MINISTRY OF EDUCATION AND SPORTS

UGANDA BUSINESS AND TECHNICAL EXAMINATIONS BOARD

MODULAR ASSESSMENT SYLLABUS FOR NATIONAL CERTIFICATE IN ELECTRICAL INSTALLATION SYSTEMS AND MAINTENANCE (NCES)

2022

TABLE OF CONTENTS

TABLE OF CONTENTS 2
PROGRAMME OVERVIEW 3
MODULARIZATION OF ASSESSMENT 3
CORE MODULES AND THEIR EXPECTED OUTCOME 4
SUPPORT MODULES 4
MODULE STRUCTURE FOR NATIONAL CERTIFICATE IN ELECTRICAL INSTALLATION SYSTEMS AND MAINTENANCE 5
NCES FINAL ASSESSMENT PAPER FORMAT 7
CORE MODULES DETAILS 13
CORE MODULE NAME: DOMESTIC ELECTRICAL INSTALLATION, MAINTENANCE AND REPAIR 13
CORE MODULE NAME: SOLAR PV SYSTEMS INSTALLATION, MAINTENANCE AND REPAI 23
CORE MODULE NAME: GENERATORS INSTALLATION, MAINTENANCE AND REPAIR 32
CORE MODULE NAME: ELECTRICAL MOTORS INSTALLATION, MAINTENANCE AND REPAIR 49
SUPPORT MODULES DETAILS 58
SUPPORT MODULE: NCES 101-ELECTRICAL INSTALLATION SCIENCE 58
SUPPORT MODULE: NCES 102-ELECTRICAL SUPPLY AND INSTALLATION 64
SUPPORT MODULE: NCES 201-ELECTRICAL MACHINES AND BASIC ELECTRONICS 69

PROGRAMME OVERVIEW

This Modular Assessment Guide has been prepared to guide training institutions preparing trainees for Uganda Business and Technical Examinations Board (UBTEB) assessment and the industry.

The Syllabus for National Certificate in Electrical Installation Systems and Maintenance has been divided into core modules and support modules to develop the guide. The core modules are flexible to allow free entry and exit of learners to the world of work after attaining employable skills.

Each Core module is independent but emphasising competences and the trainee has a choice to pick which to start with; putting into account the available resources and time they have to complete the training.

At the end of each core module, the trainee who successfully completes the training is given a competence certificate in that particular core module. But those who successfully complete all the modules will be awarded with a National Certificate in Electrical Installation Systems and Maintenance.

MODULARIZATION OF ASSESSMENT

The modularization of assessment is intended to bring together a particular set of skills and competencies that can lead to an occupation or job as a complete package. The completion of such packages by the trainee leads to a certificate of competence in that particular module. It is the trainee's responsibility to pursue additional training or to enter the workforce for any gainful employment. This will help the trainees to compile their learning achievements, and those that may not be able to undertake the entire training can join the world of work and come back later when they need more sets of skills. The trainee will be given a complete certificate on completion of all the packages under that certificate. This will also help in the recognition of prior learning for those who join the training with some experience.

In addition, the modularization of assessment is meant to integrate other skills like entrepreneurship, communication, computer skills, and work ethics through a typical work process, which can lead to the production of a holistically trained graduate who can perform to the required standard in the world of work.

CORE MODULES AND THEIR EXPECTED OUTCOME

Sn	Module	Expected Outcome	Award
1)	Domestic Electrical Installation, Maintenance, and Repair	Install, maintain, and repair domestic electrical installations	Certificate of Competence in Domestic Electrical Installation, Maintenance, and Repair
2)	Solar PV Systems Installation, Maintenance and Repair	Install, maintain, and repair solar PV systems.	Certificate of Competence in Solar PV Systems Installation, Maintenance, and Repair
3)	Generators Installation, Maintenance, and Repair	Install, maintain, and repair generators	Certificate of Competence in Generator Installation, Maintenance, and Repair
4)	Electrical Motors Installation, Maintenance and Repair	Install, maintain, and repair electrical motors	Certificate of Competence in Electrical Motors Installation, Maintenance and Repair

SUPPORT MODULES

Sn	Module Code	Module Name	Assessment Series
1)	NCES 101	Electrical Installation Science	Year 1 July-August
2)	NCES 102	Electrical Supply and Installation	Year 1 July-August
3)	TCCS 101	Life Skills	Year 1 December-December
4)	TCCA 101	Computer Applications	Year 1 December-December
5)	TCTM 101	Applied Technician Mathematics I	Year 1 December-December
6)	TCES102	Engineering Drawing	Year 1 December-December
7)	NCES 201	Electrical Machines and Basic Electronics	Year 2 July-August
8)	TCTM 201	Applied Technician Mathematics II	Year 2 December-December
9)	TCBE 201	Entrepreneurship Skills	Year 2 December-December
10)	TCCS 201	Basic Kiswahili	Year 2 December-December

MODULE STRUCTURE FOR NATIONAL CERTIFICATE IN ELECTRICAL INSTALLATION SYSTEMS AND MAINTENANCE

YEAR	Code	Module Title	No. of Weeks	Hours per Week	L	P	CH	CU
ONE	NCES111	Domestic Electrical Installation, Maintenance and Repair Theory	15	4	0	60	60	4
	NCES112	Domestic Electrical Installation, Maintenance and Repair Practice	15	6	0	90	45	3
	NCES113	Domestic Electrical Installation, Maintenance and Repair Real Life Project	15	6	0	90	45	3
	NCES114	Domestic Electrical Installation, Maintenance and Repair Industrial Training	6	40	0	240	30	2
	NCES 101	Electrical Installation Science	15	4	0	60	60	4
	NCES 102	Electrical Supply and Installation	15	4	0	60	60	4
	NCES121	Solar PV Systems Installation, Maintenance and Repair Theory	15	4	0	60	60	4
	NCES122	Solar PV Systems Installation, Maintenance and Repair Practice	15	6	0	90	45	3
	NCES123	Solar PV Systems Installation, Maintenance and Repair Real Life Project	15	6	0	90	45	3
	NCES124	Solar PV Systems Installation, Maintenance and Repair Industrial Training	6	40	0	240	30	2
	TCCS101	Life Skills	30	2	60	0	60	4
	TCCA101	Computer Applications	30	2	60	0	60	4
	TCTM101	Applied Technician Mathematics I	30	2	60	0	60	4
	TCES102	Engineering Drawing	30	2	60	0	60	4
TWO	NCES 201	Electrical Machines and Basic Electronics	15	4	60	0	60	4
	NCES211	Generators Installation, Maintenance and Repair Theory	15	4	0	60	60	4
	NCES212	Generators Installation, Maintenance and Repair Practice	15	6	0	90	45	3
	NCES213	Generators Installation, Maintenance and Repair Real Life Project	15	6	0	90	45	3
	NCES214	Generators Installation, Maintenance and Repair Industrial Training	6	40	0	240	30	2
	NCES221	Electrical Motors Installation, Maintenance and Repair Theory	15	4	0	60	60	4
	NCES222	Electrical Motors Installation, Maintenance and Repair Practice	15	6	0	90	45	3
	NCES223	Electrical Motors Installation, Maintenance and Repair Real Life Project	15	6	0	90	45	3
	NCES224	Electrical Motors Installation, Maintenance and Repair Industrial Training	6	40	0	240	30	2
	TCTM201	Applied Technician Mathematics II	30	2	60	0	60	4

YEAR	Code	Module Title	No. of Weeks	Hours per Week	L	P	CH	CU
	TCBE201	Entrepreneurship Skills	30	2	60	0	60	4
	TCCS201	Basic Kiswahili	30	2	60	0	60	4
	Total						**1320**	**88**

NCES FINAL ASSESSMENT PAPER FORMAT

Year 1 June-July Assessment Series	
Paper Name and Code	**Assessment Format**
NCES111 Domestic Electrical Installation, Maintenance and Repair Theory	Each paper shall consist of eight questions, each carrying 20 marks, and the trainee shall answer five questions. The questioning techniques to be applied should seek to assess the trainee's ability to comprehend, apply, analyze, synthesize, and evaluate conditions. The assessment will last three hours in total.
NCES112 Domestic Electrical Installation, Maintenance and Repair Practice	Each paper shall consist of one compulsory practical question carrying 100 marks, and it shall be marked on the spot. UBTEB will send an external assessor to assess the trainees as they progress with the assessments. The questioning techniques to be applied should seek the trainee's ability to demonstrate and apply the practical skills acquired during the training. UBTEB will send the cutting list of items needed for practical preparation to the institutions two weeks before the assessment date. The examination will last six hours in total.
NCES113 Domestic Electrical Installation, Maintenance and Repair Real Life Project	The paper shall consist of continuous assessment marks. UBTEB shall verify the authenticity of the awarded marks from the completed projects on the ground and trainees' participation through presentations. The tasks to be performed should seek to test learners' abilities to comprehend, apply, analyze, synthesize, and evaluate conditions. The trainees are expected to: • Prepare and interpret drawings. • Plan the execution of the job. • Prepare bills of quantities. • Carry out actual installation, maintenance, and repair. • Carry out the work according to IEE regulations. The total duration of the assessment will be 90 practical hours.
NCES114 Domestic Electrical Installation, Maintenance and Repair Industrial Training	Industrial Training shall be assessed out of 100 marks and will be carried out at the end of year one The module will be assessed as shown below: Requirements Contribution Attendance 10% Work performance involvement 25% Initiative and innovation 10% Time management 10% Discipline and safety 10% Practical skills 20% Written report 15%

	Total 100% The total duration of the industrial training shall be six (**6**) weeks
NCES101 Electrical Installation Science	Each paper shall consist of eight questions, each carrying 20 marks, and the trainee shall answer five questions. The questioning techniques to be applied should seek to assess the trainee's ability to comprehend, apply, analyze, synthesize, and evaluate conditions. The assessment will last three hours in total.
NCES102 Electrical Supply and Installation	Each paper shall consist of eight questions, each carrying 20 marks, and the trainee shall answer five questions. The questioning techniques to be applied should seek to assess the trainee's ability to comprehend, apply, analyze, synthesize, and evaluate conditions. The assessment will last three hours in total.
Year 1 November-December Assessment Series	
Paper Name and Code	**Assessment Format**
NCES121 Solar PV Systems Installation, Maintenance and Repair Theory	Each paper shall consist of eight questions, each carrying 20 marks, and the trainee shall answer five questions. The questioning techniques to be applied should seek to assess the trainee's ability to comprehend, apply, analyze, synthesize, and evaluate conditions. The assessment will last three hours in total.
TCCS101 Life Skills TCTM101 Applied Technician Mathematics I	Each paper shall consist of eight questions, each carrying 20 marks, and the trainee shall answer five questions. The questioning techniques to be applied should seek to assess the trainee's ability to comprehend, apply, analyze, synthesize, and evaluate conditions. The assessment will last three hours in total.
NCES122 Solar PV Systems Installation, Maintenance and Repair Practice	Each paper shall consist of one compulsory practical question carrying 100 marks, and it shall be marked on the spot. UBTEB will send an external assessor to assess the trainees as they progress with the assessments. The questioning techniques to be applied should seek the trainee's ability to demonstrate and apply the practical skills acquired during the training. UBTEB will send the cutting list of items needed for practical preparation to the institutions two weeks before the assessment date. The examination will last six hours in total.
NCES123 Solar PV Systems Installation, Maintenance and Repair Real Life Project	The paper shall consist of continuous assessment marks. The real-life project should be solar PV system installation, maintenance, and repair OR commercial battery charger design and construction. UBTEB shall verify the authenticity of the awarded marks from the completed projects on the ground and trainees' participation through presentations. The tasks to be performed should seek to test the trainees' abilities to comprehend, apply, analyze, synthesize, and evaluate conditions. The trainees are expected to: • Prepare and interpret drawings. • Plan the execution of the job.

	• Prepare bills of quantities. • Carry out actual installation, maintenance, and repair. • Carry out the work in according to IEE regulations. The total duration of the Assessment shall be **90** practical hours.
NCES124 Solar PV Systems Installation, Maintenance and Repair Industrial Training	Industrial Training shall be assessed out of 100 marks and will be carried out at the end of year one. The module will be assessed as shown below: Requirements — Contribution Attendance — 10% Work performance involvement — 25% Initiative and innovation — 10% Time management — 10% Discipline and safety — 10% Practical skills — 20% Written report — 15% Total — 100% The total duration of the industrial training shall be six (**6**) weeks
TCCA101 Computer Applications	The paper will consist of three practical questions, each carrying 50 marks. A candidate will be required to answer any two questions. A printout of the practical outputs, together with soft copies of all files used, will be sent to the assessing body. This practical assessment will last for two hours.
TCES102: Engineering Drawing	The paper shall consist of six questions, and the candidate will be required to answer any four of them. All questions will carry equal marks. The questioning techniques to be applied should seek to determine the candidate's ability to remember, comprehend, apply, analyze, synthesize, and evaluate conditions. The duration will be three hours.
Year 2 June-July Assessment Series	
Paper Name and Code	**Assessment Format**
NCES211 Generators Installation, Maintenance and Repair Theory	Each paper shall consist of eight questions, each carrying 20 marks, and the trainee shall answer five questions. The questioning techniques to be applied should seek to assess the trainee's ability to comprehend, apply, analyze, synthesize, and evaluate conditions. The assessment will last three hours in total.
NCES212 Generators Installation, Maintenance and Repair Practice	Each paper shall consist of one compulsory practical question carrying 100 marks, and it shall be marked on the spot. UBTEB will send an external assessor to assess the trainees as they progress with the assessments. The

	questioning techniques to be applied should seek the trainee's ability to demonstrate and apply the practical skills acquired during the training. UBTEB will send the cutting list of items needed for practical preparation to the institutions two weeks before the assessment date. The examination will last six hours in total.
NCES213 Generators Installation, Maintenance and Repair Real Life Project	The paper shall consist of continuous assessment marks. The selected real-life project should be either generator installation, maintenance, or repair OR welding machine design and construction. UBTEB shall verify the authenticity of the awarded marks from the completed projects on the ground and trainees' participation through presentations. The tasks to be performed should seek to test learners' abilities to comprehend, apply, analyze, synthesize, and evaluate conditions. The trainees are expected to: • Prepare and interpret drawings. • Plan the execution of the job. • Prepare bills of quantities. • Carry out actual installation, maintenance, and repair. • Carry out the work according to IEE regulations. The total duration of the assessment will be 90 practical hours.
NCES214 Generators Installation, Maintenance and Repair Industrial Training	Industrial Training shall be assessed out of 100 marks and will be carried out at the end of year one The module will be assessed as shown below: Requirements Contribution Attendance 10% Work performance involvement 25% Initiative and innovation 10% Time management 10% Discipline and safety 10% Practical skills 20% Written report 15% Total 100% The total duration of the industrial training shall be six (6) weeks
NCES201 Electrical Machines and Basic Electronics	This paper shall consist of eight questions in two sections, A (Electrical Machines) and B (Basic Electronics), each carrying 20 marks, and the trainee shall be required to answer at least two questions from each section. The

	questioning techniques to be applied should seek to assess the trainee's ability to comprehend, apply, analyze, synthesize, and evaluate conditions. The assessment will last three hours in total.
Year 2 November-December Assessment Series	
Paper Name and Code	**Assessment Format**
NCES221 Electrical Motors Installation, Maintenance and Repair Theory	Each paper shall consist of eight questions, each carrying 20 marks, and the trainee shall answer five questions. The questioning techniques to be applied should seek to assess the trainee's ability to comprehend, apply, analyze, synthesize, and evaluate conditions. The assessment will last three hours in total.
TCTM201 Applied Technician Mathematics II TCBE201 Entrepreneurship Skills	Each paper shall consist of eight questions, each carrying 20 marks, and the trainee shall answer five questions. The questioning techniques to be applied should seek to assess the trainee's ability to comprehend, apply, analyze, synthesize, and evaluate conditions. The assessment will last three hours in total.
NCES222 Electrical Motors Installation, Maintenance and Repair Practice	Each paper shall consist of one compulsory practical question carrying 100 marks, and it shall be marked on the spot. UBTEB will send an external assessor to assess the trainees as they progress with the assessments. The questioning techniques to be applied should seek the trainee's ability to demonstrate and apply the practical skills acquired during the training. UBTEB will send the cutting list of items needed for practical preparation to the institutions two weeks before the assessment date. The examination will last six hours in total.
NCES223 Electrical Motors Installation, Maintenance and Repair Real Life Project	The paper shall consist of continuous assessment marks. UBTEB shall verify the authenticity of the awarded marks from the completed projects on the ground and trainees' participation through presentations. The tasks to be performed should seek to test learners' abilities to comprehend, apply, analyze, synthesize, and evaluate conditions. The trainees are expected to: • Prepare and interpret drawings. • Plan execution of the job. • Prepare bills of quantities • Carry out actual installation, maintenance, and repair. • Carry out the work in according to IEE regulations. The total duration of the Assessment shall be 90 practical hours.
NCES224 Electrical Motors Installation, Maintenance and Repair Industrial Training	Industrial Training shall be assessed out of 100 marks and will be carried out at the end of year one. The module will be assessed as shown below: Requirements — Contribution Attendance — 10% Work performance involvement — 25% Initiative and innovation — 10%

	Time management 10% Discipline and safety 10% Practical skills 20% Written report 15% Total 100% The total duration of the industrial training shall be six (6) weeks
TCCS201 Basic Kiswahili	The paper shall consist of two sections: Section A (general Kiswahili) and Section B (professional). Section A shall consist of five questions, and a candidate will be required to answer any three of them. Section B shall consist of three questions, and a candidate shall be required to answer any two of them. All questions will carry equal marks. The questioning techniques to be applied should seek to determine the candidate's ability to remember, comprehend, apply, analyze, synthesize, and evaluate conditions. The assessment will last three hours in total.

CORE MODULES DETAILS

CORE MODULE NAME: DOMESTIC ELECTRICAL INSTALLATION, MAINTENANCE AND REPAIR

Training Outcome: By the end of this module, the trainee should be able to install, maintain and repair domestic electrical installations.

Duties	Tasks	Competences	Syllabus Indicative Content	Duration
1) Promote health and safety practices.	- Prevent common workplace hazards.	- Avoid using faulty electrical equipment. - Prevent a slick or wet floor. - Take precautions when working near falling objects or at a height with a ladder. - Avoid using insufficient lighting. - Take precautions when working near chemicals, such as cleaning agents, pesticides, and acids. - Take precaution when working near machinery with moving parts. - Take extra care in places with a lot of noise. - Identify classes of fires - Select fire extinguishers. Use fire extinguishers	- Workshop/Site Safety and Regulations • Workshop hazards: fire, electric shock, accidents • Fire classifications; types of fires • Methods of extinguishing the fires • First aid for treating an electric shock casualty. • Safety wears like helmets, goggles, overalls, boots, gloves, • Safety posters - Basic tools and equipment • Identification and correct application of tools • Care and maintenance • electrical installation systems and maintenance • Identification and correct application of measuring instruments • Commonly used Electrical terms. • Types of regulations. i.e • Statutory • Non statutory • Set of regulations.	10 Hours
	- Rescue victim of electric shock	- Isolate the supply immediately. - Physically removes the victim using non-conducting implements.	- Methods of first aid (mouth-to-mouth, Holger Nelson) - Demonstration of the above methods	02 Hours

Duties	Tasks	Competences	Syllabus Indicative Content	Duration
		- Check for a pulse or breathing. - Give artificial respiration if necessary. - Contact doctor		
2) Cables and conductors	- Carry out cable size calculation	- Determine the load. - Determine the voltage. - Determine the distance. - Determine the cable type. - Determine the allowable voltage drop. - Calculate the cable size. - Check the results of the calculation to ensure that the cable size meets the minimum requirements for the electrical circuit or equipment.	- Definition of cable - Conductor materials used in cables. - Insulating materials - Types of cables - Types of cable joints and terminations - Areas of applications for cables. - Application of Diversity Factor. - Determine the correct Cable size - IEE regulations for the cables	04 Hours
	- Install cables.	- Plan the installation. - Select the cables. - Prepare the cable. - Install conduit, If necessary. - Run the cables through the conduit or along the intended path. - Terminating the cables - Test the installation to ensure that the cables are properly connected. - Secure the cables in place using cable ties, clips, or other means. - Label the cables with markers or labels to identify their purpose, voltage, and other relevant information.	Introduction to Electrical Installation Cables - Definition of electrical installation cables - Types of electrical installation cables - Properties of electrical installation cables - Applications of electrical installation cables Choosing the Right Electrical Installation Cables - Factors to consider when selecting electrical installation cables. - Types of insulation and jackets - Voltage and current ratings - Environmental conditions and cable types Preparing for Cable Installation - Planning the installation - Measuring and cutting the cables - Labelling the cables Cable Installation	08 Hours

Duties	Tasks	Competences	Syllabus Indicative Content	Duration
			- Installing conduit or trunking - Running the cables through the conduit - Connecting the cables to devices and electrical panels - Securing the cables and testing the installation Cable Termination - Types of cable terminations - Preparing cables for termination - Terminating cables at outlets, switches, and electrical panels - Insulating and protecting cable terminations Cable Maintenance - Importance of cable maintenance - Inspecting cables for damage - Testing cables for continuity and resistance - Replacing and repairing cables Safety Precautions - Electrical safety measures to take during cable installation. - Safe cable handling practices - Avoiding electrocution and electrical fires - Proper grounding techniques Troubleshooting Common Cable Problems - Identifying cable problems - Testing and diagnosing common cable issues - Repairing and replacing cables	
3) Prepare bills of quantity	- Draw wiring lay out diagrams.	- Carry out a site survey. - Sketch/Draw ground plan - Take measurements. - Estimate quantity of materials. - Quote local market prices for	- Consumer's Installation - Draw ground floor plans. - Graphical symbols to BS 3939 - Supply sequence - Consumer unit	04 Hours

Duties	Tasks	Competences	Syllabus Indicative Content	Duration
		electrical materials. - Determine the labour cost.		
4) Carry out Domestic installation	- Install conduits, trunkings, and ducts, mount MK boxes.	- Survey site - Select tools and materials. - Select conduit system components. - Take measurements. - Mark wall - Chess wall - Lay conduits - Fix moulded and join boxes	- Install plastic, metallic, and flexible conduits. - Fix fittings - Make conduit bends. - Install trunkings (plastic and metallic). - Install ducts. - Observe the procedures for installing the above - Observe the IEE regulations. - Observe safety precautions.	08 Hours
	- Install lighting circuits.	- Draw an electrical diagram. - Determine the number of lighting points. - Select a switching arrangement. - Select materials and tools. - Draw in cables. - Identify different cable joints. - Install lighting accessories. - Execute the termination. - Test the lighting circuits	- Lighting circuits (one-way, two-way, and intermediate switching) - Draw a cable joint diagram. - Make cable joints. - Draw block diagrams and line diagrams. - Circuit and wiring diagrams - Identify the different switching methods. - Install filament lamps. - Install discharge lamps (fluorescent, mercury vapour, sodium vapour, and tungsten halogen lamps). - Stroboscopic effect. - The operation of fluorescent fittings on a DC power supply - Follow the procedures for installing the above lights. - Observe IEE regulations	10 Hours
	- Install power circuits.	- Draw ring and radial circuits. - Determine the number of ring	- Power circuits (radial and ring circuits) - Draw block diagrams, line diagrams, and	08 Hours

Duties	Tasks	Competences	Syllabus Indicative Content	Duration
		circuits. - Determine the number of radial circuits. - Select materials and tools. - Draw in cables. - Install socket outlets. - Test socket outlet circuits.	wiring diagrams for radial and ring circuits. - Observe the procedures for installing the above - Observe the IEE regulations. - Observe safety precautions.	
	- Install heating circuits.	- Draw circuit diagrams. - Select tools and materials. - Draw in cables. - Install the cooker control unit. - Install the water heater indicator switch. - Install the cooker connector. - Execute the termination. - Carry out the functionality test.	- Water heater circuits - Cooker circuits - Draw the block diagrams, line diagrams, and wiring diagrams for the cooker control unit and water heater. - Identify components. - Follow the procedures for installing the above - Observe the IEE regulations. - Observe safety precautions.	08 Hours
	- Install bell and alarm circuits.	- Identify the bell relay. - Select the bell type. - Select the indicator type. - Install single stroke bell. - Install a continuous-ring bell. - Install a trembler bell. - Install a bell indication system. - Install a fire alarm system. - Install burglar alarm system	- Installation of bell circuits (types of bells, bell indicators, bell relays, bell supplies, bell and call systems, and segregation of circuits) - Alarm circuits (fire and burglar alarm systems) - Select the applicable wiring system. - IEE regulations for the above circuits - Draw the block diagrams, line diagrams, and wiring diagrams for bell circuits and their indicator systems. - Fire alarm systems - Identify components. - Follow the procedures for installing the above - Observe the IEE regulations. - Observe safety precautions.	08 Hours

Duties	Tasks	Competences	Syllabus Indicative Content	Duration
	- Install the consumer unit.	- Size of over current devices - Test over current protective devices - Install over current protective devices. - Install main switch. - Install RCD - Install load cable.	- Control and Protection - Main switch gears (for isolation and switching): isolators, switch fuses, fuse switches, circuit breakers, changeover switches, distribution boards/switch boards, overload relays, contactors. - Protective devices: re-wireable fuses to BS 3036, cartridge fuses to BS - 1361 and 1362, high-breaking-capacity fuses to BS 88, miniature circuit breakers to BS 3871 - Application of the diversity factor ○ State IEE regulations for the above control and protective devices	08 Hours
	- Install an earthing system.	- Select site. - Take measurements. - Excavate earthing pit. - Select materials and tools. - Install earth electrode. - Install earthing conductor. - Test earth electrode resistance. - Improve earth electrode conductivity.	- Definitions of earthing terms (earth, earth electrode, earth electrode resistance, main earth terminal, earth lead, circuit protective conductor (CPC), and extraneous metal work bonding) - Purpose of earthing - Earthing system - Types of earthing (neutral and equipment earthing) - Earth loop impedance - Factors influencing earth resistance of electrodes. - Preparation of the pit, termination of the electrode) - Testing the earth electrode resistance	08 Hours
	- Install a lightning	- Select site.	- Definition of lightning terms (Air termination,	04 Hours

Duties	Tasks	Competences	Syllabus Indicative Content	Duration
	protection system	- Take measurements. - Excavate grounding pit. - Install grounding rod. - Lay the grounding cable. - Install mounting base on the highest point of the roof. - Fix lighting rod on the mounting base - Connect the grounding cable to the lighting rod and ground rod. - Test ground rod resistance. - Improves ground rod conductivity.	Bonding / Down conductor, Ground / Earth terminals, Test joints, Connector and support to complete the system) - Protection against Lightning - Factors to determine whether lightning protection is required. - Components of a protection system - Zone of protection - Installation of lightning protection - Calculation about lightning	
5) Inspect and Test domestic electrical installation.	- Carry out circuit protective conductor continuity test. - Carry out ring final circuit continuity test. - Carry out insulation resistance test. - Carry out polarity test. - Carry out earth fault loop impedance test. - Cary out functional test	- Test for continuity of circuit protective conductor and conductors i.e., CPC, Neutral conductor, Live conductor. - Test for polarity - Test for the earth loop impedance - Test for insulation resistance. - Follow the procedures for the tests above. - Select instruments. - Record the purpose of the test. - Take safety precautions. - Record the expected results. - Connects the meter. - Record the actual results. - Rectify faults. - Observe safety precautions. - State the IEE Regulations	- Visual inspection (broken components, sizes of components, quality of equipment) - Continuity tests carried out before supply connection, CPC and bonding conductors, ring circuits, polarity, insulation resistance. - Earth electrode resistance - Earth electrode test - Test with supply connected (polarity with a test lamp, earth fault loop impedance, operation of residual current device	08 Hours
6) Maintain and	- Carry out	- Clean conductors, terminals, and	- Repair and maintenance of electrical	08 Hours

Duties	Tasks	Competences	Syllabus Indicative Content	Duration
repair domestic electrical installations	Maintenance.	connectors of all corrosion. - Tighten terminals and connectors, including the breaker. - Check the equipment's grounding system, including conduit end bushing connections. - Check the grounding electrode. Conductor, and associated connections. - Examine the conductor insulation for damage and, if necessary, repair it. - Replace any damaged cables, equipment, and accessories	appliances. - Check the terminals of associated accessories in an installation (clean and tighten). - Check for open circuit, short circuit, and earth leakage faults. - Examine the protective device's rating and effectiveness. - Check on the effectiveness of the earthing system. - Observe the safety precautions. - State the IEE regulations.	
	- Rectify faults	- Locate the faulty part. - Determines the cause of the fault. - Rectify Open Circuit Faults - Rectify short-circuit faults. - Rectify Overload Fault - Rectify Earth Faults	Introduction to Electrical Faults - Definition of electrical faults - Types of electrical faults - Causes of electrical faults - Consequences of electrical faults Overloading and Short Circuits - Definition of overloading and short circuits - Causes of overloading and short circuits - Symptoms and effects of overloading and short circuits - Troubleshooting methods and solutions Ground Faults and Open Circuits - Definition of ground faults and open circuits - Causes of ground faults and open circuits - Symptoms and effects of ground faults and open circuits - Troubleshooting methods and solutions	10 Hours

Duties	Tasks	Competences	Syllabus Indicative Content	Duration
			Arc Faults and High Resistance Connections - Definition of arc faults and high resistance connections - Causes of arc faults and high resistance connections - Symptoms and effects of arc faults and high resistance connections - Troubleshooting methods and solutions Electric Shock and Fire Hazards - Definition of electric shock and fire hazards - Causes of electric shock and fire hazards - Symptoms and effects of electric shock and fire hazards - Preventive measures and safety precautions - Chapter 6: Electrical Fault Detection and Diagnosis - Electrical testing equipment - Troubleshooting techniques - Safety precautions during fault detection and diagnosis - Documentation and record-keeping Rectifying Electrical Faults - Repair and replacement of faulty components - Restoring power and testing for proper function - Preventive maintenance and measures to avoid future faults	

Assessment

The module will be assessed through practical work, assignments, tests and final assessment. Their relative contribution to the final grade is as below:

Requirements	Contribution
Assignments	5%

Duties	Tasks	Competences	Syllabus Indicative Content	Duration
Tests	10%			
Practical work	25%			
Final assessment	60%			
Total	100%			

CORE MODULE NAME: SOLAR PV SYSTEMS INSTALLATION, MAINTENANCE AND REPAI

Training Outcome: By the end of this module, the trainee should be able to install, maintain and repair solar PV systems.

Duties	**Tasks**	**Competences**	Syllabus Indicative Content	Duration
1) Promote health and safety practices.	- Promote safety. - Carry out tasks safely and work at heights.	- Wear PPE - Co-operate with other workers. - Follow rules and procedures of work. - Focus on the work. - Assess the task. - Identify the hazards. - Define safe systems. - Implement the systems. - Do as much work as possible from the ground. - Prevent falls by using the right type of equipment. - Use work equipment to minimize the distance and consequences of a fall. - Maintain and check equipment regularly. - Doesn't overload or overreach when working at height. Provide protection from falling objects	- Workshop/Site Safety and Regulations • Workshop hazards: fire, electric shock, accidents • Types of fires, Classes of fires • Methods of extinguishing the fires. • First aid on treating an electric shock casualty. • Safety wears like helmet, goggles, overalls, boots, gloves, • safety posters - Basic Tools and Equipment • Identification and correct application of tools • Care and maintenance • electrical installation systems and maintenance • Identification and correct application of measuring instruments • Electrical terms commonly used.	10 Hours
2) Build electronic circuits.	- Build electronic circuits.	- Build a voltage regulator. - Build an automatic lighting system. - Construct a sensing device.	Basic electronics - -Semi conductors - Definition of semi-conductors - Properties of semi-conductors - Formation of P type and N type semi-conductors - Electronic components - Resistors, Capacitors, thyristors, diodes, Transistors	14 Hours

			- Resistance measurement and colour codes - Diode and Transistor testing - DC power supplies - Unregulated power supplies - Step down transformer - Single phase bridge rectifier and Half wave bridge rectifier - Centre tapped rectifiers. - Introduction to switching and linear rectifiers - Application od DC power supplies. - Transistor s' configuration - Casing electronics components - Soldering electronics components	
3) Introduction to solar PV technology		- Describe the principles of solar radiation. - Use metrological data. - Use solar PV measuring instruments. - Identify solar PV components. - Select solar PV components. - Draw a block diagram of the solar PV system.	- Solar PV Technology o Solar radiation principles o Applications of solar PV technology o Advantages of solar PV technology o Limitations of solar PV technology o Solar cells and modules - Solar Radiation o Weather and metrological data o Application of insolation data in photo voltaic system - Components of a Solar PV System o Solar modules o Solar batteries o Charge controllers o Inverters o Power conditioning units o Types, functions, advantages, and	08 Hours

			disadvantages of the solar modules and their components o Types of PV Systems. o Solar Cookers, o Solar Water heaters o Solar dryers.	
4) Prepare BOQ	- Estimation of quantity of materials - Install conduits, trunking, ducts and mounting MK boxes.	- Visit the site. - Take measurements. - Sketch ground plan - Draw lay out diagram. - Sizing solar components - Quote local market prices of electrical materials. - Determine the number and specifications of Solar modules, charge controllers, batteries, and inverters. - Determine Total number of sockets, lighting points, switches, etc. - Determine Total length of load cable, sockets, and lighting cables. - Determine Number of distribution boards - Determine Earthing materials. - Determines Labour cost. - Determine amount of electrical materials - Determine grand total. - Select tools and materials. - Take measurements. - Mark wall - Chess wall - Lay conduits, trunkings - Fix moulded and joint boxes.	- Site planning - Determination of solar radiation of a locality - Load energy consumption analysis - Determine the sizes of individual components!	06 Hours
5) Install Solar PV	- Install lighting	- Determines the number of lightings points.	- Draw block diagrams, line diagrams.	08 Hours

systems.	system.	- Select switching arrangement. - Select materials and tools. - Draw in cables. - Install lighting accessories. - Carries out termination. - Test lighting circuits.	- Circuit and wiring diagrams - Identify the different switching methods. - Install A.C and D.C lights. - Supply the system with direct current configuration / Direct / A.C configuration.	
	- Install socket outlet circuits.	- Determines the number of radial and ring circuits. - Select materials and tools. - Draw in cables. - Install socket outlets. - Test socket outlet circuits	- Draw block diagrams, line diagrams and wiring diagrams for Radial and Ring circuits. - Observe procedures for installing the above - Observe the IEE regulations. - Observe safety precautions	08 Hours
	- Install plastic conduits, metallic and Flexible.	- Install plastic conduits, metallic and Flexible. - Fix fittings - Make conduit bends. - Install trunkings (plastic and metallic) - Install ducts. - Observe procedures for installing the above - Observe the IEE regulations. - Observe safety precautions	- Cutting conduits, - Bending - Identification of different types and sizes of conduits and trunkings - Lay conduits and trunkings - Draw possible diagrams. - Observe safety precautions. - Follow procedures. - State the IEE regulations.	08 Hours
	- Install consumer unit	- select over current protective devices. - Size over current protective device - Test over current protective device - Install over current protective device. - Install main switch. - Install RCD and surge arrestors. - Install load cable	- Consumer's Installation - Site survey / preparations - Plan, Draw and design ground floor plan. - Draw electrical drawing. - Graphical symbols related to solar PV. - Carry out load analysis. - Sizing of different components and materials	08 Hours

	- Install solar PV components.	- Install Solar modules, - Install charge controllers. - Install batteries. - Install inverters.	- PV installation • Preparation (planning and transport) • Good installation practice • Light fixtures • Appliances - -Methods of mounting solar modules - -proper methods of ventilation	08 Hours
	- Install earthing system.	- Select site. - Take measurements. - Excavate earthing pit. - Select materials and tools. - Install earth electrode. - Install earthing conductor. - Test earth electrode resistance. Improves earth electrode conductivity	- Types of earth electrodes - Type of soil - preparation of the pit, termination of the electrode. - Testing the earth Resistance using the Megger tester instrument - Follow the procedures. - Observe safety. - Follow the IEE Regulations.	04 Hours
6) Test electrical installation.	- Carry out circuit protective conductor continuity test. - Carry out ring final circuit continuity test. - Carry out insulation resistance test. - Carry out polarity test. - Carry out earth fault loop impedance test. - Cary out functional test	- Record the expected results. - Connects the meter. - Record the actual results. - Rectify faults. -	- Continuity tests carried out before supply connection, CPC and bonding conductors, ring circuits, polarity, insulation resistance. • Earth electrode resistance • Test with supply connected (polarity with a test lamp, earth fault loop impedance, operation of residual current device) - Connect with D.C / A.C configuration.	10 Hours

7) Maintain electrical installation.	- Carry out Maintenance.	- Clean conductors, terminals, and connectors of all corrosion. - Tighten terminals and connectors including breaker. - Check the equipment grounding system, including conduit end bushing connections. - Check the grounding electrode, grounding electrode conductor, and associated connections. - Check conductor insulation for damage, and repair if necessary. - Replace deteriorated cables, equipment, and accessories.	- Maintenance of a PV system - -Testing /troubleshooting PV system - Routine maintenance of Components	10 Hours
8) Design and Build Battery Charger	- Design and build battery charger	- Determine the specifications of the battery charger: the battery voltage and capacity, charging current and time, and the type of battery chemistry (lead-acid, lithium-ion, etc.). - Select the charging method: constant current charging, constant voltage charging, and trickle charging, etc - Choose the appropriate components based on the charging method and charging specifications: transformer, rectifier, voltage regulator, and charging circuitry. - Design the circuit. - Assemble the components. - Test the battery charger. - Enclose the battery charger in a suitable housing to protect the circuitry and ensure safe operation.	Introduction - Definition of a battery charger - Benefits of a battery charger - Types of batteries Basic Principles of Battery Charging - Overview of battery charging - Factors affecting battery charging. - Types of battery charging methods - Voltage and current requirements for battery charging Designing a Battery Charger - Choosing the right charging method - Determining the charging capacity - Design the circuit for battery charger. - Selecting the components for the charger Building a Battery Charger - Assembling the components - Wiring the charger	10 Hours

		- Label the battery charger with the charging specifications. - Document the design and construction process.	- Testing the charger - Troubleshooting common problems Advanced Features of Battery Chargers - Automatic charging control - Temperature compensation - Overcharge protection - LCD display and user interface Safety Precautions - Electrical safety measures during charger design and building - Safe battery handling practices - Preventing electrocution and fire hazards - Proper grounding and isolation techniques Documentation and Certification - Documenting the charger design and building process - Obtaining certification and approval from relevant authorities - Maintaining the charger and keeping records	
	- Repair and Maintain battery charger	Repairing a Battery Charger: - Identify the problem such as blown fuse, a broken wire, or a faulty component. - Disassemble the charger to access the interior components. - Inspect the components for any signs of damage or wear. - Check for loose connections, burned or damaged components, or signs of corrosion. - Troubleshoot the issue to identify the	Introduction to Battery Chargers - Overview of battery charger types and their applications - Basic components of a battery charger and their functions - Safety considerations when repairing and maintaining battery chargers. Common Battery Charger Issues and Troubleshooting - Identifying common problems with battery chargers, such as insufficient	08 Hours

		root cause of the problem: Use a multimeter or other diagnostic tools to test the components and circuits in the charger. - Replace the faulty component. - Reassemble the charger. - Test the charger to ensure that it is functioning properly. Maintaining a Battery Charger: - Regularly clean the exterior of the battery charger to remove any dust, debris, or other contaminants. - Inspect the charger regularly for any signs of damage or wear, such as frayed wires, loose connections, or damaged components. - Calibrate the charger periodically to ensure that it is delivering the correct voltage and current to the battery. - Store the charger properly. - Follow any instructions or guidelines provided by the manufacturer for maintenance and care of the charger.	charging, overcharging, or damage to the charger - How to troubleshoot these issues and isolate the root cause - Use of diagnostic tools and equipment Battery Charger Repair and Replacement - Detailed instructions on how to repair and replace different components of a battery charger, including fuses, capacitors, transformers, and diodes - Guidelines on selecting replacement parts and the tools required for repair. - Techniques for desoldering and soldering new components onto the circuit board. Cleaning and Maintenance of Battery Chargers - Importance of regular cleaning and maintenance of battery chargers - Tips on how to clean battery chargers and remove dust, debris, and other contaminants. - Advice on preventative maintenance techniques to prolong the lifespan of the charger. Calibration and Testing of Battery Chargers - Overview of different types of tests that can be performed on a battery charger, including voltage and current measurements, insulation resistance testing, and load testing - How to calibrate the charger to ensure it delivers the correct voltage and current to	

			the battery - Techniques for testing the battery charger's performance and verifying that it is operating within acceptable parameters. Safety Considerations - Guidelines on how to ensure the safety of the technician when repairing or maintaining a battery charger - Identification of potential hazards such as electrical shock, burns, and toxic fumes. - Use of personal protective equipment (PPE) and other safety measures to reduce risk of injury	

Assessment

The module will be assessed through practical work, assignments, tests and final assessment. Their relative contribution to the final grade is as below:

Requirements	Contribution
Assignments	5%
Tests	10%
Practical work	25%
Final assessment	60%
Total	100%

CORE MODULE NAME: GENERATORS INSTALLATION, MAINTENANCE AND REPAIR

Training Outcome: By the end of this module, the trainee should be able to install, maintain and repair generators.

Sub-modules	Tasks	Competences	Syllabus Indicative Content	Duration
1) Promote health and safety practices.	- Promote workplace safety	- Wear PPE - Follow the rules and procedures at work. - Avoid using faulty electrical equipment. - Take precaution when working near machinery with moving parts. - Take extra care in places with a lot of noise. - Follow the safety and maintenance guidelines in the operator's manual. - Operate the generator outdoors in an area with plenty of ventilation. - Use heavy-duty extension cords to connect appliances to the outlets on the generator. - Turn the generator on before plugging appliances into it. - Turned off the generator and cooled it before fuelling it. - Keep the generator dry and do not use it in rain or wet conditions. - He/she doesn't power the house wiring by plugging the generator into a wall outlet. Known as "back feeding," this practice puts utility workers, neighbours, and households at risk of electrocution. - Test the batteries on a regular basis and replace them as needed.	- Workshop/Site Safety and Regulations - Workshop hazards: fire, electric shock, accidents - Types of fires, Classes of fires - Methods of extinguishing the fires - First aid for treating an electric shock casualty. - Safety wears like helmets, goggles, overalls, boots, gloves. - Safety posters - Basic tools and equipment - Identification and correct application of tools - Care for batteries - Identification and correct application of measuring instruments - Protection of generators (from overload, overcurrent, and overtemperature) - Ground-fault protection - Define generator-related terms.	08 Hours

2) Basic concepts		- Explain the principle of operation of a generator. - Identify parts of a generator. - Describe the major parts of a generator. - Test-run the generator. - Install the load cable.	- Basic construction of a generator - Principle of operation of a generator - Generation of alternating voltage - Types of generators - Generator characteristics. - Mechanical drives of a generator (natural gas engine, wind, water, thermal) - Types of enclosures - Types of excitation systems and their illustrations - Cooling systems - Special wiring systems (hospitals, farmyards, high temperature installations, corrosive atmospheres, temporary installations) - Testing and inspection. Tests carried out on a generator.	06 Hours
3) Prepare bill of quantities	- Draw wiring lay out diagram. - Estimate quantity and costs of materials	- Visit the site. - Take measurements. - Sketch ground plan - Draw lay out diagram. - Quote local market prices of electrical materials. - Determine Total Load capacity.		06 Hours

		- Determine Total length of load cable. - Determine Number of distribution boards - Determine Earthing materials. - Determine the cost of electrical materials. - Determine Labour cost. - Determine grand total.		
4) Install generator.	- Install generator.	- Select site. - Obtain appropriate information on generator. - Select materials and tools. - Prepare the foundation. - Place the generator on the centre of the foundation. - Earth the generator - Install load cable. - Install ATS panel. - Test run generator - Commission generator	- Mechanical connection - Electrical connection - Control circuit (automatic and manual) - Load connection. - Tests carried out (stator and rotor, exciter, PM rotor) - Observe safety precautions. - Follow procedures for installing. - Follow the IEE Regulations	08 Hours
	- Earth generator	- Select site. - Select materials and tools. - Prepare two earthing pits, one for body earthing and another for neutral earthing. - Take measurements. - Excavate grounding pits. - Install earth electrodes. - Install earthing conductors. - Never connects the body and neutral earth together. - Test earth electrode resistance. - Improves earth electrode conductivity.	- Carry out earthing connections. - Test for effectiveness of earthing.	04 Hours
5) Troubleshoot	- Troubleshoot	- Test the resistance of the stator through the outlets.		08 Hours

generator	possible faults and causes in a generator	○ Record the expected reading. ○ Turn on the circuit breaker. ○ Test the resistance through each leg. ○ Record the actual readings. - Check for burnt-out stator windings. ○ Remove the stator cover. ○ Check for any broken rope on the stator windings as evidence of overheating. ○ Check the colour of the wire, black colour as evidence of burnt-out windings. ○ Test the resistance of each coil to ground. - Test the resistance of the rotor, brushes and slip rings. ○ Remove the AVR and Brushes ○ Record the expected readings. ○ Test the resistance through the brushes. ○ Test the resistance on the slip rings. ○ Test the resistance of each coil/brush to ground. ○ Record the actual readings. - Test the AVR ○ Un-plug the AVR. ○ Hook up 12V on the brushes and check the output voltage on the stator. ○ Record the expected voltage on the stator. ○ Record actual voltage on the stator. ○ Plug in the AVR and check the output voltage on the stator. ○ Test the cable supplying power to AVR. ○ Replace AVR - Check the brushes and slip rings for proper power transfer. ○ Pull out the brushes. ○ Check for worn out brushes. ○ Get the resistance reading direct from the slip rings.		

		○ Clean the slip rings. ○ Replace brushes. - Restore lost residual magnetism. ○ Select 12V battery. ○ Select connection wire. ○ Open stator cover ○ Supply the 12V to the stator. - Check for burnt-out rotor windings. ○ Disassemble the generator. ○ Check the colour of the wire, black colour as evidence of burnt-out windings. ○ Take the measurements of the rotor. ○ Replace the rotor. ○ Assemble the generator		
	- Troubleshoot a generator that does not start.	- Visually Check the gas level in the tank pipe, should not be less than ¾ - Check the oil level. - Low oil sensor shuts down the engine. - Check the fuel valve is opening. - Choke to start the engine. - Turn the ignition switch on. - Check the air filter for blockage. - Check whether the choke works. - Remove the gas line off to see whether the gas valve gets gas through it and drain in to appropriate container. - Replace flex line with a transparent tube to see whether the gas flow is good. - If there is no gas, then the valve is closed. - Reconnect gas line. - Remove air filter housing see the carburettor easily. - Keep rubber gasket and brass bushings. - Remove the gas line from the carburettor.	- Generator that runs but has no power output. - Identify possible faults, - Causes - Remedies - Generator voltage drops off excessively. - Generator voltage does not build to maximum. - Corrective maintenance	06 Hours

		- Remove throttle assemble. - Remove the carburettor. - Leave gasket on the carburettor. - Open the screw at the bottom. - Check for dirt and debris in carburettor jet. - Check rubber seal. - Blow it out with compressed air. - Reassemble the carburettor. - Reassemble the generator. - Restart the generator.		
6) Install and Maintain Transfer Switch	- Introduction to Manual Transfer Switches	- Describe the operation of transfer switch. - Describe type of transfer switch - Selecting a Manual Transfer Switch - Pre-Installation Preparation - Installing the Manual Transfer Switch - Connecting the Backup Generator - Safety Considerations - Troubleshooting and Maintenance - Troubleshooting and Maintenance - Compliance and Standards	Introduction to Manual Transfer Switches - Overview of manual transfer switches - Importance of manual transfer switches in backup power systems - Types of manual transfer switches Selecting a Manual Transfer Switch - Factors to consider in selecting a manual transfer switch. - Types of manual transfer switches and their features - Choosing the right size and capacity of manual transfer switch Pre-Installation Preparation - Preparing the	08 Hours

			installation site - Ensuring proper ventilation and clearances - Acquiring necessary tools and materials - Reviewing the installation instructions Installing the Manual Transfer Switch - Mounting the transfer switch - Connecting the electrical wiring - Installing the necessary conduit and fittings - Testing the transfer switch before use Connecting the Backup Generator - Connecting the generator to the transfer switch - Configuring the generator for use with the transfer switch - Testing the generator and transfer switch together Safety Considerations - Safety precautions to take during installation	

			and operation. - Grounding requirements - Emergency procedures in case of malfunction Troubleshooting and Maintenance - - Common issues with manual transfer switches - Troubleshooting steps to identify and resolve problems. - Regular maintenance and upkeep to ensure proper function. Compliance and Standards - Relevant codes and standards for manual transfer switch installations - Compliance with local and national regulations - Obtaining necessary permits and inspections	
	- Wire transfer switches	- Wire Single Phase Manual Transfer / Changeover Switch - Wire Single Phase Automatic Changeover / Transfer Switch (ATS) - Wire automatic transfer switch using circuit breakers. - Wire automatic transfer switch using magnetic contactors	- Identify the load. - Contactors, Relays, Auxiliary contacts, Overload, and Indicator lamp.	08 Hours
	- Prepare	- Select site near the main panel. - Select components such as. o Portable Generator		02 Hours

		○ Transfer Switch ○ Power Inlet Box ○ Power cord - Select tools and equipment		
	- Install manual transfer switch	- Mount the manual transfer switch near the main electric panel. - Select the circuits to be powered by the generator. - Turn off power to the house at the main electric shut off. - Remove the cover on the main electric panel (work inside the electric panel is only recommended for licensed electricians). - Locate an available knockout hole on the electric panel and remove the plug. - Attach the armoured cable from the transfer switch to the electric panel. - Connect the ground and neutral wires from the transfer switch to the appropriate bus bars on the main panel. - Locate the first circuit to be powered by the generator and remove the power wire on the existing circuit breaker. - Replace that wire with the red wire from the transfer switch marked “A.” - Splice the black wire marked “A” from the transfer switch to the removed power wire using a wire nut. - Repeat this process for all the circuits, ensuring the red and black wires from the transfer switch are a matched pair. - Use non-metallic wiring to connect the transfer switch to a power inlet outside. - Use the provided generator cord to connect the power inlet to the generator or make his/her own cable if a longer one is desired using bulk wire and connectors. - Ensure the generator has unleaded fuel and oil inside, then start the generator.		08 Hours

		- Test the wiring connections, flip the switches on the transfer switch from “Line” to “Gen.” to the selected circuits.		
	- Inspect and test the automatic transfer switch	- Exterior visual inspection. Check for any obvious signs of damage or wear. - Check for signs of moisture. - Look for signs of excessive heat. - Remove collected dust and debris, using a vacuum or similar device. - Clean the transfer switch not using wet products for electronic component. - Check contacts for Signs of corrosion. - Seek professional assistance from personnel explicitly trained in transfer switch maintenance. - Check The AC Line Voltage o Use Voltage Meter to check that all the incoming power is correct. o Use HZ Meter to check that all the HZ is correct. o Look at the AC power line and check for discoloration. o Test all AC connections and adjust if needed. - Check The Generator Line Voltage o Use the Voltage meter to check all the incoming power from the Generator is correct. o Use HZ Meter to check Generator HZ & adjust as needed. o Look at Generator power lines and check for discoloration. o Test all Generator power connections and adjust if needed. - Check all Control wires & relays. o Check the condition of all control wires. o Look at the condition of all control relays. o Test all control wires & relays, adjust if needed. - Test ATS for proper operation o Check for complete & proper operation. o Close power failure switch & record outcome		08 Hours

		○ Clean internal & external of ATS ○ Clean dust from ATS - Clean any debris left on site		
	- Install automatic transfer switch	- Determine the power needs. - Choose the right automatic transfer switch. - Turn off power supply. - Install the automatic transfer switch. - Connect the generator. - Connect the electrical panel. - Test the automatic transfer switch. - Turn on power supply: - Check all the connections and wires to ensure they are tight and secure. - Test the switch a few times to ensure it works properly.	Introduction - Description of an automatic transfer switch - Benefits of having an automatic transfer switch installed. - Factors to consider before installing an automatic transfer switch. Tools and materials needed. - List of tools needed for installation. - List of materials needed for installation. - Safety precautions Preparing for installation - Shutting off the power supply - Checking the electrical panel - Choosing the right transfer switch Installing the automatic transfer switch - Mounting the transfer switch - Wiring the transfer	08 Hours

			switch to the electrical panel - Wiring the transfer switch to the generator - Grounding the transfer switch Testing the automatic transfer switch - Starting the generator - Testing the transfer switch - Troubleshooting common problems Final checks and clean-up - Checking all connections and wires - Verifying proper installation - Cleaning up the workspace	
	- Maintain automatic transfer switch	- De-energize the switchgear (with the exception of ATS equipped with an isolation bypass feature, which does not need to be de-energized). - Remove the arc chutes and pole covers to allow visual inspection of the main and arcing contacts. - Test and recalibrate all AC sensing and time-delay functions in the switchgear. - Vacuum the accumulated dust from the switchgear and accessory panels. - Inspect for moisture or signs of previous wetness or dripping. - Clean grime with an approved non-conductive solvent.		08 Hours

		- Inspect all main arcing contacts for excessive corrosion and/or pitting. - Inspect all control relay contacts for excessive corrosion and discoloration due to excessive heat. - Manually operate the main transfer movement to check proper contact alignment, deflection, and wiping action. - Check all cable and control wire connections to the transfer switch controller, sensing panels and other system components. Tighten if necessary. - Re-energize the switchgear and conduct a test. - Record pickup and dropout settings for under voltage, overvoltage, under frequency, over frequency, and phase imbalance. - Inspect the condition of controls, switches, indicator bulbs, circuit boards / modules, wiring connections, linkages, limit switches and relays.		
	- Repair automatic transfer switch	- Select tools and equipment for transfer switch repair: o Automatic Transfer Switch e.g., Progressive Dynamics 5100 Series o Lever Lock Wire Connectors and/or Butt Connectors (12-10 AWG) o Screwdrivers (Standard & Phillips) o Wire Cutters & Strippers o Masking Tape & Marker o Voltmeter or Digital Multimeter (For Troubleshooting & Testing) - Follow step by step procedure to repair automatic transfer switch. o Disconnect Power & Prepare Workspace to Repair Transfer Switch ▪ Turn power off at the pedestal or disconnect the cord.		08 Hours

		▪ Make sure the mains power is turned off. ▪ Ensure that no hot wires are coming into the transfer relay switch box. ▪ Make sure he/she has all the parts and tools needed to repair transfer switch within reach. ▪ Use a rag or vacuum handy for cleaning up any dust. - Mark All Current Connections ▪ Use masking tape and a marker to identify all the existing wiring connections. ▪ Identify which wires are coming from every point. ▪ Mark the wires and notice their connection points. - Transfer Wiring to the Repaired/new Transfer Switch ▪ Disconnect and reconnect all wires to their corresponding posts in the new ATS relay box. ▪ To avoid incorrect wiring, work with one connection at a time. ▪ Remove each set of wires from the old box. ▪ Then, connect them to the corresponding connection points in the new box. ▪ Use the marked wires as his/her guide. ▪ Connect breaker box wires. ▪ Connect source wires from mains power. ▪ Connect source wires from shore power. - Test the Work and Clean Up ▪ Test AC power at all outlets. ▪ Turn off the mains power. As a result, AC power will be cut off from the distribution		

		panel. ▪ Turn power back on at the RV pedestal, or plug your shore power back in. - Wait 20-45 seconds and should soon have AC power again. There is one very easy sign to indicate you have AC power. The microwave will beep. At least ours does. And that is now music to my ears.		
7) Design and build Welding Machine	- Design and build Welding Machine	Determine the welding machine type and specifications. - Select the type of welding machine that is suitable for your welding application. - Determine the welding machine specifications such as the maximum amperage output, voltage, duty cycle, and other requirements. Design the welding machine circuitry. - Design the circuitry of the welding machine based on the specifications. - Determine the number of transformers, rectifiers, and capacitors required for the circuitry. - Choose the type of rectifier and the rectification method to use. Choose the components needed for the welding machine. - Select the necessary components such as transformers, rectifiers, capacitors, switches, relays, and fuses for the welding machine. - Choose high-quality components that meet the required specifications. Draw the welding machine schematics and layout. - Create a schematic diagram of the welding machine circuitry. - Design the layout of the components and the welding machine enclosure. Build the welding machine enclosure.	Introduction to Welding Machines - Overview of welding machines - Importance of welding machines in welding process - Types of welding machines Understanding the Welding Process - Overview of the welding process - Types of welding processes - Factors affecting welding process. Designing a Welding Machine - Factors to consider in designing a welding machine. - Basic components of a welding machine - Different types of	20 Hours

		- Build the welding machine enclosure using metal or plastic materials. - Ensure that the enclosure provides adequate space for the components and proper ventilation for cooling. Install the components and circuitry. - Install the components such as transformers, rectifiers, and capacitors in the welding machine enclosure. - Wire the circuitry according to the schematic diagram. Test the welding machine. - Test the welding machine by connecting it to a load and measuring its output. - Ensure that the welding machine meets the required specifications. Troubleshoot and make necessary adjustments. - Troubleshoot any issues with the welding machine and make necessary adjustments. - Ensure that the welding machine is safe to use and meets safety standards. Perform regular maintenance and service. - Regularly perform maintenance and service on the welding machine to ensure it continues to operate efficiently and safely. - Replace any worn out or damaged components as needed. Assembles the Welding Machine - Labels terminals. - Tests the Welding Machine - Repairs and maintains welding machines.	welding machine designs - Advantages and disadvantages of each design Selecting Components for Welding Machine - Overview of different types of components needed for a welding machine. - Factors to consider in selecting components. - Advantages and disadvantages of different component options Building a Welding Machine - Tools and equipment needed for building a welding machine. - Steps in building a welding machine. - Safety precautions to take during welding machine construction. - Testing the machine after construction Troubleshooting and Maintenance of Welding Machine - Common problems with welding machines	

			- Tips for troubleshooting and fixing common problems. - Maintenance and upkeep of welding machines - Importance of regular maintenance and servicing Applications of Welding Machines - Overview of different applications of welding machines - Types of welding processes used for different applications. - Advantages and disadvantages of each type of welding process	

Assessment

The module will be assessed through practical work, assignments, tests and final assessment. Their relative contribution to the final grade is as below:

Requirements	Contribution
Assignments	5%
Tests	10%
Practical work	25%
Final assessment	60%
Total	100%

CORE MODULE NAME: ELECTRICAL MOTORS INSTALLATION, MAINTENANCE AND REPAIR

Training Outcome: By the end of this module, the trainee should be able to install, maintain and repair electrical motors.

Sub-modules	Tasks	Competences	Syllabus Indicative Content	Duration
1) Promote health and safety practices.	- Promote safety during motor installation.	- Ensure that motors are installed, protected and fused in accordance with IEE Regulations - Use Eyebolts or lifting lugs for lifting the motor only. - Ensure that the eyebolt is fully threaded and tight in its mounting hole. - Ensure that Frames and accessories of motors are grounded in accordance with IEE Regulations - Ensure that Rotating parts such as pulleys, couplings, external fans, and shaft extensions are permanently guarded. - Use the proper size of line current protection and motor controls as required by IEE Regulations - Disconnect power before working on motor or driven equipment. - Does not use motors with automatic thermal protectors in applications where automatic restart will be hazardous to personnel or equipment. - Discharge all capacitors before servicing motor. - Always keep hands and clothing away from moving parts. - Does not attempt to measure the temperature rise of a motor by touch but by thermometer, resistance, imbedded detector, or thermocouple.	- Workshop/Site Safety and Regulations - Workshop hazards: fire - First aid on treating fire. - Safety wears like helmet, goggles, overalls, boots, gloves, - safety posters - Basic Tools and Equipment - Identification and correct application of tools - Identification and correct application of measuring instruments - Ground fault protection	08 Hours

		- Identify classes of fires - Select fire extinguishers. - Operate fire extinguishers. - Fight fire - Switch the Isolator to the 'OFF' Position or Remove the Plug - Prove the Test Instrument - Prove System Dead - Reprove the Test Instrument, if Possible - Secure the Isolation		
2) Basic concept of motors	- Introduction to motor		Motors: - Construction - Principles of operation - Back EMF of a motor - Types of motors and their characteristics - Reverse of direction of relation of a motor - D.C face plate starter and its operation - Types of speed control - Methods of controlling induction motors (direct on line starter, forward and reverse, automatic star delta starter) - Types of motor enclosures and their application - Methods of mounting - Minimum and Maximum horsepower of motors	08 Hours
3) Prepare bill of quantities	- Draw wiring lay out diagram. - Estimate quantity	- Visit the site. - Take measurements. - Sketch ground plan	- Consider the size of motor. - Single phase / three phase - Motor enclosures	08 Hours

	and costs of materials	- Draw lay out diagram. - Quote local market prices of electrical materials. - Estimate quantity of electrical materials - Determine the cost of electrical materials. - Determine Labour cost. - Determine grand total	- Methods of starting	
4) Install motors	- Install motor	- Select site for the motor or select the motor type for a given site. - Select tools and materials. - Inspect the motor. o Check to be sure that motor has not been exposed to dirt, grit, or excessive moisture in shipment or storage before installation. o Measure insulation resistance. o Clean and dry the windings as required. o Never start a motor which has been wet without having it thoroughly dried. - Floor Mounting o Mount Motor with a firm, rigid foundation. o Follow the manufacturer guidelines for motor mounting. - V-belt drive installation o Select proper type and number of belts and sheaves. o Align sheaves carefully to avoid axial thrust on motor bearing. o Position the drive sheave on the motor toward the motor so that it is as close as possible to the bearing. o Ensure that the motor is secured by all mounting bolts before tightening belts.	- Single Phase AC motors o Construction o Types of single-phase AC motors and their characteristics o Methods of starting single phase AC motors - Three Phase AC Motors o The three-phase induction motor construction o Production of a rotating magnetic field and torque slip o Rotor constants, current and copper loss o Torque slip and torque speed characteristics o Types of three phase induction motors o Starting of induction motors	14 Hours

		○ Adjust belt tension to belt manufacturer's recommendations. - Install isolator. - Install circuit board. - Install control panel.		
	- Install motor starters	- Motor starter - Direct On Line Stater ○ Draw the power circuit. ○ Draw the control circuit. ○ Select tools and materials. ○ Wire the starter. - Forward and Reverse Starter ○ Draw the power circuit. ○ Draw the control circuit. ○ Select tools and materials. ○ Wire the starter. - Star Delta Starter ○ Draw the power circuit. ○ Draw the control circuit. ○ Select tools and materials. Wire the starter	• components required for a particular type of starter. • Draw control circuit diagram, power circuit diagram and wiring circuit diagram. • Direct on line - With one start and stop push button - Controlled from two positions. - Controlled from three positions. • Sequential starting of motors(manually) - Controlled from one position. - Remote control from two positions - Remote control from three positions i.e two motors or three motors and above. • Automatic starting of sequencing of motors - By use of direct on line controlled from- one position - Two positions and three positions by use of stop and start push buttons. - Manual and automatic operation. • Manual and automatic star and Delta starter. • Connect ON circuit, OFF circuit ON and OFF RELAY circuit.	12 Hours

			• Flickering circuit. • Follow the procedures. • Follow safety procedures. IEE regulations.	

5) Maintain motors	- Dismantle and assemble the motor	- Select tools.
		- Observe safety.
		- Remove terminal box cover and cooling fan cover.
		- Remove front and back cover nut bolts.
		- Mark front and back covers
		- Remove front cover.
		- Remove fan locker.
		- Remove rotor with back cover from the stator
		- Remove back cover from the rotor shaft.
		- Remove non-driving end bearing from the shaft.
		- Remove bearing back cover.
		- Remove bearing front cover.
		- Clean both covers and rotor shaft.
		- Apply grease on both sides of the rotor shaft and bearing housings.
		- Install old or new bearing on the front cover.
		- Install front cover with bearing on the shaft.
		- Install the non-driving end bearing on the shaft.
		- Install rotor inside the stator with front cover.
		- Install back cover.
		- Tighten front and back cover nuts and bolts.
		- Observe free rotation of the shaft.
		- Clean and Installs cooling fan locker(key)
		- Install the cooling fan.
		- Install fan lock.
			- Visual and mechanical maintenance
			- Physical inspection
			  - Damage
			  - Anchorage and mounting.
			  - Grounding
			  - Connection
			  - Lubrication
			  - Ventilation
			  - Rotor airgap
			- Electrical tests on an AC Induction motor
			  - Insulation test
			  - Insulation resistance of surge protectors
			  - Motor starter test
			  - Resistance temperature detectors
			  - Differential Relay checks
			  - Pickup tests
				10 Hours

		- Install cooling fan cover		
	- Inspect motor	- Check alignment. - Check lose connection - Examine brushes. - Check motor temperature. - Check motor speed. - Check that the bearings are in good condition and operating properly. - Ensure that there is no mechanical obstruction to prevent rotation in the motor or in the driven load. - Ensure that all bolts and nuts are tightened securely. - Ensure that the line voltage and frequency correspond to the voltage and frequency stamped on the nameplate of the motor. - Ensure that the voltage is actually available at motor terminals. - Ensure that the fuses and other protective devices are in proper condition. - Ensure that All connections and contacts are properly made in the circuits between the control apparatus and motor.		10 Hours
	- Test motor	- Carryout open circuit test. - Carryout short circuit test. Carryout grounding test		04 Hours
	- Lubricate motor.	- Stop motor. - Disconnect and lock out of service. - Remove contaminants from grease inlet area. - Remove filler and drain plugs. - Check filler and drain holes for blockage and clean as necessary.		06 Hours

		- Add proper type and amount of grease. Wipe off excess grease and replace filler and drain plugs		
6) Rewind motor	- Rewind stator, rotor, and armature	- Select tools and materials. - Record information from the name plate. - Disassemble motor. - Record data of stator/rotor/armature windings. - Draw schematic diagram of the old/original connection. - Remove the old windings. - Insert the rectangular shaped paper insulation in the slots - Make a circular winding pattern of the same diameter and same number of turns with the original - Insert the circular patterned coil to the slots. - Connect an extension wire to the terminals. - Tie and fix the windings. - Apply an insulating varnish to the new windings and let it dry. - Solder joints. - Test the continuity of the windings. - Terminates the necessary terminals based on the schematic diagram drawn before the winding was dismantled. - Reassemble the motor. - Make report.	- Motor Rewinding o Taking data o Testing and analysing faults in motors o Dismantling o Removal of windings o Measuring the gauge of the windings o Purchase of winding materials o Replacement of windings and assembling o Testing the repaired motor o Follow procedures. o Observe the IEE regulations.	14 Hours
7) Troubleshoot motor	- Possible faults, causes and action.	- Check fuses with proper type and rating. - Check and reset overload in starter. - Check to see that power supplied agrees with motor nameplate and load factor.	- Motor fails to start. - Motor runs slowly. - Motor runs hot. - Motor is noisy.	10 Hours

		- Check for proper line connections with the diagram supplied with motor. - Open circuit in winding or control switch Indicated by humming sound when switch is closed. - Check for loose wiring connections. - Check that all control contacts are closing. - Check to see if motor and drive turn freely. - Check bearings and lubrication. - Check for Short circuited stator indicated by blown fuses. - Check for Poor stator coil connection. - Look for broken bars or end rings. - Reduce the load if the motor is overloaded.	- Motor overload - Motor fault tracing tests o Grounded winding o Open winding o Shorted winding o Reversed coiled. - Motor starters faults	
		- Check lines for open phase. - Reduce load to reduce overload. - Check connection for Low voltage. - Check overload relay, stator and pushbuttons for open circuit or fuses blown	Motor stalls	04 Hours
		- Reduce load. - Open vent holes and check for a continuous stream of air from the motor. - Check to make sure that all leads are well connected. - Locate and repair grounded coil. Check for faulty leads and connections.	Motor overheats while running under load	04 Hours
		- Realign the motor. - Strengthen base against weak support. - Balance coupling. - Rebalance driven equipment.	Motor vibrates	04 Hours

		- Replace defective bearing. - Line up bearing properly. - Check for open circuit. Adjust bearing or add shim.		
		- Remove interference causing the fan to rub air shield. - Clear fan from striking insulation. Tighten holding bolts causing loose on bed plate.	Scraping noise	04 Hours
		- Bent or sprung shaft Straighten or replace shaft. - Decrease belt tension to reduce excessive belt pull. - Move pulley closer to motor bearing. - Realign the drive. - Maintain proper quantity of grease in bearing. - Remove old grease, wash bearings thoroughly in kerosene and replace with new grease. - Reduce quantity of grease in case of excess lubricant - Check alignment, side and end thrust for overloaded bearing. Replace bearing in case of broken ball or rough races.	Hot bearings and bearings ball	08 Hours

Assessment

The module will be assessed through practical work, assignments, tests and final assessment. Their relative contribution to the final grade is as below:

Requirements	Contribution
Assignments	5%
Tests	10%
Practical work	25%
Final assessment	60%
Total	100%

SUPPORT MODULES DETAILS

SUPPORT MODULE: NCES 101-ELECTRICAL INSTALLATION SCIENCE

SUPPORT MODULE: NCES 101- Electrical Installation Science

Duration: 50 Hours

Module Overview

This module introduces the trainee to the principles of direct currents, alternating currents, electromagnetism, illumination and measuring instruments.

Learning Outcomes

By the end of this module, the trainee should be able to:

- Take measurement of the house which is to be installed in metres.
- Convert units: millimetres to metres, kilometres to metres, kilograms to grams, kilowatts to watts, milliampere to ampere, kilovolts to volts, and kilo joule to joule.
- Differentiate between alternating current and direct current.
- Describe the application of capacitors.
- Describe the principles of electromagnetism.
- Demonstrate how to charge and discharge a capacitor.
- Calculate the alternating quantities (currents and voltages).
- Determine voltages and currents to be used in electrical circuits.
- Measure electrical quantities using measuring instruments.

Competences

The trainee:

- Distinguishes between the various electrical SI units, multipliers and sub- multipliers and their derivations.
- Analyses an electrical circuit according to Coulombs' law in relation to charge and current.
- Calculates resistance, voltage and current in a circuit.
- Connects resistors/ lamps in series and parallel.
- Measures voltage across resistors/lamps.
- Describes the factors that affect the resistance of a conductor.
- Applies Kirchhoff's circuit laws
- Calculate power and energy.
- Charges and discharge a capacitor through a resistor.
- Illustrates using graphs the charging and discharging processes of a capacitor (current growth and decay).
- Performs calculation involving charging and discharging of a capacitor.
- Describes the various applications of capacitors according to their types.
- Illustrates using diagrams the two types of connections of capacitors (series and parallel) and the derivation of their total capacitances.
- Derives and applies the formula for the energy stored in a capacitor.
- Describes the applications of magnets.
- Draws magnetic circuits and hysteresis loops.
- Applies the principles and laws of electromagnetism to practical D.C and A.C machines (e.g., Motors, transformers, generators and other machines).
- Distinguishes between mutual inductance and self-inductance.
- Calculates inductance.
- Calculates mean; runs values and forms and peak factors for given a.c circuit
- Calculates power in single phase A.C circuits and power factors.
- Determines power in a pure resistive circuit, pure capacitive circuit and pure inductive circuit.
- Draws the voltage and current waveforms.
- Calculates current, voltage and power factor in series, parallel and series parallel a.c circuits.
- Evaluates reactive, apparent and active powers.
- Illustrates star and delta connections.
- Evaluates power in balanced and unbalanced three phase loads.
- Apply inverse-square law and cosine law of illumination.
- Measures power in d.c and a.c circuits.

Detailed Module Description	Duration
Sub-module 1: Structure of Matter and their Properties • SI units, multiples and sub-multiples • Simple electron theory including flow of electron and • conventional current • Coulomb's law, charge and current • Joule's law of heating • Material properties: ductility, malleability, strength, • elasticity, hardness, toughness, thermal conductivity, • thermal insulation, electrical insulation, magnetic • conductivity, plasticity	10 Hours
• **Sub-module 2: DC circuits Analysis** • Standard symbols for electrical components • Electric current and quantity of electricity • EMF, Potential difference, internal resistance and voltage drop • Ohm's law • Conductors and insulators • Electrical power and energy • Main effects of electric current • Resistance and resistivity • Temperature coefficient of resistance • Series circuits • Potential divider theorem • Parallel networks • Current divider theorem • Series-parallel networks • Kirchhoff' laws • Superposition theorem • 2 wire D.C distributor (Ring and Radial)	22 Hours

• **Sub- module 3: Capacitors and capacitance** • Definition of capacitor • Practical types of capacitors • Electrostatic field • Electric field strength • Capacitance, PD and Electric Charge of a capacitor • Electric flux density • parallel plate capacitor • Capacitors connected in series • Capacitors connected in parallel • Capacitors connected in parallel-series • Energy stored in capacitors	14 Hours

Sub-module 4: Magnetism
• Magnetic field due to an electric current through;
  o Straight conductor
  o Coil, or solenoid
  o Electromagnet
• screw rule and grip rule
• Force on a current-carrying conductor
• Principle of operation of a simple d.c. motor
• Principle of operation of a moving-coil instrument
	10 Hours

Sub-module 5: Magnetic circuits • Magnetic fields • Magnetic flux and flux density • Magnetomotive force and magnetic field strength • Permeability and B–H curves • Hysteresis loop and loss • Reluctance • Composite series magnetic circuits • Comparison between electrical and magnetic quantities	12 Hours

Sub-module 6: Electromagnetic induction
• Laws of electromagnetic induction
  o Faraday's laws of electromagnetic induction
  o Lenz's law
  o Fleming's Right-hand rule
• Calculation of Induced emf
• Self-Inductance and Mutual inductance
	14 Hours

Sub-module 7: Alternating voltages and currents
• Generation of an emf
• A.C. values of the generated emf
  o Instantaneous values
  o peak value or the maximum value or the amplitude
  o average or mean value.
  o root mean square (r.m.s.) value a
• The equation of a sinusoidal voltages and currents
• Combination of sinusoidal voltages and currents
	14 Hours

Sub-module 8: Single Phase AC Circuits
• Purely resistive a.c. circuit
• Purely inductive a.c. circuit
• Purely capacitive a.c. circuit
• Single-phase series a.c. circuits
  o R–L series a.c. circuit
  o R–C series a.c. circuit
  o R–L–C series a.c. circuit
• Power in Single-phase a.c. circuits
  o Apparent power
  o True or active power
  o Reactive power,
  o Power triangle and power factor
  o Power factor improvement.
• Single-phase parallel a.c. circuits
  o R–L parallel a.c. circuit
	10 Hour

○ R–C parallel a.c. circuit ○ L–C parallel circuit ○ LR–C parallel a.c. circuit • Calculations of currents, voltages, reactance, impedance and power in single phase series and parallel a.c circuits	
Sub-module 9: Three Phase AC Circuits • Concept of three-phase supply • The phase-sequence • Line and phase values • star connection and delta connection • Advantages of three-phase systems • Calculations of Power in three phase balanced and un balanced systems • Measurements of power in three phase system by the one, two and three wattmeter methods	10 Hours
Sub-module 10: Illumination • Concept of illumination and basic terms • Inverse-square law • Cosine law • Simple Lighting design calculations	10 Hours
Sub-module 11: Measuring Instruments • Moving coil instruments • Moving iron instruments • Increasing the range of measuring instruments • Multi meters • Watt meters • Cathode-ray oscilloscopes • Measuring electrical quantities • Energy meters	10 Hours

SUPPORT MODULE: NCES 102-ELECTRICAL SUPPLY AND INSTALLATION

SUPPORT MODULE: NCES 102-Electrical Supply and Installation
Duration: 50 Hours

Module Overview

The module equips the trainee with the skills of;

- Transmitting and distributing power using correct cables and conductors to the final consumers, workshop safety, the correct use of basic workshop tools,
- Wiring systems, control and protection and consumer installation
- Lightning protection, earthing, testing and inspection

Learning Outcomes

By the end of this module, the trainee should be able to:

- Observe workshop safety and regulations.
- Care and maintain basic tools in the workshop.
- Demonstrate how power is generated, transmitted and distributed to the local consumer.
- Use correct cables and conductors.
- Make cable joints.
- Choose suitable fuses /circuit breakers for a particular installation.
- Install the house using a suitable wiring system.
- Carry out the consumer's installation.
- Install earthing system.
- Install the lightning protection system.
- Test and inspect after an installation have been completed.

Competences

The trainee:

- Describes the concept of electricity generation.
- Identifies the different sources of power generation.
- Identifies components as applied to the grid system e.g. Conductors, insulators and poles.
- Identifies different transmission and distribution voltages.
- Identifies the components of the distribution system e.g. Transformers, distribution lines, poles, insulators and meters.
- Illustrates the electric power distribution processes.
- Identifies different types of transformers.

- Describes the construction and operation of the transformer.
- Compares the transformer on no-load and on load.
- Analyses transformer impedance and referred values.
- Identifies different types of transformer losses.
- Computes transformer efficiency.
- Identifies types of conductor materials used in cables.
- Identifies types of insulating materials used in cables.
- Selects/uses the correct types of cable.
- Makes and terminates cable joints.
- Selects a correct wiring system for a particular installation.
- Terminates the armoured cables.
- Cuts, bends and uses conduits in an installation.
- Installs at least two common wiring systems e.g., PVC-SWA and conduits.
- Observes basic requirements for installation of PVC-SWA, PILC-SWA, and MIMS, metal conduits, Trunking, cable trays, ducting systems and bus bars and wiring system.
- Installs main switch gears including protective devices.
- Identifies and draws a sequence of control system and a consumer unit.
- Wires up different types of lighting circuits, power circuits, water heater circuits, bell circuits, indicator boards, alarm circuits and cooker circuits.
- Applies IEE regulations on above circuits.
- Describes different earthing terms.
- Identifies types of earthing methods.
- Earths domestic installations.
- Tests earth electrode resistance.
- Identifies places where lighting protection is required.
- Identifies component of a lighting system.
- Designs a zone of protection for a building.
- Installs the lightning protection system.
- Carries out visual inspection.
- Tests a domestic installation.

Detailed Module Description	**Duration**

Sub-module 1: Generation • Sources of power/energy generation • Renewable sources of energy: solar, hydro, wind, geothermal, wave, tidal energies • Non-renewable sources of energy: nuclear, thermal, batteries and cells • Power generation system: turbine, generator, insulator, cable, conductor, transformer, insulator, switchgear, substation, bus bars	6 Hours
Sub-module 2: Transmission • Types of transmission • The grid system • Components of the transmission lines: conductors, insulators, towers, jumpers, cross arm, guard ring, guy • Transmission voltages	4 Hours
Sub-module 3: Distribution Types of distribution: overhead and underground distribution • Components of the distribution system e.g., transformers, distribution lines, poles, insulators and meters • Types of poles: wooden, concrete, metallic • Distribution voltages • Consumer supplies	6 Hours
Sub-module 4: Transformers • Principle of operation of Transformers • Ideal transformer equations • Numerical examples on Ideal transformer equations • phasor diagram of Transformer on no-load • E.m.f. equation of a transformer • Transformer losses and efficiency • Auto transformers • Current transformers • Voltage transformers • Transformer losses • Transformer efficiency • Transformer tests • sites selection for transformers. • Site preparation	14 Hours

• Installation of transformers • Mounting mode (pole mounted, ground mounted) • Maintenance of transformers. • Cooling methods of transformer. • Earthing of the transformer	
Sub-module 5: Cables and Conductors • Definition of cable • Conductor materials used in cables. • Insulating materials • Types of cables • Types of cable joints and terminations	14 Hours
Sub-module 6: Wiring System • PVC-SWA, PILC, MIMS, PVC conduits • Trunking system • Metal conduits, Trunking, cable trays • Ducting systems, bus-bars • Factors affecting the choice of wiring system (ambient temperature, moisture, corrosion, mechanical damage, damage by animals, ultra violet rays) • Regulation requirements for each of the above wiring systems	12 Hours
Sub-module 7: Control and Protection • Main switch gears (for isolation and switching): isolators, switch fuses, fuse switches, circuit breakers, change over switches, distribution board/switch board, overload relay, contactors. • Protective devices: re-wireable fuses to BS 3036, cartridge fuses to BS 1361 and 1362, high breaking capacity fuses to BS 88, miniature circuit breakers to BS 3871 • IEE regulations for the above control and protective devices	16 Hours
Sub-module 8: Consumer's Installation • Supply sequence • Consumer unit • Lighting circuits (one way, two way and intermediate switching) • Power circuits (radial and ring circuits) • Water heater circuits	22 Hours

• Cooker circuits • Installation of bell circuits (types of bells, bell indicators, bell relays, bell supplies, bell and call systems and segregation of circuits) • Alarm circuits (fire and burglar alarm system) • IEE regulations for the above circuits	
Sub-module 9: Earthing • Definition of earthing terms (earth, earth electrode, earth electrode resistance, main earth terminal, earth lead, circuit protective conductor (CPC), extraneous metal work bonding) • Purpose of earthing • Earthing system • Types of earthing (neutral and equipment earthing) • Earth loop impedance • Factors influencing earth resistance of electrodes, • preparation of the pit, termination of the electrode) • Testing earth electrode resistance • Process of earthing (selection)	16 Hours

SUPPORT MODULE: NCES 201-ELECTRICAL MACHINES AND BASIC ELECTRONICS

SUPPORT MODULE: NCES 201-Electrical Machines and Basic Electronics
Duration: 40 Hours

Module Overview

This module introduces the trainee to;

- DC and AC motors.
- AC generators and synchronous motors
- Building and repairing of simple electronic circuits.

Learning Outcome

By the end of this module, the trainee should be able to;

- To operate and repair an electric machine.
- Build and repair simple electronic circuits.

Competences

The trainee:

- Identifies different types of electrical machine and their characteristics.
- Identifies methods of reversing the rotation of dc motors.
- Identifies different types of speed control.
- Identifies different methods of starting single phase ac motors.
- Describes the construction and operation of a three-phase induction motor.
- Determines slip and its application in three phase induction motors.
- Identifies different types of three phase induction motors.
- Compares different starting methods of induction motors.
- Differentiates between cage and wound motors.
- Describes the construction and operation of a three-phase ac generator.
- Identifies the relationships between number of pole pairs, speed and frequency.
- Differentiates between open and short circuit tests of a three-phase ac generator.
- Describes the operation and construction of synchronous motor.
- Identifies starting methods of synchronous motors.
- Compares methods of synchronisation.
- Describes semi-conductors including its properties.
- Illustrates the formation of p-type and n-type semi-conductors.

• Identifies different types of components used in electronic circuits. • Carries out resistance measurement and interprets resistance colour coding. • Tests diodes to determine the resistance of the diode in both forward and reverse directions. • Tests transistors. • Selects a step-down transformer. • Measures primary and secondary windings. • Identifies the application of half wave and full wave rectifiers • Connects a transistor as an amplifier in three configurations (common base, emitter and collector). • Constructs multi stage amplifiers. • Compares the difference between analogue and digital electronics. • Identifies basic logic gates. • Draws truth tables. • Develops logic gates circuits.

Detailed Module Description	Duration
Sub-module 1: DC Machines • D.C. machine construction • E.m.f. generated in an armature winding • Shunt, series and compound windings • Types of d.c. generators and their characteristics • Types of d.c. motor and their characteristics • DC face plate starter and its operation	14 Hours
Sub-module 2: Single Phase AC motors • Construction • Types of single-phase AC motors and their characteristics • Methods of starting single phase AC motors	10 Hours
Sub-module 3: Three Phase AC Motors • The three-phase induction motor construction • Production of a rotating magnetic field and torque slip • Rotor constants, current and copper loss • Induction motor calculations • Torque slip and torque speed characteristics	16 Hours

• Torque equation • Maximum torque • Types of three phase induction motors • Starting of induction motors • Cage motors, wound rotors	
Sub-module 4: The Three Phase AC Generators • Construction • Excitation supply • Relationship between number of poles, speed and frequency • Synchronous generator characteristics • The open and short circuit tests • Regulations • Load characteristics	12 Hours
Sub-module 5: Synchronous Motors • Synchronous motor principles • Starting a synchronous motor • Synchronisation and method of synchronisation • Synchronous motor phasor diagram • Operating a synchronous motor with fixed excitation and at constant power	14 Hours
Sub-module 6: Introduction to Electronics • Importance of electronics • Branches of electronics	02 Hours
Sub-module 7: Semi-Conductors • Definition of semi-conductors • Properties of semi-conductors • Formation of P-type and N-type semi-conductors	02 Hours
Sub- module 8: Electronic Components • Resistors, capacitors, thyristors, diodes, transistors • Resistance measurement and colour codes • Diode and transistor testing	04 Hours

Sub-module 9: DC Power Supplies • Unregulated power supplies • Step down transformer for power supplies • Single phase bridge rectifier and half wave rectifiers • Centre tapped rectifiers. • Three phase rectifiers • Introduction to switching and linear regulators • Application of DC power supplies	10 Hours
Sub-module 10: Amplifier Circuits • Transistors configuration • Methods of transistor biasing • Classes of amplifier and their application • Multi-stage amplifiers • Methods of coupling amplifier • Operational amplifiers	10 Hours
Sub-module 11: Introduction to Digital Electronics • Comparison between analogue and digital electronics • Types of analogue and digital systems i.e. • televisions, watches, metering systems, clocks, phones, • automated teller machines (ATMs), car systems, etc. • Basic logic gates and their truth table (NOT, AND, OR, • NAND, NOR)	4 Hours

END