentation 4.5 Conducting end user training 4.6 Conducting final inspection and validation 4.6.1 Safety standards relating to final inspection and validation. 4.6.2 Regulation requirements 4.6.3 Checklist relating to final inspection	• Practical • Projects • Third party report • Portfolio of evidence • Written tests • Oral questioning

Learning Outcome	Content	Suggested Assessment Methods
	4.7 Handing over automation system to the end user 4.7.1 Handover documentation 4.7.2 Final acceptance	
5. Monitor automation system	5.1 Monitoring and diagnostic tools 5.1.1 Meaning 5.1.2 Purpose 5.1.3 Developing monitoring and diagnostic tools 5.1.4 Types of monitoring and diagnostic tools eg. 5.1.4.1 HMI 5.1.4.2 Data logger 5.1.4.3 SCADA 5.2 Integrating monitoring and diagnostic tools 5.2.1 Methods of integration 5.2.2 Procedure of integrating 5.3 Extracting data from monitoring tools 5.3.1 Data types 5.3.2 Data extraction Techniques 5.3.3 Procedure of data extraction 5.4 Storing data 5.4.1 Data loggers 5.4.2 Storage systems 5.4.3 Data security 5.5 Analysing data 5.5.1 Analysis techniques 5.5.2 Key Performance Indicators	• Practical • Projects • Third party report • Portfolio of evidence • Written tests • Oral questioning

Learning Outcome	Content	Suggested Assessment Methods
	5.5.3 Data analysis tools 5.6 Carrying out System optimization 5.6.1 Identify optimization areas 5.6.2 Optimization strategies 5.6.3 Application of optimization strategies	
6. Maintain automation system	6.1 Preparing maintenance schedule 6.1.1 Types of maintenance 6.1.2 Maintenance schedule 6.2 Preparing system maintenance check list 6.3 Selection of maintenance tools and equipment 6.4 Carrying out inspection and tests 6.5 Diagnosing faults 6.5.1 Types of faults in automation system 6.5.2 Procedure of fault diagnosis 6.6 Rectifying faults 6.6.1 Repair activities 6.6.2 Replacement 6.7 Preparing maintenance report	• Practical • Projects • Third party report • Portfolio of evidence • Written tests • Oral questioning

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			
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 Dobrivojic 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 IDE language		
5.	Power point	For trainer's use	1	1:25

	presentations			
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