



COMPETENCY BASED CURRICULUM INDUSTRIAL ELECTRICAL CERTIFICATE-III

**Technical Trainers Training and Resource Center
Department of Workforce Planning and Skills Development
Ministry of Education and Skills Development**

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FOREWORD

Bhutan has seen a gradual increase in the requirement of skilled workers in recent years due to growth of industries. However, supply of skilled workforce that are responsive to the needs of the industry has not been able to keep in pace with the industry demand. Since the skilled workers are crucial ingredient for socio-economic development of the country, it is important to have adequate number of trained and certified workers. With growing industries, the “Industry Electrical Technician” is not only the most significant occupation but also have high demand in the labour market. In an effort to meet the skilled human resources requirement in the area of power sector, it is imperative to deliver training based on Competency Based Training system in Industrial Electrical Certificate-3 to ensure quality and adequate number of work force in this sector.

To this end, the Department of Workforce Planning and Skills Development (DWPSD) is pleased to present revised Competency Based Curriculum for Industrial Electrical Certificate-3 course developed based on national competency standard. Since it is an outcome of a more participatory process of curriculum development, it is expected to provide training delivery with reformed approaches having its content being directly related to labour market needs, focusing on imparting of skills and assessment based on industry work standards. We believe that the Competency Based Curriculum will help in bridging the skill gap between industry’s needs and training institutes thereby enhance the employability of the technical graduates.

The Department acknowledges the valuable contributions made by institutes, officials, and experts from relevant industries who were involved in the design and development of this curriculum. As it is a dynamic document which may require revision based on the needs of the changing labour market, the Department look forward to receiving valuable feedbacks from the institutes and the industries to further improve and refine the curriculum

The Department hope that this document will help advance Competency Based Learning in most of the TVET Institutions.



(Sangay Dorji)

Offtg. Director

Department of Workforce Planning and Skills Development

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Competency Profile
Trade: Industrial Electrical Certificate-3

Competency Area	Sub- Competency Area	Competencies/Tasks 			
A: Carry out industrial wiring	A1 Install motor starter	A1.01 Perform control and power cable ferruling & tagging	A1.02 Construct Direct on- line (DoL) starter	A1.03 Construct forward reverse starter	A1.04 Construct jogging/inching control circuit
		A1.05 Construct star-delta starter	A1.06 Construct auto transformer starter	A1.07 Install soft starter	A1.08 Install VFD
	A2 Install standby power supply	A2.01 Install Diesel Generator	A2.02 Install battery backup supply	A2.03 Commission standby power supply	
	A3 Perform power cable jointing and termination (medium voltage)	A3.01 Prepare cable trench	A3.02 Lay power cable	A3.03 Perform power cable termination	A3.04 Perform LT power cable jointing
		A3.05 Perform XLPE power cable jointing			
B: Carry out maintenance of electric motors and generators	B1: Perform motor and generator inspection	B1.01 Perform pre-start inspection of generator	B1.02 Perform inspection of generator on load	B1.03 Perform pre-start inspection of induction motor	B1.04 Perform inspection of induction motor on load
	B2: Test motor and generators	B2.01 Perform continuity test	B2.02 Perform IR test	B2.03 Perform no-load test	B2.04 Perform on-load test

		B2.05 Perform winding polarity test	B2.06 Perform winding resistance test		
	B3: Perform motor servicing and rewinding	B3.01 Disassemble motor	B3.02 Remove winding	B3.03 Prepare winding coil	B3.04 Insert motor winding coil
		B3.05 Apply varnish on winding	B3.06 Assemble motor		
	B4: Perform servicing of generator	B4.01 Replace oil/fuel filter	B4.02 Change coolant	B4.03 Replace air filter	B4.04 Replace carbon brush
		B4.05 Maintain battery	B4.06 Service thermostat	B4.07 Clean fuel tank	
C: Carryout maintenance of transformers and its accessories	C1 Monitor transformer	C1.01 Inspect breather assembly	C1.02 Inspect conservator and OLTC oil level	C1.03 Inspect for abnormal noise in transformer	C1.04 Inspect bushings
		C1.05 Inspect OTI & WTI pocket oil level	C1.06 Inspect WTI and OTI temperature	C1.07 Inspect Buchholz relay oil level	C1.08 Inspect leakage of transformer oil
		C1.09 Inspect arcing horn	C1.10 Check healthiness of earthing(s)		
	C2 Perform functional test of transformer protection devices	C2.01 Perform Buchholz relay test	C2.02 Perform pressure relief device test	C2.03 Perform Winding Temperature Indicator (WTI) test	C2.04 Perform Oil Temperature Indicator (OTI) test

		C2.05 Perform Magnetic Oil Gauge (MOG) test	C2.06 Perform On-Load Tap Changer test	C2.07 Perform Oil Surge Relay (OSR) test	
	C3 Service transformer	C3.01 Replace bushings	C3.02 Maintain arc-horn gap	C3.03 Filter transformer oil	C3.04 Top-up transformer oil
		C3.05 Change transformer oil	C3.06 Regenerate/replace silica gel	C3.07 Change breather	C3.08 Inspect valves condition
		C3.09 Change the gaskets	C3.10 Tighten terminal connection		
	C4 Perform transformer test	C4.01 Perform breakdown voltage test of transformer oil	C4.02 Perform IR, DAR & PI test of transformer	C4.03 Perform Ratio Test	C4.04 Perform winding resistance test
		C4.05 Perform Tan-Delta test	C4.06 Perform Dissolved Gas Analysis (DGA) Test		
	D: Carryout maintenance of control system and protective switchgear(s)	D1 Monitor control and protective switchgears	D1.01 Inspect oil level of PT/CVT & CT	D1.02 Inspect the SF6 gas level of CB	D1.03 Inspect LA & surge monitor
			D1.05 Inspect condition of CB tripping and closing coil	D1.06 Inspect condition of isolator and earth switch	D1.07 Inspect Automatic Voltage Regulator (AVR)
		D2 Perform functional test of control and protective	D2.01 Test CB closing and tripping circuit	D2.02 Test CB operating mechanism	D2.03 Test isolator and earth switch

	switchgears				
	D3 Service control & protective switchgears	D3.01 Replace tripping and closing coil of CB	D3.02 Replace electromechanical relays	D3.03 Refill SF6 gas	D3.04 Replace LA and surge monitor
	D4 Perform testing of switchgears	D4.01 Perform IR test of LA	D4.02 Perform IR test of CT and PT	D4.03 Perform ratio test of CT	D4.04 Perform polarity test of CT
		D4.05 Perform winding resistance test of CT	D4.06 Perform IR test of CB	D4.07 Perform Contact Resistance Measurement (CRM) test	
E: Carryout installation and maintenance of PLC	E1 Perform installation of PLC	E1.01 Install PLC hardware	E1.02 Connect PLC unit with input and output devices	E1.03 Test connection of PLC module with input and output devices	E1.04 Install PLC software
		E1.05 Establish communication between PLC and programmer (PC)			
	E2 Program basic programmable logic controller (PLC) circuit	E2.01 Program DoL starter	E2.02 Program forward- reverse starter	E2.03 Program counter circuit	E2.04 Program automatic star-delta starter
	E3 Perform maintenance of PLC system	E3.01 Inspect components of PLC system	E3.02 Perform periodic maintenance	E3.03 Troubleshoot PLC system	

COURSE INFORMATION

COURSE TITLE	Industrial Electrical
LEVEL	Certificate Level 3
COURSE OBJECTIVE	Upon completion of this training program, the trainees will be able to: • Carry out industrial wiring • Carry out maintenance of electric motors and generators • Carry out maintenance of transformer and its accessories • Carry out maintenance of control system and protective switchgears • Carry out installation and maintenance of PLC system
COURSE DESCRIPTION	This course is designed to provide trainees with the knowledge, skills and attitudes required to be competent Industrial Electrical Technician. This course will prepare the trainees to exhibit professionalism, teamwork, adaptability, and safety practices as per the requirement of workplace. To obtain certification of this course, all learning outcomes prescribed must be achieved.
COURSE DURATION	1626 Hours (942 Hours Institute Duration, 420 Hours/3Months OJT and 264 Hours General subjects & Assessment)
TRAINER AND TRAINEE RATIO	1:12 (Practical) 1:20 (Theory)
ENTRY REQUIREMENT	Completed Domestic wiring Certificate-2 OR T & DL certificate 2
TVET TRAINER REQUIREMENTS	• Must have a minimum qualification of Diploma in relevant field with three years of working experience; • Must have undergone Training of Trainers-Technical Instruction and Pedagogy; • Must¹ have at least 5 years job/industry experience

¹ Applicable only if institutes hire instructor or guest lecturer from industry

COURSE OUTLINE

Sl. No	Subject /Module	Duration (Hours)	Content Competencies (Mapped)
1.	Core modules	942	CC
2.	OJT	420/3 months	CC
3.	Applied Dzongkha	42	SS
4.	ICT	48	SS
5.	Applied Mathematics	53	SS
6.	Technical English	51	SS
7.	Assessment	70	
	Total Course Duration	1626	

Note: (*) This curriculum contains core modules which cover main competencies of Industrial Electrical Certificate-3 and OJT component. There are separate curricula for subjects/modules for delivery of soft skills, professional development & values and environmental concern & safety. In order to achieve the qualification of Industrial Electrical Certificate-3, the subjects and modules listed must be accomplished as per the credit hours provided.

Content Competencies:

CC-Core Competencies

SS-Soft Skills

PD-Professional Development and Values

ES-Environmental concern and Safety

COURSE STRUCTURE FOR CORE COMPETENCIES

Training Modality	Module Title	Learning Outcomes	Nominal Duration (Hrs)
Institute Training	A. Carrying out industrial wiring	A1. Install motor starter A2. Install standby power supply A3. Perform power cable jointing and termination (Medium voltage)	202
	B. Carrying out maintenance of electric motors and generators	B1. Perform motor and generator inspection B2. Test motor and generators B3. Perform motor servicing and rewinding B4. Perform servicing of generators	230
	C. Carrying out maintenance of transformer and its accessories	C1. Monitor transformer C2. Perform functional test of transformer protection devices C3. Service transformer C4. Perform transformer test	252
	D. Carrying out maintenance of control system and protective switchgears	D1. Monitor control and protective switchgears D2. Perform functional test of control ad protective switchgears D3. Service control and protective switchgears D4. Perform testing of switchgears	174
	E. Carrying out installation and maintenance of PLC	E1. Perform installation of PLC E2. Program basic PLC circuits E3. Perform maintenance of PLC system	84
On The Job Training	A. Carrying out industrial wiring	A1. Install motor starter A2. Install standby power supply A3. Perform power cable jointing and termination (Medium voltage)	420 Hrs/ 3 Months
	B. Carrying out maintenance of electric motors and generators	B1. Perform motor and generator inspection B2. Test motor and generators B3. Perform motor servicing and rewinding B4. Perform servicing of generators	
	C. Carrying out maintenance of transformer and its accessories	C1. Monitor transformer C2. Perform functional test of transformer protection devices C3. Service transformer C4. Perform transformer test	
	D. Carrying out maintenance of control system	D1. Monitor control and protective switchgears D2. Perform functional test of control ad protective switchgears D3. Service control and protective switchgears	

	and protective switchgears	D4. Perform testing of switchgears	
	E. Carrying out installation and maintenance of PLC	E1. Perform installation of PLC E2. Program basic PLC circuits E3. Perform maintenance of PLC system	
Total Duration			1362

ASSESSMENT AND CERTIFICATION SYSTEM

ASSESSMENT

Formative assessment for every module and learning outcome will be conducted through assignments, project works, continuous assessment, demonstration of practical skills/observations, oral questioning and written test.

Summative assessment after completion of each national certificate level will be conducted by TVET Quality Council, Bhutan Qualifications and professional certification authority, MoESD as per the National Competency Standards and Guidelines for National Assessment and Certification System, provided the course is accredited with TVET Quality Council, Bhutan Qualifications and professional certification authority, MoESD.

CERTIFICATION

On successful completion of every module, the institute will award a certificate of achievement to the trainees. The TVET Quality Council, Bhutan Qualifications and professional certification authority, MoESD will award a National Certificate to the trainees upon the successful completion of NC level assessment.

COURSE DELIVERY

1. Modular
2. Demonstration
3. Lecture
4. Industrial training/attachment
5. Project work
6. Problem-based learning
7. Project-based learning

RESOURCES

Materials

- Markin cloth, mortar pan, wires, insulation tape, DPST switch, TPST switch, centrifugal switch, MPCB, MCCB, enamel copper wire, dry bamboo, cotton tape, insulation paper, wire sleeve, sand paper, welding needle, varnish, tray, emery cloth, grease, cable lugs bearing, oil/fuel filter, oil, fuel, tray, coolant, rubber abrasive, pressure spring, cleaning agent, carbon brush, distilled water, nuts & bolts, screw, washer, thermostat, heat source, fuel tank, fuel, Teflon tape, water, din rail, power cable, control cable, contactors, OLTR, push button elements, push button, contactor add-on blocks, terminal block, indicator lamp, cable ties, ferrules, cable tags, SFU, cable glands, wooden screws, anchor bolts, petroleum gel, battery terminal clamp, PLC software, limit switch, sensor, wooden board, push button box, master cable, relay, mason thread, cement, aggregates, water, planks, MS rod, binding wire, anchor bolt, tray support, bricks, route marker, cable termination kit, mopping cloth, XLPE cable, jointing kit, hacksaw blade, marker pen, cylinder, gas pipe, lighter, fuel, hacksaw blade, sand paper, tissue paper, gas regulator, inspection check list, pen, transformer oil seal, funnel, bucket, jug, container, heat source, Oil sampling bottle, transformer oil, trip coil, close coils, brush, SF6 gas, Binding wire, pulley, conductor, terminal clamp, PP rope, anti-rust spray, battery, sensors, indicator lamp, wooden board, indicator box, din rail, fuse, terminal block and relay

Tools

- Pliers, screw driver set, crimping tools, centre punch, mallet, ball peen hammer, bearing puller, chisel, snip, cutting mallet, former, measuring tape, wire inserter, electrician knife, winding compactor, oil filter funnel, file, spirit level, wire stripper,

spade, sledge hammer, pick axe, crow bar, shovel, knife, plumb bob, towel, binding hook, scraping tool, heat torch, hacksaw frame, cable stripper, discharge rod and conductor cutter

Instruments

- Multi-meter, hydrometer, tachometer, clamp-on meter, IR tester, wire gauge, micro-meter, ammeter, wattmeter, voltmeter, pyrometer, power factor meter, filler gauge, TTR tester and earth tester

Software

- PLC software

Equipment

- Portable blower, generator, auto transformer, power supply unit, brake drum, 3-phase induction motor, 1-phase induction motor, single phase capacitor start motor, slip ring motor and single-phase centrifugal motor, winding machine, varnish curing oven, brake drum, DG set, air compressor, water pump, Variable Frequency Drive (VFD), batteries, power drilling machine, inverter, rectifier, changeover switch, standby power supply unit, PLC CPU & modules, PC, concrete vibrator, mixer, wheel barrow, hydraulic crimping tool, hydraulic crimping machine, IR tester, Buchholz relay, PRD, WTI, OTI, MOG, ladder, transformer, SF6 circuit breaker, isolator, earth-switch, circuit breaker, electromechanical relays, gas filling kit, SF6 gas leakage detector, lightning arrester, IR tester, derrick pole, BDV testing kit, relay testing kit, galvanometer, CT, PLC, CPU, Human Machine Interface (HMI), Switching Mode Power Supply (SMPS) and computer

Personal Protective Equipment (PPE)

- Safety gloves, safety boots, safety helmet, safety goggles, safety harness, mouth mask, ear muff, ear plug and reflective vest

Learning Materials

- Competency Based Learning Materials (CBLM)
- Reference books
- Hand-outs
- Audio visuals
- LMS
- Google classroom

Infrastructure and training facilities

- *Theory classroom size:* Minimum of 1 m² per trainee;
- *Practical Workshop size:* Minimum of 2.25 m² per trainee. Variables must be considered depending upon type of skills being taught and the number of trainees participating at a time.

MODULE INFORMATION:
INDUSTRIAL ELECTRICAL CERTIFICATE-III

MODULE 1
ON
CARRYING OUT INDUSTRIAL WIRING

MODULE INFORMATION

Occupation	Industrial Electrical Technician
Competency Area	Carry out industrial wiring
Module Title	Carrying out industrial wiring
Module Code	7411-L3-M1
Module Description	This module is structured to provide learners with the knowledge, skills and right attitude required to install motor starter, install standby power supply and perform power cable jointing & termination.
Nominal Duration	202 Hours
Certificate Level	Certificate Level 3
Pre-requisite	Completed Domestic wiring C2 or T&DL C2
Learning Outcome	1. Install motor starter 2. Install standby power supply 3. Perform power cable jointing and termination

Module Title	Carrying out industrial wiring		
Module Code	7411-L3-M1		
Learning Outcome 1	Install motor starter		
Duration	Theory: 16 hours	Practical:74 hours	Total: 90 hours
Assessment Criteria	- Ferruling and tagging of control and power cable are performed as per the standard procedures - Direct On-Line (DOL) starter is constructed as per the standard procedures - Forward-reverse starter is constructed as per the standard procedures - Jogging/inching control circuit is constructed as per the standard procedures - Star-Delta starter is constructed as per the standard procedures - Auto-transformer starter is constructed as per the standard procedures - Soft starter is installed as per the standard procedures - Variable Frequency Drive is installed as per the standard procedures		
Content	A1.01 Performing control and power cable ferruling & tagging Knowledge - Purpose of cable ferruling and tagging - Rules related to cable ferruling - Advantage of cable ferruling - Methods of cable tagging - Types of ferrule Skills - Interpreting drawing - Using crimping tool - Observation skills Attitude, safety and environmental concern - Effective time management - Being team player - Having integrity and work ethics - Efficient use of materials - Proper handling and storage of tools, materials and equipment - Ensuring appropriate use of PPE - Ensuring to follow OHS rules and regulations - Ensuring proper disposal of waste A1.02 Constructing Direct On-Line starter Knowledge - Types of motor starter - Working principle of DOL starter - DOL starter components and their functions - Application of DOL starter - Differences between control circuit and power circuit		

	<i>Skills</i> • Using Multimeter • Using clamp-on meter • Interpreting circuit diagram • Using portable drilling machine • Cable laying, ferruling and tagging skills • Communication skills • Analytical skill <i>Attitude, safety and environmental concern</i> • Effective time management • Having integrity and work ethics • Efficient use of materials • Proper handling and storage of tools, materials and equipment • Ensuring appropriate use of PPE • Ensuring to follow OHS rules and regulations • Ensuring proper disposal of waste • Ensuring to provide appropriate control voltage and proper termination A1.03 Constructing forward reverse starter <i>Knowledge</i> • Importance of interlock circuit • Working principle of forward reverse starter • Components of forward reverse starter and their functions • Application of forward reverse starter • Differences between control circuit and power circuit <i>Skills</i> • Using Multimeter • Using portable drilling machine • Cable laying, ferruling and tagging skills • Using portable blower • Interpreting circuit diagram • Communication skills • Analytical skills <i>Attitude, safety and environmental concern</i> • Effective time management • Having integrity and work ethics • Efficient use of materials • Proper handling and storage of tools, materials and equipment • Ensuring appropriate use of PPE • Ensuring to follow OHS rules and regulations • Ensuring proper disposal of waste • Ensuring to provide appropriate control voltage and proper termination
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	A1.04 Constructing jogging/inching control circuit Knowledge • Working principle of jogging/inching control circuit • Application of jogging/inching control • Differences between control circuit and power circuit Skills • Using Multimeter • Using clamp-on meter • Interpreting circuit diagram • Using portable drilling machine • Cable laying, ferruling and tagging skills • Using portable blower • Communication skills • Analytical skills Attitude, safety and environmental concern • Effective time management • Having integrity and work ethics • Efficient use of materials • Proper handling and storage of tools, materials and equipment • Ensuring appropriate use of PPE • Ensuring to follow OHS rules and regulations • Ensuring proper disposal of waste • Ensuring to provide appropriate control voltage and proper termination A1.05 Constructing star-delta starter Knowledge • Working principle of star-delta starter • Types of star-delta starter • Application of Star-Delta starter • Differences between control circuit and power circuit • Types and application of timer Skills • Using Multimeter • Interpreting circuit diagram • Using portable drilling machine • Cable laying, ferruling and tagging skills • Using portable blower • Communication skills • Analytical skills Attitude, safety and environmental concern • Effective time management • Having integrity and work ethics • Efficient use of materials • Proper handling and storage of tools, materials and equipment • Ensuring appropriate use of PPE • Ensuring to follow OHS rules and regulations
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	• Ensuring proper disposal of waste • Ensuring to provide appropriate control voltage and proper termination A1.06 Constructing auto-transformer starter Knowledge • Working principle of Auto-transformer • Differences between control circuit and power circuit • Determining the tapping voltage • Application of Auto-transformer starter Skills • Using Multimeter • Using clamp-on meter • Using pyrometer • Using Tachometer • Interpreting circuit diagram • Using portable drilling machine • Cable laying, ferruling and tagging skills • Using portable blower • Communication skills • Analytical skills Attitude, safety and environmental concern • Effective time management • Having integrity and work ethics • Efficient use of materials • Proper handling and storage of tools, materials and equipment • Ensuring appropriate use of PPE • Ensuring to follow OHS rules and regulations • Ensuring proper disposal of waste • Ensuring to provide appropriate control voltage and proper termination A1.07 Installing soft starter Knowledge • Definition of Soft Starter • Application of Soft Starter • Selection of Soft Starter • Working principles of Soft Starter Skills • Using Multimeter • Using clamp-on meter • Interpreting circuit diagram • Using portable drilling machine • Cable laying, ferruling and tagging skills • Using portable blower • Communication skills • Analytical skills
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	<i>Attitude, safety and environmental concern</i> • Effective time management • Having integrity and work ethics • Efficient use of materials • Proper handling and storage of tools, materials and equipment • Ensuring appropriate use of PPE • Ensuring to follow OHS rules and regulations • Ensuring proper disposal of waste A1.08 Installing Variable Frequency Drive (VFD) <i>Knowledge</i> • Definition of Variable Frequency Drive (VFD) • Application of Variable Frequency Drive (VFD) • Selection of Variable Frequency Drive (VFD) • Working principles of Variable Frequency Drive (VFD) • Parameter configuration of VFD (Acceleration/ deacceleration/ speed control/Torque control) <i>Skills</i> • Using Multimeter • Interpreting circuit diagram • Interpreting VFD manual • Using portable drilling machine • Cable laying, ferruling and tagging skills • Using portable blower • Communication skills • Analytical skills <i>Attitude, safety and environmental concern</i> • Effective time management • Having integrity and work ethics • Efficient use of materials • Proper handling and storage of tools, materials and equipment • Ensuring to follow OHS rules and regulation • Ensuring appropriate use of PPE • Ensuring proper disposal of waste • Ensuring adequate ventilation • Ensuring proper mounting and securing of VFD
Learning Conditions	Learning Materials • Competency Based Learning Materials (CBLM) • Hand-outs • Audio Visuals • Reference books • Manuals • LMS • Google classroom

	Learning facilities and infrastructure • Classroom with adequate facilities • Information Technology (IT) lab • Library • Workshop Materials • Markin cloth, din rail, power cable, control cable, contactors, OLTR, MCB, Motor Protection Circuit breaker (MPCB), push button elements, push button, contactor add-on blocks, terminal block, indicator lamp, wires, cable ties, ferrules, cable tags, insulation tape, lugs, wooden screws, nuts & bolts, drill bit, timer and SFU Tools • Crimping tools, wire stripper, pliers, screwdriver set, adjustable wrench, ring type spanner set, open ended spanner set, ball peen hammer, Allen key set and measuring tape Instruments • Multimeter, tachometer, pyrometer and clamp-on meter Equipment • Induction motor, portable drilling machine, portable blower, auto-transformer, Variable Frequency Drive (VFD), soft starter and control panel PPE • Safety gloves, safety boots, safety helmet, safety goggles, safety harness, mouth mask and reflective vest
Instructional Methodologies	The trainer shall use <i>inter alia</i>, the following instructional methods: • Lecture • Interactive discussion • Demonstration • Industrial visit/training • Guided practice • Group practice with project-based learning • Individual practice with problem-based learning
Method of Assessment	The trainer shall use <i>inter alia</i>, the following assessment methods: • Practical observation • Oral/viva-voce • Written test • Assignment • Project work

Module Title	Carrying out industrial wiring		
Module Code	7411-L3-M2		
Learning Outcome 2	Install standby power supply		
Duration	Theory: 4 hours	Practical: 14 hours	Total: 18 hours
Assessment Criteria	• Diesel Generator is installed as per the standard procedures • Battery backup supply is installed as per the standard procedures • Standby power supply is commissioned as per the standard procedures		
Content	A2.01 Installing Diesel Generator Knowledge • Types of standby power supply • Importance of standby power supply • Introduction to diesel generator • Components of diesel generator and their functions • Working principle of Diesel generator • Parameters of DG • Load calculation Skills • Using Multimeter • Using phase sequence meter • Using clamp on meter • Interpreting manual • Interpreting circuit diagram • Communication skills • Analytical skills Attitude, safety and environmental concern • Effective time management • Having integrity and work ethics • Efficient use of materials • Proper handling and storage of tools, materials and equipment • Ensuring appropriate use of PPE • Ensuring to follow OHS rules and regulations • Ensuring proper disposal of waste • Ensuring to provide correct phase sequence A2.02 Installing battery backup supply Knowledge • Types of batteries • Charging and discharging of batteries • Mode of charging batteries • Types of battery connection • Types of battery terminal clamp • Selection of battery capacity (battery sizing) Skills • Using Multimeter		

	• Interpreting circuit diagram • Testing battery • Observation skills <i>Attitude, safety and environmental concern</i> • Effective time management • Having integrity and work ethics • Efficient use of materials • Proper handling and storage of tools, materials and equipment • Ensuring appropriate use of PPE • Ensuring to follow OHS rules and regulations • Ensuring proper disposal of waste • Ensuring to avoid excessive force while tightening battery terminal A2.03 Commissioning standby power supply <i>Knowledge</i> • Importance of pre-commissioning test of standby power supply • Periodic maintenance of standby power supply <i>Skills</i> • Using Multimeter • Communication skills <i>Attitude, safety and environmental concern</i> • Effective time management • Having integrity and work ethics • Efficient use of materials • Proper handling and storage of tools, materials and equipment • Ensuring appropriate use of PPE • Ensuring to follow OHS rules and regulations • Ensuring proper disposal of waste • Ensuring to provide correct connection as per the circuit diagram
Learning Conditions	Learning Materials • CBLM • Hand-outs • Audio Visuals • Reference books • Manuals • LMS • Google classroom Learning Facilities and infrastructure • Classroom with adequate facilities • Information Technology (IT) lab • Library • Workshop

	Materials - Wires, insulation tape, thimble/lugs, cables, cable glands, nuts & bolts, screws, anchor bolts, Markin cloth, petroleum gel, battery terminal clamp and emery cloth Tools - Crimping tool, hammer, spirit level, measuring tape, screwdriver set, spanner set, pliers, electrician knife, wire stripper, Allen key set and wrench set Equipment - Batteries, power drilling machine, inverter, battery charger and Diesel generator set PPE - Safety gloves, safety boots, safety helmet, safety goggles, safety harness, mouth mask and reflective vest
Instructional Methodologies	The trainer shall use <i>inter alia</i>, the following instructional methods: - Lecture - Interactive discussion - Demonstration - Industrial visit/training - Guided practice - Group practice with project-based learning - Individual practice with problem-based learning
Method of Assessment	The trainer shall use <i>inter alia</i>, the following assessment methods: - Practical observation - Oral/viva-voce - Written test - Assignment - Project work

Module Title	Carrying out industrial wiring		
Module Code	7411-L3-M1		
Learning Outcome 3	Perform power cable jointing and termination (medium voltage)		
Duration	Theory: 10 hours	Practical:84 hours	Total: 94 hours
Assessment Criteria	• Cable trench is constructed as per the standard procedures • Power cable is laid as per standard procedures • XLPE power cable is terminated as per the standard procedures • LT power cable jointing is performed as per the standard procedures • XLPE power cable jointing is performed as per the standard procedures		
Content	A3.01 Preparing cable trench Knowledge • Purpose of trench • Types of trench • Constructional features of trench • Factors determining size of trench • Importance of providing cable tray supports • Mixing ratio of RCC and PCC • RCC setting time Skills • Interpreting drawing • Masonry skills • Applying first aid • Communication skills Attitude, safety and environmental concern • Effective time management • Having integrity and work ethics • Efficient use of materials • Proper handling and storage of tools, materials and equipment • Ensuring appropriate use of PPE • Ensuring to follow OHS rules and regulations • Ensuring proper disposal of waste A3.02 Laying power cable Knowledge • Types of Under Ground (UG) cable • Construction of UG cable • Advantages and disadvantages of UG cable • Methods of laying UG cable • Importance of route marker • Types of route marker • Purpose of providing soft bedding • Purpose of brick/concrete protection and cable warning tape • Importance of maintaining correct bending radii		

	Skills • Interpreting drawing • Cable layout skills • Cable dressing skills • Communication skills Attitude, safety and environmental concern • Effective time management • Having integrity and work ethics • Efficient use of materials • Proper handling and storage of tools, materials and equipment • Ensuring appropriate use of PPE • Ensuring to follow OHS rules and regulations • Ensuring proper disposal of waste • Ensuring to avoid over twisting and bending of cable A3.03 Performing XLPE power cable termination Knowledge • Types of cable termination • Purpose of cable termination • Cause and effect of poor cable termination Skills • Interpreting manual • Using crimping tool • Using cable stripper • Using heat gun • Using IR tester Attitude, safety and environmental concern • Effective time management • Having integrity and work ethics • Efficient use of materials • Proper handling and storage of tools, materials and equipment • Ensuring appropriate use of PPE • Ensuring to follow OHS rules and regulations • Ensuring proper disposal of waste • Ensuring to avoid non-uniform and overheating of cable A3.04 Performing LT power cable jointing Knowledge • Purpose of cable jointing • Methods of cable jointing • Types of cable jointing kit • Causes and effects of poor joint Skills • Interpreting manual • Using heat gun
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	• Using crimping/compression tool • Using IR tester • Using cable stripper <i>Attitude, safety and environmental concern</i> • Effective time management • Having integrity and work ethics • Efficient use of materials • Proper handling and storage of tools, materials and equipment • Ensuring appropriate use of PPE • Ensuring to follow OHS rules and regulations • Ensuring proper disposal of waste • Ensuring to avoid non-uniform and overheating of cable A3.05 Performing XLPE power cable jointing <i>Knowledge</i> • Methods of cable jointing • Types of cable jointing kit • Causes and effects of poor joint <i>Skills</i> • Interpreting manual • Using heat gun • Using crimping/compression tool • Using IR tester • Using cable stripper • Using XLPE scrapper <i>Attitude, safety and environmental concern</i> • Effective time management • Having integrity and work ethics • Efficient use of materials • Proper handling and storage of tools, materials and equipment • Ensuring appropriate use of PPE • Ensuring to follow OHS rules and regulations • Ensuring proper disposal of waste • Ensuring to avoid non-uniform and overheating of cable • Ensuring to provide adequate insulation • Ensuring to maintain semiconductor level as per standard • Ensuring to maintain XLPE level as per standard
Learning Conditions	Learning Materials • CBLM • Hand-outs • Audio Visuals • Reference books • Manuals • LMS • Google classroom

	Learning Facilities and infrastructure • Classroom with adequate facilities • Information Technology (IT) lab • Library • Workshop Materials • Mason thread, cement, aggregates, sand, water, planks, MS rod, binding wire, anchor bolt, tray support, bricks, power cable, route marker, cable termination kit, HT/LT insulation tape, emery cloth, silicon grease, mopping cloth, XLPE cable, lugs, joining kit, hacksaw blade, marker pen, sand paper, Markin cloth, tissue paper, gas cylinder, gas pipe, gas regulator, lighter, nails and fuel Tools • Spade, sledge hammer, pick axe, crow bar, shovel, cable knife, plumb bob, trowel, binding hook, mortar pan, file, screwdriver, scraping tool, pliers, hacksaw frame, heat gun and cable stripper Equipment • Concrete vibrator, mixer, wheel barrow and hydraulic crimping tool PPE • Safety gloves, safety boots, safety helmet, safety goggles, mouth mask, workshop dress and reflective vest
Instructional Methodologies	The trainer shall use <i>inter alia</i>, the following instructional methods: • Lecture • Interactive discussion • Demonstration • Industrial visit/training • Guided practice • Group practice with project-based learning • Individual practice with problem-based learning
Method of Assessment	The trainer shall use <i>inter alia</i>, the following assessment methods: • Practical observation • Oral/viva-voce • Written test • Assignment • Project work • Rubrics

MODULE 2
ON
CARRYING OUT MAINTENANCE OF ELECTRIC MOTORS AND
GENERATORS

MODULE INFORMATION

Occupation	Industrial Electrical Technician
Competency Area	Carry out maintenance of electric motors and generators
Module Title	Carrying out maintenance of electric motors and generators
Module Code	7411- L3-M2
Module Description	This module is structured to provide the learners with knowledge, skills and right attitude to perform motor servicing & rewinding and perform servicing of generator
Nominal Duration	230 Hours
Qualification Level	Certificate Level 3
Pre-requisite	Completed Module: 7411-L3-M1
Learning Outcome	1. Perform motor and generator inspection 2. Test motors and generators 3. Perform motor servicing & rewinding 4. Perform servicing of generator

Module Title	Carrying out maintenance of electric motors and generators		
Module Code	7411-L3-M2		
Learning Outcome 1	Perform motor and generator inspection		
Duration	Theory: 10 hours	Practical: 32 hours	Total: 42 hours
Assessment Criteria	• Pre-start inspection of generator is performed as per the standard procedures • Inspection of generator on load is performed as per standard procedures • Pre-start inspection of induction motor is performed as per the standard procedures • Inspection of induction motor on load is performed as per the standard procedures		
Contents	B1.01 Performing pre-test inspection of generator Knowledge • Types of generator • Components of generator and their functions • Working principle of generator • Application of generator • Parameters of generator Skills • Using Multimeter • Using hydrometer • Analytical skills • Communication skills Attitude, safety and environmental concern • Effective time management • Having integrity and work ethics • Efficient use of materials • Proper handling and storage of tools, materials and equipment • Ensuring appropriate use of PPE • Ensuring to follow OHS rules and regulations • Ensuring proper disposal of waste B1.02 Performing inspection of generator on-load Knowledge • Calculation of generator load • Calculation of fuel consumption • Purpose of inspection Skills • Using multimeter • Observation skills • Analytical skills • Numeracy skills Attitude, safety and environmental concern • Effective time management • Having integrity and work ethics		

	• Efficient use of materials • Proper handling and storage of tools, materials and equipment • Ensuring appropriate use of PPE • Ensuring to follow OHS rules and regulations • Ensuring proper disposal of waste • Ensuring to check the engine oil level and coolant B1.03 Performing pre-test inspection of induction motor Knowledge • Types of motor • Components of induction motor and its function • Working principle of induction motor • Application of induction motor Skills • Using portable blower • Observation skills • Analytical skills Attitude, safety and environmental concern • Effective time management • Having integrity and work ethics • Efficient use of materials • Proper handling and storage of tools, materials and equipment • Ensuring appropriate use of PPE • Ensuring to follow OHS rules and regulations • Ensuring proper disposal of waste B1.04 Performing inspection of induction motor on-load Knowledge • Purpose of inspection Skills • Using Multimeter • Using pyrometer • Using tachometer • Using clamp-on meter • Communication skills • Analytical skills Attitude, safety and environmental concern • Effective time management • Having integrity and work ethics • Efficient use of materials • Proper handling and storage of tools, materials and equipment • Ensuring appropriate use of PPE • Ensuring to follow OHS rules and regulations • Ensuring proper disposal of waste
Learning Conditions	Learning Materials • CBLM

	• Hand outs • Audio-visuals • Reference books • Manuals • LMS • Google classroom Learning Facilities and Infrastructure • Classroom with adequate facilities • Library • IT lab • Workshop Materials • Markin cloth and observation check list Tools • Pliers, screwdriver set, adjustable wrench, ring type spanner set, Allen key set and open-ended spanner set Equipment • Portable blower, motor and generator Instrument • Multimeter, hydrometer, pyrometer, tachometer and clamp-on meter PPE • Safety gloves, safety boots, safety helmet, safety goggles, safety harness, mouth mask and reflective vest
Instructional Methodologies	The trainer shall use <i>inter alia</i>, the following instructional methods: • Lecture • Interactive discussion • Demonstration • Industrial visit/training • Guided practice • Group practice with project-based learning • Individual practice with problem-based learning
Method of Assessment	The trainer shall use <i>inter alia</i>, the following assessment methods: • Practical observation • Oral/viva-voce • Written test • Assignment • Project work

Module Title	Carrying out maintenance of electric motors and generators		
Module Code	7411-L3-M1		
Learning Outcome 2	Test motor and generators		
Duration	Theory: 8 hours	Practical: 34 hours	Total: 42 hours
Assessment Criteria	• Continuity test is performed as per the standard procedures • IR test is performed as per the standard procedures • No load test is performed as per the standard procedures • On load test is performed as per the standard procedures • Winding polarity test is performed as per the standard procedures • Winding resistance test is performed as per the standard procedures		
Contents	B2.01 Performing continuity test Knowledge • Types of test • Identification of terminals • Purpose of continuity test Skills • Using Multimeter • Communication skills Attitude, safety and environmental concern • Effective time management • Having integrity and work ethics • Efficient use of materials • Proper handling and storage of tools, materials and equipment • Ensuring appropriate use of PPE • Ensuring to follow OHS rules and regulations • Ensuring proper disposal of waste B2.02 Performing IR test Knowledge • Purpose of IR test • Causes of insulation failure • Importance of selecting IR test voltage Skills • Operating IR tester • Communication skills • Analytical skills Attitude, safety and environmental concern • Effective time management • Having integrity and work ethics • Efficient use of materials • Proper handling and storage of tools, materials and equipment • Ensuring appropriate use of PPE • Ensuring to follow OHS rules and regulations • Ensuring proper disposal of waste		

	B2.03 Performing no-load test Knowledge • Purpose of testing motor with no load • Type of losses • Calculation of losses • Effect of voltage variation Skills • Using clamp-on meter • Using tachometer • Numeracy skills • Communication skills • Analytical skills Attitude, safety and environmental concern • Effective time management • Having integrity and work ethics • Efficient use of materials • Proper handling and storage of tools, materials and equipment • Ensuring appropriate use of PPE • Ensuring to follow OHS rules and regulations • Ensuring proper disposal of waste B2.04 Performing on-load test Knowledge • Purpose of on-load test of motor • Calculation of motor efficiency, losses, slips and torque • Consequences of overloading motor Skills • Using clamp-on meter • Using multimeter • Using tachometer • Using pyrometer • Communication skills • Numeracy skills • Analytical skills Attitude, safety and environmental concern • Effective time management • Having integrity and work ethics • Efficient use of materials • Proper handling and storage of tools, materials and equipment • Ensuring appropriate use of PPE • Ensuring to follow OHS rules and regulations • Ensuring proper disposal of waste B2.05 Performing winding polarity test Knowledge • Purpose of winding polarity test
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	• Importance of tagging the winding terminals • Methods of performing winding polarity test Skills • Interpreting circuit diagram • Using Multimeter • Using IR tester • Communication skills • Analytical skills Attitude, safety and environmental concern • Effective time management • Having integrity and work ethics • Efficient use of materials • Proper handling and storage of tools, materials and equipment • Ensuring appropriate use of PPE • Ensuring to follow OHS rules and regulations • Ensuring proper disposal of waste B2.06 Performing winding resistance test Knowledge • Purpose of winding resistance test of motor Skills • Using Multimeter • Using Ohm meter • Communication skills • Analytical skills Attitude, safety and environmental concern • Effective time management • Having integrity and work ethics • Efficient use of materials • Proper handling and storage of tools, materials and equipment • Ensuring appropriate use of PPE • Ensuring to follow OHS rules and regulations • Ensuring proper disposal of waste
Learning Conditions	Learning Materials • CBLM • Hand outs • Audio-visuals • Reference books • Manuals • LMS • Google classroom Learning Facilities and Infrastructure • Classroom with adequate facilities • Library • IT lab

	• Workshop Materials • Markin cloth, wires, insulation tape, DPST switch, TPST switch, centrifugal switch, MPCB, MCCB and motor starter Tools • Spanner set, pliers, screwdriver set, ball peen hammer, Allen key set and crimping tool Instrument • Clamp-on meter, IR tester, tachometer, multi-meter, ammeter, wattmeter, voltmeter, Ohm meter and pyrometer Equipment • Auto transformer, power supply unit, brake drum, 3-phase induction motor, single-phase induction motor and generator PPE • Safety gloves, safety boots, safety helmet, safety goggles, reflective vest, ear muff and mouth mask
Instructional Methodologies	The trainer shall use <i>inter alia</i>, the following instructional methods: • Lecture • Interactive discussion • Demonstration • Industrial visit/training • Guided practice • Group practice with project-based learning • Individual practice with problem-based learning
Method of Assessment	The trainer shall use <i>inter alia</i>, the following assessment methods: • Practical observation • Oral/viva-voce • Written test • Assignment • Project work

Module Title	Carrying out maintenance of electric motors and generators		
Module Code	7411-L3-M2		
Learning Outcome 3	Perform motor servicing and rewinding		
Duration	Theory: 17 hours	Practical: 85 hours	Total: 102 hours
Assessment Criteria	• Motor is disassembled as per the standard procedures • Winding coil is removed as per the standard procedures • Winding coil is prepared as per the standard procedures • Winding coils are inserted as per the standard procedures • Varnish is applied on winding as per the standard procedures • Motor is assembled as per the standard procedures		
Contents	B3.01 Disassembling motor Knowledge • Definition of texture and pebble dash • Stages of surface preparation and its purposes • Estimation of materials Skills • Using bearing puller • Communication skills • Analytical skills Attitude, safety and environmental concern • Effective time management • Having integrity and work ethics • Efficient use of materials • Proper handling and storage of tools, materials and equipment • Ensuring appropriate use of PPE • Ensuring to follow OHS rules and regulations • Ensuring proper disposal of waste • Ensuring to use right tools B3.02 Removing winding Knowledge • Types of winding • Types of winding diagram • Purpose of winding diagram • Terminologies of motor winding • Importance of recording winding data prior to its removal Skills • Using micro-meter • Using wire gauge • Using vernier caliper • Communication skills • Analytical skills • Numeracy skills Attitude, safety and environmental concern • Effective time management		

	• Having integrity and work ethics • Efficient use of materials • Proper handling and storage of tools, materials and equipment • Ensuring appropriate use of PPE • Ensuring to follow OHS rules and regulations • Ensuring proper disposal of waste • Ensuring to use right tools B3.03 Preparing winding coil <i>Knowledge</i> • Purpose of arbor/former • Types of arbor/former • Sizes of winding material <i>Skills</i> • Using winding machine • Using arbor/former • Communication skills • Analytical skills • Numeracy skills <i>Attitude, safety and environmental concern</i> • Effective time management • Having integrity and work ethics • Efficient use of materials • Proper handling and storage of tools, materials and equipment • Ensuring appropriate use of PPE • Ensuring to follow OHS rules and regulations • Ensuring proper disposal of waste B3.04 Inserting motor winding coil <i>Knowledge</i> • Types of insulation • Purpose of insulation • Purpose of welding/soldering • Importance of using wedge <i>Skills</i> • Using compactor • Using welding/soldering/brazing machine • Communication skills • Analytical skills <i>Attitude, safety and environmental concern</i> • Effective time management • Having integrity and work ethics • Efficient use of materials • Proper handling and storage of tools, materials and equipment • Ensuring appropriate use of PPE • Ensuring to follow OHS rules and regulations
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	• Ensuring proper disposal of waste B3.05 Applying varnish on winding Knowledge • Purpose of applying varnish • Types of varnish • Methods of varnishing • Purpose of heating winding before applying varnish • Determining the oven temperature Skills • Operating varnish curing oven • Communication skills Attitude, safety and environmental concern • Effective time management • Having integrity and work ethics • Efficient use of materials • Proper handling and storage of tools, materials and equipment • Ensuring appropriate use of PPE • Ensuring to follow OHS rules and regulations • Ensuring proper disposal of waste • Ensuring to avoid overheating of insulation B3.06 Assembling motor Knowledge • Purpose of greasing • Types of motor connection Skills • Using IR tester • Using Multimeter • Using bearing puller • Communication skills • Analytical skills Attitude, safety and environmental concern • Effective time management • Having integrity and work ethics • Efficient use of materials • Proper handling and storage of tools, materials and equipment • Ensuring appropriate use of PPE • Ensuring to follow OHS rules and regulations • Ensuring proper disposal of waste • Ensuring correct connection of motor
Learning Conditions	Learning Materials • CBLM • Hand outs • Audio-visuals • Reference books

	• Manuals • LMS • Google classroom Learning Facilities and Infrastructure • Classroom with adequate facilities • Library • IT lab • Workshop Materials • Enamel copper wire, PVC insulated wire, dry bamboo, cotton tape, glass tape, insulation tape, insulation paper, wire sleeve, sand paper, soldering lead & flux, varnish, tray, emery cloth, Markin cloth, grease, cable lugs, cleaning agent, spray varnish/Epoxy resin and bearing Tools • Spanner set, centre punch, mallet, ball-peen hammer, bearing puller, chisel, snip, cutting pliers, arbor/former, measuring tape, wire inserter, electrician knife and winding compactor Instrument • Wire gauge, micro-meter, vernier caliper, multimeter, IR tester, surge tester and tachometer Equipment • Induction motor, winding machine, varnish curing oven, autotransformer, soldering iron and brake drum PPE • Safety gloves, safety boots, safety helmet, safety goggles, reflective vest and mouth mask
Instructional Methodologies	The trainer shall use <i>inter alia</i>, the following instructional methods: • Lecture • Interactive discussion • Demonstration • Industrial visit/training • Guided practice • Group practice with project-based learning • Individual practice with problem-based learning
Method of Assessment	The trainer shall use <i>inter alia</i>, the following assessment methods: • Practical observation • Oral/viva-voce • Written test • Assignment • Project work

Module Title	Carrying out maintenance of electric motors and generators		
Module Code	7411-L3-M2		
Learning Outcome 4	Perform servicing of generator		
Duration	Theory: 13 hours	Practical: 31 hours	Total: 44 hours
Assessment Criteria	• The oil/fuel filter is replaced as per the standard procedures • Coolant is changed as per the standard procedures • Air filter is replaced as per the standard procedures • Carbon brush is serviced as per the standard procedures • Battery is maintained as per the standard procedures • Thermostat is serviced as per the standard procedures • Fuel tank is cleaned as per the standard procedures		
Contents	B4.01 Replacing oil/fuel filter Knowledge • Purpose of oil/fuel filter • Types of filter • Intervals of changing filter • Importance of filling new oil filter with oil prior to fitting • Consequences of delaying in oil/fuel filter replacement Skills • Using oil filter wrench • Communication skills • Analytical skills Attitude, safety and environmental concern • Effective time management • Having integrity and work ethics • Efficient use of materials • Proper handling and storage of tools, materials and equipment • Ensuring appropriate use of PPE • Ensuring to follow OHS rules and regulations • Ensuring proper disposal of waste • Ensuring to follow manufacturers specification B4.02 Changing coolant Knowledge • Importance of DG cooling system • Components of cooling system and their functions • Types of coolant • Purpose of radiator • Properties of coolant Skills • Operating DG set • Communication skills • Analytical skills Attitude, safety and environmental concern • Effective time management • Having integrity and work ethics		

	• Efficient use of materials • Proper handling and storage of tools, materials and equipment • Ensuring appropriate use of PPE • Ensuring to follow OHS rules and regulations • Ensuring proper disposal of waste • Ensuring to cool down the engine prior to checking • Ensuring to check coolant after topping up B4.03 Replacing air filter Knowledge • Function of air filter • Types of air filter • Interval of changing air filter Skills • Using blower • Communication skills Attitude, safety and environmental concern • Effective time management • Having integrity and work ethics • Efficient use of materials • Proper handling and storage of tools, materials and equipment • Ensuring appropriate use of PPE • Ensuring to follow OHS rules and regulations • Ensuring proper disposal of waste B4.04 Replacing carbon brush Knowledge • Purpose of carbon brush • Carbon brush grades • Application of carbon brush • Importance of carbon brush bedding • Types of carbon brush • Importance of maintaining gap between carbon brush and slip ring Skills • Setting carbon brush and holder • Using feeler gauge • Communication skills Attitude, safety and environmental concern • Effective time management • Having integrity and work ethics • Efficient use of materials • Proper handling and storage of tools, materials and equipment • Ensuring appropriate use of PPE • Ensuring to follow OHS rules and regulations • Ensuring proper disposal of waste • Ensuring to avoid over tensioning of pressure spring
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	B4.05 Maintaining battery Knowledge • Importance of maintaining battery health • Types of battery • Construction of battery • Methods of charging battery • Procedures of adding electrolyte • Causes and effects of battery failure Skills • Using hydro meter • Using Multimeter • Communication skills Attitude, safety and environmental concern • Effective time management • Having integrity and work ethics • Efficient use of materials • Proper handling and storage of tools, materials and equipment • Ensuring appropriate use of PPE • Ensuring to follow OHS rules and regulations • Ensuring proper disposal of waste • Ensuring not to over-charge the battery • Ensuring to provide wooden or rubber battery stand • Ensuring to be cautious while handling electrolyte and battery • Ensuring correct selection of polarity B4.06 Servicing thermostat Knowledge • Working principle of thermostat • Function of thermostat • Application of thermostat Skills • Using Multimeter • Communication skills Attitude, safety and environmental concern • Effective time management • Having integrity and work ethics • Efficient use of materials • Proper handling and storage of tools, materials and equipment • Ensuring appropriate use of PPE • Ensuring to follow OHS rules and regulations • Ensuring proper disposal of waste • Ensuring to cool down the engine prior to checking • Ensuring to avoid overheating of engine B4.07 Cleaning fuel tank Knowledge • Importance of cleaning fuel tank • Functions of fuel tank
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	• Components of fuel tank Skills • Operating air compressor • Operating oil pump • Communication skills Attitude, safety and environmental concern • Effective time management • Having integrity and work ethics • Efficient use of materials • Proper handling and storage of tools, materials and equipment • Ensuring appropriate use of PPE • Ensuring to follow OHS rules and regulations • Ensuring proper disposal of waste • Ensuring to avoid over pressure of air or water to fuel indicators
Learning Conditions	Learning Materials • CBLM • Hand outs • Audio-visuals • Reference books • Manuals • LMS • Google classroom Learning Facilities and Infrastructure • Classroom with adequate facilities • Library • IT lab • Workshop Materials • Markin cloth, fuel, oil filter, fuel filter, coolant, rubber abrasive, pressure spring, cleaning agent, carbon brush, emery paper, distilled water, petroleum jelly, terminal lugs, cables, nuts & bolts, screw, washer, thermostat, fuel tank, Teflon tape and water Tools • Spanner set, pliers, ratchet set, wrench set, screw driver set, funnel, file, electrician knife, trays and Allen key set Instrument • Feeler gauge, hydrometer and Multimeter Equipment • Blower, DG set, lead acid battery, air compressor and oil pump PPE • Safety helmet, safety boots, safety goggles, safety gloves, reflective vest and workshop dress

Instructional Methodologies	The trainer shall use <i>inter alia</i>, the following instructional methods: • Lecture • Interactive discussion • Demonstration • Industrial visit/training • Guided practice • Group practice with project-based learning • Individual practice with problem-based learning
Method of Assessment	The trainer shall use <i>inter alia</i>, the following assessment methods: • Practical observation • Oral/viva-voce • Written test • Assignment • Project work

MODULE 3
ON
CARRYING OUT MAINTENANCE OF TRANSFORMER AND ITS
ACCESSORIES

MODULE INFORMATION

Occupation	Industrial Electrical Technician
Competency Area	Carry out maintenance of transformer and its accessories
Module Title	Carrying out maintenance of transformer and its accessories
Module Code	7411- L3-M3
Module Description	This module is structured to provide the learners with knowledge, skills and right attitude required to monitor transformer, perform functional test of transformer protection devices, service transformer and perform transformer tests
Nominal Duration	252 Hours
Qualification Level	Certificate Level 3
Pre-requisite	Completed Module 7411-L3-M2
Learning Outcome	1. Monitor transformer 2. Perform functional test of transformer protection devices 3. Service transformer 4. Perform transformer test

Module Title	Carrying out maintenance of transformers and its accessories		
Module Code	7411-L3-M3		
Learning Outcome 1	Monitor transformer		
Duration	Theory: 19 hours	Practical: 41 hours	Total: 60 hours
Assessment Criteria	- Breather assembly is inspected as per standard procedures - Oil level in the conservator is inspected as per the standard procedures - Abnormal sound in transformer is inspected as per standard procedures - Bushings are inspected as per standard procedures - OTI and WTI oil level pockets are inspected as per standard procedures - Buchholz relay oil level is inspected as per standard procedures - WTI and OTI temperature is inspected as per standard procedures - Oil leakages from transformer is inspected as per standard procedures - Arching horn is inspected as per standard procedures - Healthiness of earthing(s) is inspected as per standard procedures		
Contents	C1.01 Inspecting breather assembly Knowledge - Definition of transformer - Working principle of transformer - Components of transformer and its function - Types of transformers - Function of breather - Identification of breather assembly - Requirement of oil level in the oil cup - Purpose of silica gel - Properties of silica gel - Storage and disposal of silica gel - Purpose of timely checking of silica gel Skills - Observation skills - Communication skills - Analytical skills Attitude, safety and environmental concern - Effective time management - Having integrity and work ethics - Efficient use of materials - Proper handling and storage of tools, materials and equipment - Ensuring appropriate use of PPE - Ensuring to follow OHS rules and regulations - Ensuring proper disposal of waste - Ensuring correct interpretation of color - Ensuring to inspect as per checklist C1.02 Inspecting conservator and OLTC oil level Knowledge - Introduction to Magnetic Oil Gauge (MOG) and oil level indicator		

	• Purpose of checking oil level • Consequences of low/high level of oil Skills • Observation skills • Analytical skills • Communication skills Attitude, safety and environmental concern • Effective time management • Having integrity and work ethics • Efficient use of materials • Proper handling and storage of tools, materials and equipment • Ensuring appropriate use of PPE • Ensuring to follow OHS rules and regulations • Ensuring proper disposal of waste C1.03 Inspecting abnormal noise in transformers Knowledge • Causes of abnormal noise in transformer Skills • Listening skills • Using sound level meter • Analytical skills • Communication skills Attitude, safety and environmental concern • Effective time management • Having integrity and work ethics • Efficient use of materials • Proper handling and storage of tools, materials and equipment • Ensuring appropriate use of PPE • Ensuring to follow OHS rules and regulations • Ensuring proper disposal of waste C1.04 Inspecting bushing condition Knowledge • Types of bushing • Purpose of bushing • Construction of bushing • Defects in bushing Skills • Observation skills • Analytical skills • Communication skills Attitude, safety and environmental concern • Effective time management • Having integrity and work ethics • Efficient use of materials
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	• Proper handling and storage of tools, materials and equipment • Ensuring appropriate use of PPE • Ensuring to follow OHS rules and regulations • Ensuring proper disposal of waste C1.05 Inspecting OTI & WTI pocket oil level Knowledge • Importance of OTI and WTI in transformer • Working principle of WTI and OTI • Types of WTI and OTI • Identification of WTI and OTI Skills • Observation skills • Analytical skills • Communication skills • Numeracy skills Attitude, safety and environmental concern • Effective time management • Having integrity and work ethics • Efficient use of materials • Proper handling and storage of tools, materials and equipment • Ensuring appropriate use of PPE • Ensuring to follow OHS rules and regulations • Ensuring proper disposal of waste • Ensuring to report any leakages or sweating C1.06 Inspecting WTI and OTI temperature Knowledge • Importance of inspecting WTI and OTI temperature Skills • Meter reading skills • Observation skills • Analytical skills Attitude, safety and environmental concern • Effective time management • Having integrity and work ethics • Efficient use of materials • Proper handling and storage of tools, materials and equipment • Ensuring appropriate use of PPE • Ensuring to follow OHS rules and regulations • Ensuring proper disposal of waste C1.07 Inspecting Buchholz relay oil level Knowledge • Importance of Buchholz relay in transformer • Construction of Buchholz relay • Working principle of Buchholz relay • Identification of Buchholz relay
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	Skills • Observation skills • Analytical skills • Communication skills Attitude, safety and environmental concern • Effective time management • Having integrity and work ethics • Efficient use of materials • Proper handling and storage of tools, materials and equipment • Ensuring appropriate use of PPE • Ensuring to follow OHS rules and regulations • Ensuring proper disposal of waste C1.08 Inspecting leakage of transformer oil Knowledge • Importance of inspecting oil leakage from transformer • Causes of transformer oil leak Skills • Observation skills • Analytical skills • Communication skills Attitude, safety and environmental concern • Effective time management • Having integrity and work ethics • Efficient use of materials • Proper handling and storage of tools, materials and equipment • Ensuring appropriate use of PPE • Ensuring to follow OHS rules and regulations • Ensuring proper disposal of waste C1.09 Inspecting arcing horn Knowledge • Definition of arcing horn • Working principle of arcing horn • Importance of inspecting arcing horn Skills • Observation skills • Analytical skills • Communication skills Attitude, safety and environmental concern • Effective time management • Having integrity and work ethics • Efficient use of materials • Proper handling and storage of tools, materials and equipment • Ensuring appropriate use of PPE • Ensuring to follow OHS rules and regulations • Ensuring proper disposal of waste
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	C1.10 Checking healthiness of earthing(s) Knowledge • Types of earthing(s) • Importance of earthing Skills • Using earth resistance tester • Communication skills • Analytical skills Attitude, safety and environmental concern • Effective time management • Having integrity and work ethics • Efficient use of materials • Proper handling and storage of tools, materials and equipment • Ensuring appropriate use of PPE • Ensuring to follow OHS rules and regulations • Ensuring proper disposal of waste
Learning Conditions	Learning Materials • CBLM • Hand-outs • Audio-visuals • Reference books • Manuals • LMS • Google classroom Learning Facilities and Infrastructure • Classroom with adequate facilities • Library • IT lab • Workshop Materials • Inspection check list and pen PPE • Safety gloves, safety boots, safety helmet, safety goggles, safety harness, mouth mask and reflective vest
Instructional Methodologies	The trainer shall use <i>inter alia</i>, the following instructional methods: • Lecture • Interactive discussion • Demonstration • Industrial visit/training • Guided practice • Group practice with project-based learning • Individual practice with problem-based learning

Method of Assessment	The trainer shall use <i>inter alia</i>, the following assessment methods: • Practical observation • Oral/viva-voce • Written test • Assignment • Project work
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Module Title	Carrying out maintenance of transformers and its accessories		
Module Code	7411-L3-M3		
Learning Outcome 2	Perform functional test of transformer protection devices		
Duration	Theory: 21 hours	Practical: 63 hours	Total: 84 hours
Assessment Criteria	• Buchholz relay is tested as per standard procedures • PRD is tested as per standard procedures • WTI is tested as per standard procedures • OTI is tested as per standard procedures • MOG is tested as per the standard procedures • OLTC is tested as per the standard procedures • The OSR is tested as per the standard procedures		
Contents	C2.01 Performing Buchholz Relay test Knowledge • Identification of alarm and trip contact • Purpose of performing Buchholz relay test Skills • Using Multimeter • Interpreting control circuit diagram • Analytical skills • Communication skills Attitude, safety and environmental concern • Effective time management • Having integrity and work ethics • Efficient use of materials • Proper handling and storage of tools, materials and equipment • Ensuring appropriate use of PPE • Ensuring to follow OHS rules and regulations • Ensuring proper disposal of waste • Ensuring to avoid shorting of alarm and trip contacts with ground C2.02 Performing Pressure Relief Device (PRD) Test Knowledge • Function of PRD • Construction of PRD • Working principle of PRD • Identification of alarm and trip contact • Purpose of performing PRD test Skills • Using Multimeter • Interpreting control circuit diagram • Analytical skills • Communication skills Attitude, safety and environmental concern • Effective time management • Having integrity and work ethics		

	• Efficient use of materials • Proper handling and storage of tools, materials and equipment • Ensuring appropriate use of PPE • Ensuring to follow OHS rules and regulations • Ensuring proper disposal of waste • Ensuring to avoid shorting of trip contact with ground C2.03 Performing Winding Temperature Indicator (WTI) test Knowledge • Identification of alarm and trip contact • Purpose of performing WTI test Skills • Using Multimeter • Interpreting control circuit diagram • Analytical skills • Communication skills Attitude, safety and environmental concern • Effective time management • Having integrity and work ethics • Efficient use of materials • Proper handling and storage of tools, materials and equipment • Ensuring appropriate use of PPE • Ensuring to follow OHS rules and regulations • Ensuring proper disposal of waste C2.04 Performing Oil Temperature Indicator (OTI) test Knowledge • Identification of alarm and trip contact • Purpose of performing OTI test Skills • Using Multimeter • Interpreting control circuit diagram • Analytical skills • Communication skills Attitude, safety and environmental concern • Effective time management • Having integrity and work ethics • Efficient use of materials • Proper handling and storage of tools, materials and equipment • Ensuring appropriate use of PPE • Ensuring to follow OHS rules and regulations • Ensuring proper disposal of waste • Ensuring to avoid shorting of alarm and trip contacts with ground C2.05 Performing Magnetic oil Gauge (MOG) test Knowledge • Identification of alarm contact
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	• Purpose of performing MOG test Skills • Using Multimeter • Interpreting control circuit diagram • Analytical skills • Communication skills Attitude, safety and environmental concern • Effective time management • Having integrity and work ethics • Efficient use of materials • Proper handling and storage of tools, materials and equipment • Ensuring appropriate use of PPE • Ensuring to follow OHS rules and regulations • Ensuring proper disposal of waste • Ensuring to avoid shorting of alarm and trip contacts with ground C2.06 Performing On-Load Tap Changer (OLTC) Test Knowledge • Definition of tap changer • Types of tap changer • Function of OLTC • Working principle of OLTC • Advantages and disadvantages of OLTC • Purpose of performing OLTC test Skills • Using Multimeter • Interpreting control circuit diagram • Interpreting transformer nameplate data • Analytical skills • Communication skills • Numeracy skills Attitude, safety and environmental concern • Effective time management • Having integrity and work ethics • Efficient use of materials • Proper handling and storage of tools, materials and equipment • Ensuring appropriate use of PPE • Ensuring to follow OHS rules and regulations • Ensuring proper disposal of waste • Ensuring to avoid repeated operation of drive mechanism C2.07 Performing Oil Surge Relay (OSR) Test Knowledge • Function of OSR • Working principle of OSR • Components of OSR • Identification of alarm and trip contact
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	• Purpose of performing OSR test Skills • Using Multimeter • Interpreting control circuit diagram • Analytical skills • Communication skills Attitude, safety and environmental concern • Effective time management • Having integrity and work ethics • Efficient use of materials • Proper handling and storage of tools, materials and equipment • Ensuring appropriate use of PPE • Ensuring to follow OHS rules and regulations • Ensuring proper disposal of waste • Ensuring to avoid shorting of alarm and trip contacts with ground
Learning Conditions	Learning Materials • CBLM • Hand-outs • Audio-visuals • Reference books • Manuals • LMS • Google classroom Learning Facilities and Infrastructure • Classroom with adequate facilities • Library • IT lab • Workshop Materials • Markin cloth, funnel, transformer oil, bucket, probes, wire, jug and container Tools • Wrenches, screw driver set and pliers Instrument • Multimeter Equipment • Buchholz relay, PRD, WTI, OTI, MOG, OLTC and transformer PPE • Safety gloves, safety boots, safety helmet, safety goggles, safety harness, mouth mask and reflective vest

Instructional Methodologies	The trainer shall use <i>inter alia</i>, the following instructional methods: • Lecture • Interactive discussion • Demonstration • Industrial visit/training • Guided practice • Group practice with project-based learning • Individual practice with problem-based learning
Method of Assessment	The trainer shall use <i>inter alia</i>, the following assessment methods: • Practical observation • Oral/viva-voce • Written test • Assignment • Project work

Module Title	Carrying out maintenance of transformers and its accessories		
Module Code	7411-L3-M3		
Learning Outcome 3	Service transformer		
Duration	Theory: 21 hours	Practical: 45 hours	Total: 66 hours
Assessment Criteria	• Bushing is replaced as per standard procedures • Arching horn is maintained as per standard procedures • Transformer oil is filtered as per standard procedures • The transformer oil is top-up as per standard procedures • Transformer oil is changed as per standard procedures • Silica gel is regenerated as per standard procedures • Breather is replaced as per standard procedures • Condition of valves are inspected as per standard procedures • Gasket is changed as per standard procedures • Terminal connectors are tightened as per the standard procedures		
Contents	C3.01 Replacing bushings Knowledge • Internal connections of bushing Skills • Lifting skills • Interpreting drawing • Analytical skills • Communication skills • Decision making skills Attitude, safety and environmental concern • Effective time management • Having integrity and work ethics • Efficient use of materials • Proper handling and storage of tools, materials and equipment • Ensuring appropriate use of PPE • Ensuring to follow OHS rules and regulations • Ensuring proper disposal of waste • Ensuring proper tightening of nuts and bolts • Ensuring to maintain glaze of bushing during replacement • Ensuring healthiness of bushing gasket C3.02 Maintaining arc-horn gap Knowledge • Types of arcing horn • Standard for setting arcing horn gap • Identification of arc horn (Male & Female) Skills • Lifting skills • Interpreting drawing • Analytical skills		

	• Communication skills • Decision making skills <i>Attitude, safety and environmental concern</i> • Effective time management • Having integrity and work ethics • Efficient use of materials • Proper handling and storage of tools, materials and equipment • Ensuring appropriate use of PPE • Ensuring to follow OHS rules and regulations • Ensuring proper disposal of waste C3.03 Filtering Transformer oil <i>Knowledge</i> • Types of transformer oil • Purpose of transformer oil • Properties of transformer oil • Purpose of filtering transformer oil • Purpose of maintaining oil temperature • Working principle of oil filtration plant • Purpose of vacuuming during filtration <i>Skills</i> • Using filtering machine • Using BDV test kit • Using IR tester • Analytical skills • Numeracy skills • Communication skills <i>Attitude, safety and environmental concern</i> • Effective time management • Having integrity and work ethics • Efficient use of materials • Proper handling and storage of tools, materials and equipment • Ensuring appropriate use of PPE • Ensuring to follow OHS rules and regulations • Ensuring proper disposal of waste • Ensuring to avoid overheating of transformer oil • Ensuring favorable weather condition while filtering transformer oil C3.04 Topping up transformer oil <i>Knowledge</i> • Purpose of topping-up transformer oil • Purpose of vacuuming <i>Skills</i> • Using filtering machine • Using BDV test kit • Using IR tester
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	- Analytical skills - Communication skills - Numeracy skills <i>Attitude, safety and environmental concern</i> - Effective time management - Having integrity and work ethics - Efficient use of materials - Proper handling and storage of tools, materials and equipment - Ensuring appropriate use of PPE - Ensuring to follow OHS rules and regulations - Ensuring proper disposal of waste - Ensuring to avoid overheating of transformer oil - Ensuring favorable weather condition while filtering transformer oil C3.05 Changing transformer oil <i>Knowledge</i> - Purpose of changing transformer oil <i>Skills</i> - Using filtering machine - Using BDV test kit - Using IR tester - Analytical skills - Communication skills - Numeracy skills <i>Attitude, safety and environmental concern</i> - Effective time management - Having integrity and work ethics - Efficient use of materials - Proper handling and storage of tools, materials and equipment - Ensuring appropriate use of PPE - Ensuring to follow OHS rules and regulations - Ensuring proper disposal of waste - Ensuring to avoid overheating of transformer oil - Ensuring correct selection of oil grade and specification C3.06 Regenerating/replacing silica gel <i>Knowledge</i> - Types of hygroscopic substances - Properties of silica gel - Purpose of storing silica gel in airtight container <i>Skills</i> - Operating regeneration machine - Analytical skills - Communication skills <i>Attitude, safety and environmental concern</i> - Effective time management
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	• Having integrity and work ethics • Efficient use of materials • Proper handling and storage of tools, materials and equipment • Ensuring appropriate use of PPE • Ensuring to follow OHS rules and regulations • Ensuring proper disposal of waste • Ensuring to avoid overheating of silica gel C3.07 Changing breather Knowledge • Operation of breather • Purpose of changing breather Skills • Analytical skills • Communication skills Attitude, safety and environmental concern • Effective time management • Having integrity and work ethics • Efficient use of materials • Proper handling and storage of tools, materials and equipment • Ensuring appropriate use of PPE • Ensuring to follow OHS rules and regulations • Ensuring proper disposal of waste • Ensuring to avoid overheating of silica gel • Ensuring proper connection of breather C3.08 Inspecting valve condition Knowledge • Function of valves Skills • Using pipe wrench • Analytical skills • Observation skills Attitude, safety and environmental concern • Effective time management • Having integrity and work ethics • Efficient use of materials • Proper handling and storage of tools, materials and equipment • Ensuring appropriate use of PPE • Ensuring to follow OHS rules and regulations • Ensuring proper disposal of waste • Ensuring to avoid overheating of silica gel • Ensuring proper connection of breather
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	C3.09 Changing gasket Knowledge • Definition of gasket • Function of gasket • Properties of gasket • Types of gasket • Type of gasket cutting machine Skills • Using drilling machine • Using torque wrench • Gasket cutting skills • Analytical skills • Communication skills Attitude, safety and environmental concern • Effective time management • Having integrity and work ethics • Efficient use of materials • Proper handling and storage of tools, materials and equipment • Ensuring appropriate use of PPE • Ensuring to follow OHS rules and regulations • Ensuring proper disposal of waste • Ensuring appropriate selection of gasket • Ensuring to apply required torque on nuts and bolts C3.10 Tightening terminal connections Knowledge • Causes and effects of loose connection Skills • Using spanner • Analytical skills • Communication skills Attitude, safety and environmental concern • Effective time management • Having integrity and work ethics • Efficient use of materials • Proper handling and storage of tools, materials and equipment • Ensuring appropriate use of PPE • Ensuring to follow OHS rules and regulations • Ensuring proper disposal of waste • Ensuring to avoid overheating of silica gel • Ensuring to avoid over-tightening of connections • Ensuring to use appropriate size of lugs
Learning Conditions	Learning Materials • CBLM • Hand-outs • Audio-visuals

	• Reference books • Manuals • Google classroom Learning Facilities and Infrastructure • Classroom with adequate facilities • Library • IT lab • Workshop Materials • Markin cloth, anti-rust spray, derrick pole, rope, pulley, sling, nuts & bolts, transformer oil, silica gel, breather, hack saw blade, gasket, lugs and oil ring seal Tools • Torque wrench, pipe wrench, spanner, screwdriver set, pliers, gasket cutter, tripod, crimping tool, discharge rod and frying pan Instrument • IR tester, BDV test kit and Multimeter Equipment • Bushing, arcing horn, oil conditioning machine, transformer, silica gel regeneration machine, gasket cutting machine and crane PPE • Safety gloves, safety boots, safety helmet, safety goggles, safety harness, mouth mask and reflective vest
Instructional Methodologies	The trainer shall use <i>inter alia</i>, the following instructional methods: • Lecture • Interactive discussion • Demonstration • Industrial visit/training • Guided practice • Group practice with project-based learning • Individual practice with problem-based learning
Method of Assessment	The trainer shall use <i>inter alia</i>, the following assessment methods: • Practical observation • Oral/viva-voce • Written test • Assignment • Project work

Module Title	Carrying out maintenance of transformers and its accessories		
Module Code	7411-L3-M3		
Learning Outcome 4	Perform transformer test		
Duration	Theory: 12 hours	Practical: 30 hours	Total: 42 hours
Assessment Criteria	• BDV of transformer oil is tested as per standard procedures • IR, DAR and PI test are performed as per standard procedures • Ratio test is performed as per the standard procedures • Winding resistance test is performed as per the standard procedures • Tan-Delta test is performed as per the standard procedures • DGA test is performed as per the standard procedures		
Contents	C4.01 Performing BDV test of Transformer oil Knowledge • Purpose of conducting Breakdown Voltage (BDV) test • Interpretation of BDV value Skills • Using BDV test kit • Oil sampling skills • Analytical skills • Communication skills • Numeracy skills Attitude, safety and environmental concern • Effective time management • Having integrity and work ethics • Efficient use of materials • Proper handling and storage of tools, materials and equipment • Ensuring appropriate use of PPE • Ensuring to follow OHS rules and regulations • Ensuring proper disposal of waste • Ensuring proper oil sampling C4.02 Performing IR, DAR and PI test of transformer Knowledge • Purpose of conducting IR test • Factors affecting IR value of transformer • Standard IR values of transformer • Selection of DC test voltage of testing equipment • Methods of IR test • Purpose of performing Di-electric Absorption Ratio (DAR) and Polarization Index (PI) test Skills • Using insulation resistance tester • Analytical skills • Communication skills • Numeracy skills		

	<i>Attitude, safety and environmental concern</i> • Effective time management • Having integrity and work ethics • Efficient use of materials • Proper handling and storage of tools, materials and equipment • Ensuring appropriate use of PPE • Ensuring to follow OHS rules and regulations • Ensuring proper disposal of waste • Ensuring to provide correct test voltage C4.03 Performing ratio test <i>Knowledge</i> • Purpose of ratio test • Calculation of turns ratio for single and three phase transformers • Consequences of inappropriate turns ratio <i>Skills</i> • Interpreting circuit diagram • Using TTR tester • Using Multimeter • Analytical skills • Communication skills • Numeracy skills <i>Attitude, safety and environmental concern</i> • Effective time management • Having integrity and work ethics • Efficient use of materials • Proper handling and storage of tools, materials and equipment • Ensuring appropriate use of PPE • Ensuring to follow OHS rules and regulations • Ensuring proper disposal of waste • Ensuring to use appropriate measuring instruments C4.04 Performing winding resistance test <i>Knowledge</i> • Purpose of winding resistance test <i>Skills</i> • Interpreting circuit diagram • Interpreting transformer nameplate data • Using Multimeter • Analytical skills • Communication skills • Numeracy skills <i>Attitude, safety and environmental concern</i> • Effective time management • Having integrity and work ethics
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	• Efficient use of materials • Proper handling and storage of tools, materials and equipment • Ensuring appropriate use of PPE • Ensuring to follow OHS rules and regulations • Ensuring proper disposal of waste • Ensuring to use appropriate measuring instruments C4.05 Performing Tan-Delta test <i>Knowledge</i> • Definition of Tan Delta/dissipation factor • Purpose of performing tan delta test • Modes of tan delta test <i>Skills</i> • Interpreting circuit diagram • Using Multimeter • Using tan-delta test kit • Analytical skills • Communication skills • Numeracy skills <i>Attitude, safety and environmental concern</i> • Effective time management • Having integrity and work ethics • Efficient use of materials • Proper handling and storage of tools, materials and equipment • Ensuring appropriate use of PPE • Ensuring to follow OHS rules and regulations • Ensuring proper disposal of waste • Ensuring to use appropriate measuring instruments C4.06 Performing Dissolved Gas Analysis (DGA) test <i>Knowledge</i> • Types of Gases and its interpretation <i>Skills</i> • Using DGA test kit • Oil sampling skills • Analytical skills • Communication skills • Numeracy skills <i>Attitude, safety and environmental concern</i> • Effective time management • Having integrity and work ethics • Efficient use of materials • Proper handling and storage of tools, materials and equipment • Ensuring appropriate use of PPE • Ensuring to follow OHS rules and regulations
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	• Ensuring proper disposal of waste • Ensuring to use appropriate measuring instruments
Learning Conditions	Learning Materials • CBLM • Hand-outs • Audio-visuals • Reference books • Manuals • Google classroom Learning Facilities and Infrastructure • Classroom with adequate facilities • Library • IT lab • Workshop Materials • Oil sampling bottle, Markin cloth, funnel, bucket, transformer oil, connecting wires, TPN MCB and insulation tape Tools • Screwdriver, wrench, plier and discharge rod Instrument • Multimeter, IR tester, clamp-on meter, ohm meter, TTR tester, DGA test kit, Tan-delta test kit and BDV test kit Equipment • Ladder and transformer PPE • Safety gloves, safety boots, safety helmet, safety goggles, safety harness, mouth mask and reflective vest
Instructional Methodologies	The trainer shall use <i>inter alia</i>, the following instructional methods: • Lecture • Interactive discussion • Demonstration • Industrial visit/training • Guided practice • Group practice with project-based learning • Individual practice with problem-based learning
Method of Assessment	The trainer shall use <i>inter alia</i>, the following assessment methods: • Practical observation • Oral/viva-voce • Written test • Assignment • Project work

MODULE 4
ON
CARRYING OUT MAINTENANCE OF CONTROL SYSTEM AND
PROTECTIVE SWITCHGEARS

MODULE INFORMATION

Occupation	Industry Electrical Technician
Competency Area	Carry out maintenance of control system and protective switchgears
Module Title	Carrying out maintenance of control system and protective switchgears
Module Code	7411- L3-M4
Module Description	This module is structured to provide the learners with knowledge, skills and right attitude required to monitor control and protective switchgears, perform functional test of control & protective switchgears, service control & protective switchgears and perform testing of switchgears
Nominal Duration	174 Hours
Qualification Level	Certificate Level 3
Pre-requisite	Completed Module 7411-L3-M3
Learning Outcome	1. Monitor control and protective switchgears 2. Perform functional test of control & protective switchgears 3. Service control & protective switchgears 4. Perform testing of switchgears

Module Title	Carrying out maintenance of control system and protective switchgear(s)		
Module Code	7411-L3-M4		
Learning Outcome 1	Monitor control and protective switchgears		
Duration	Theory: 14 hours	Practical: 34 hours	Total: 48 hours
Assessment Criteria	- Oil level in CT, PT and CVT are inspected as per standard procedures - SF6 gas pressure is inspected as per the standard procedures - LA and surge monitor is inspected as per standard procedures - Air pressure of the pneumatic operated SF6 CB is inspected as per the standard procedures - Tripping and closing coils are inspected as per standard procedures - Isolators and earth-switch is inspected as per standard procedures - Automatic Voltage Regulator (AVR) is inspected as per the standard procedures		
Contents	D1.01 Inspecting CT, PT and CVT Knowledge - Introduction to substation equipment - Definition of CT, PT and CVT - Types of CT, PT and CVT - Function of CT, PT and CVT - Working principle of CT, PT and CVT - Level of oil required as per standard Skills - Observation skills - Communication skills - Analytical skills Attitude, safety and environmental concern - Effective time management - Having integrity and work ethics - Efficient use of materials - Proper handling and storage of tools, materials and equipment - Ensuring appropriate use of PPE - Ensuring to follow OHS rules and regulations - Ensuring proper disposal of waste - Ensuring to inspect as per checklist D1.02 Inspecting SF6 gas pressure of CB Knowledge - Types of circuit breaker and its functions - Working principle of SF6 CB - Types of SF6 CB - Properties of SF6 gas - Importance of SF6 gas pressure in CB - Differences between gang operated and single operated CB Skills - Observation skills		

	- Analytical skills - Communication skills <i>Attitude, safety and environmental concern</i> - Effective time management - Having integrity and work ethics - Efficient use of materials - Proper handling and storage of tools, materials and equipment - Ensuring appropriate use of PPE - Ensuring to follow OHS rules and regulations - Ensuring proper disposal of waste D1.03 Inspecting LA and surge monitor <i>Knowledge</i> - Definition of LA and surge monitor - Types and function of LA - Working principle of LA - Function of surge monitor counter <i>Skills</i> - Meter reading skills - Observation skills - Analytical skills - Communication skills <i>Attitude, safety and environmental concern</i> - Effective time management - Having integrity and work ethics - Efficient use of materials - Proper handling and storage of tools, materials and equipment - Ensuring appropriate use of PPE - Ensuring to follow OHS rules and regulations - Ensuring proper disposal of waste D1.04 Inspecting air pressure of pneumatic operated CB <i>Knowledge</i> - Working principle of pneumatic operated CB <i>Skills</i> - Listening skills - Analytical skills - Communication skills - Observation skills <i>Attitude, safety and environmental concern</i> - Effective time management - Having integrity and work ethics - Efficient use of materials - Proper handling and storage of tools, materials and equipment - Ensuring appropriate use of PPE
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	• Ensuring to follow OHS rules and regulations • Ensuring proper disposal of waste D1.05 Inspecting condition of tripping and closing coils of CB Knowledge • Working principle of CB • General assembly of circuit breaker • Purpose of having two tripping coils • Function of Tripping Coil 1 and 2 • Differences between gang operated and single operated CB Skills • Using Multimeter • Interpreting drawing • Identifying wire ferrules • Analytical skills • Communication skills • Observation skills Attitude, safety and environmental concern • Effective time management • Having integrity and work ethics • Efficient use of materials • Proper handling and storage of tools, materials and equipment • Ensuring appropriate use of PPE • Ensuring to follow OHS rules and regulations • Ensuring proper disposal of waste D1.06 Inspecting condition of isolator and earth switch Knowledge • Working principle of isolators and earth switch • Types of isolator and earth switch • Function of isolators and earth switch Skills • Observation skills • Analytical skills Attitude, safety and environmental concern • Effective time management • Having integrity and work ethics • Efficient use of materials • Proper handling and storage of tools, materials and equipment • Ensuring appropriate use of PPE • Ensuring to follow OHS rules and regulations • Ensuring proper disposal of waste • Ensuring correct alignment of isolators
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	D1.07 Inspecting Automatic Voltage Regulator Knowledge • Definition of AVR • Application of AVR • Selection of AVR • Working principle of AVR Skills • Observation skills • Analytical skills • Communication skills Attitude, safety and environmental concern • Effective time management • Having integrity and work ethics • Efficient use of materials • Proper handling and storage of tools, materials and equipment • Ensuring appropriate use of PPE • Ensuring to follow OHS rules and regulations • Ensuring correct alignment of isolators
Learning Conditions	Learning Materials • CBLM • Hand-outs • Audio-visuals • Reference books • Manuals • LMS • Google classroom Learning Facilities and Infrastructure • Classroom with adequate facilities • Library • IT lab • Workshop Materials • Inspection check list and pen Instrument • Multimeter Tools • Screwdriver, pliers and wire stripper PPE • Safety gloves, safety boots, safety helmet, safety goggles, safety harness, mouth mask and reflective vest

Instructional Methodologies	The trainer shall use <i>inter alia</i>, the following instructional methods: • Lecture • Interactive discussion • Demonstration • Industrial visit/training • Guided practice • Group practice with project-based learning • Individual practice with problem-based learning
Method of Assessment	The trainer shall use <i>inter alia</i>, the following assessment methods: • Practical observation • Oral/viva-voce • Written test • Assignment • Project work

Module Title	Carrying out maintenance of control system and protective switchgear(s)		
Module Code	7411-L3-M4		
Learning Outcome 2	Perform functional test of control and protective switchgears		
Duration	Theory: 6 hours	Practical: 30 hours	Total: 36 hours
Assessment Criteria	• Circuit breaker closing and tripping functional test is performed as per standard procedures • Circuit breaker operating mechanism is tested as per the standard procedures • Isolators and earth-switches are tested as per the standard procedures		
Contents	D2.01 Testing CB closing and tripping Knowledge • Function of tripping and closing circuit • Importance of testing CB closing and tripping Skills • Interpreting CB drawings • Analytical skills • Communication skills • Numeracy skills Attitude, safety and environmental concern • Effective time management • Having integrity and work ethics • Efficient use of materials • Proper handling and storage of tools, materials and equipment • Ensuring appropriate use of PPE • Ensuring to follow OHS rules and regulations • Ensuring proper disposal of waste • Ensuring correct selection of Local/Remote switch D2.02 Testing CB operating mechanism Knowledge • CB operating mechanism Skills • Interpreting CB drawings • Interpreting Ferruling code • Analytical skills • Numeracy skills Attitude, safety and environmental concern • Effective time management • Having integrity and work ethics • Efficient use of materials • Proper handling and storage of tools, materials and equipment • Ensuring appropriate use of PPE • Ensuring to follow OHS rules and regulations • Ensuring proper disposal of waste		

	D2.03 Testing isolator and earth switch Knowledge • Purpose of testing isolator and earth switch Skills • Interpreting drawing (control circuit) • Interpreting Ferruling code • Analytical skills • Numeracy skills • Listening skills Attitude, safety and environmental concern • Effective time management • Having integrity and work ethics • Efficient use of materials • Proper handling and storage of tools, materials and equipment • Ensuring appropriate use of PPE • Ensuring to follow OHS rules and regulations • Ensuring proper disposal of waste
Learning Conditions	Learning Materials • CBLM • Hand-outs • Audio-visuals • Reference books • Manuals • LMS • Google classroom Learning Facilities and Infrastructure • Classroom with adequate facilities • Library • IT lab • Workshop Materials • Markin cloth, inspection check list and pen Tools • Screwdriver, discharge rod, breaker trolley, pliers, wrench set and wire stripper Instrument • Multimeter, Circuit breaker analyzer, contact resistant measurement test kit and IR tester Equipment • SF6 circuit breaker, VCB, ACB, OCB, LA, Isolator and earth-switch PPE • Safety gloves, safety boots, safety helmet, safety goggles, safety harness, mouth mask and reflective vest

Instructional Methodologies	The trainer shall use <i>inter alia</i>, the following instructional methods: • Lecture • Interactive discussion • Demonstration • Industrial visit/training • Guided practice • Group practice with project-based learning • Individual practice with problem-based learning
Method of Assessment	The trainer shall use <i>inter alia</i>, the following assessment methods: • Practical observation • Oral/viva-voce • Written test • Assignment • Project work

Module Title	Carrying out maintenance of control system and protective switchgear(s)		
Module Code	7411-L3-M4		
Learning Outcome 3	Service control and protective switchgears		
Duration	Theory: 9 hours	Practical: 39 hours	Total: 48 hours
Assessment Criteria	• CB closing and tripping coils are replaced as per standard procedures • Electromechanical relays are replaced as per the standard procedures • SF6 circuit breaker gas filling is performed as per the standard procedures • The lightning arrester and surge monitor are replaced as per standard procedures		
Contents	D3.01 Replacing tripping and closing coil of CB Knowledge • Causes of tripping and closing coil failure Skills • Analytical skills • Communication skills • Numeracy skills Attitude, safety and environmental concern • Effective time management • Having integrity and work ethics • Efficient use of materials • Proper handling and storage of tools, materials and equipment • Ensuring appropriate use of PPE • Ensuring to follow OHS rules and regulations • Ensuring proper disposal of waste D3.02 Replacing electromechanical relays Knowledge • Definition of relays • Types of relay • Function of relays • Characteristics of relay • Application of relays Skills • Relay setting skills • Interpreting relay characteristics • Analytical skills • Numeracy skills Attitude, safety and environmental concern • Effective time management • Having integrity and work ethics • Efficient use of materials • Proper handling and storage of tools, materials and equipment • Ensuring appropriate use of PPE • Ensuring to follow OHS rules and regulations		

	• Ensuring proper disposal of waste D3.03 Refilling SF6 gas Knowledge • Function of SF6 gas • Purpose of refilling SF6 gas Skills • Using SF6 gas filling kit • Analytical skills • Numeracy skills Attitude, safety and environmental concern • Effective time management • Having integrity and work ethics • Efficient use of materials • Proper handling and storage of tools, materials and equipment • Ensuring appropriate use of PPE • Ensuring to follow OHS rules and regulations • Ensuring proper disposal of waste D3.04 Relacing LA and surge monitor Knowledge • Causes of LA failure Skills • Using derrick pole • Using IR tester • Interpreting manual • Analytical skills • Numeracy skills Attitude, safety and environmental concern • Effective time management • Having integrity and work ethics • Efficient use of materials • Proper handling and storage of tools, materials and equipment • Ensuring appropriate use of PPE • Ensuring to follow OHS rules and regulations • Ensuring proper disposal of waste
Learning Conditions	Learning Materials • CBLM • Hand-outs • Audio-visuals • Reference books • Manuals • LMS • Google classroom

	Learning Facilities and Infrastructure • Classroom with adequate facilities • Library • IT lab • Workshop Materials • Markin cloth, inspection check list, pen, trip and close coils, insulation tape, brush, nuts and bolt, Teflon tape/sealant, SF6 gas, binding wire, pulley, conductor, terminal clamp and PP rope Tools • Screwdriver, pliers, wire stripper, wrenches, conductor cutter, spanner set and discharge rod Instrument • Multimeter, refrigerant leakage detector and IR tester Equipment • Circuit breaker, relays, blower, SF6 gas filling kit, lightning arrester, surge monitor, ladder and derrick pole PPE • Safety gloves, safety boots, safety helmet, safety goggles, safety harness, mouth mask and reflective vest
Instructional Methodologies	The trainer shall use <i>inter alia</i>, the following instructional methods: • Lecture • Interactive discussion • Demonstration • Industrial visit/training • Guided practice • Group practice with project-based learning • Individual practice with problem-based learning
Method of Assessment	The trainer shall use <i>inter alia</i>, the following assessment methods: • Practical observation • Oral/viva-voce • Written test • Assignment • Project work

Module Title	Carrying out maintenance of control system and protective switchgear(s)		
Module Code	7411-L3-M4		
Learning Outcome 4	Perform testing of switchgears		
Duration	Theory: 8 hours	Practical: 34 hours	Total: 42 hours
Assessment Criteria	- IR test of lightning arrester is performed as per standard procedures - IR test of CT and PT is performed as per the standard procedures - Ratio of CT is performed as per standard procedures - Polarity test of CT is performed as per the standard procedures - Winding resistance test of CT is performed as per standard procedure - IR test of CB is performed as per standard procedures - CRM test is performed as per standard procedures		
Contents	D4.01 Performing IR test of LA Knowledge - Purpose of performing IR test for LA Skills - Using IR tester - Analytical skills Attitude, safety and environmental concern - Effective time management - Having integrity and work ethics - Efficient use of materials - Proper handling and storage of tools, materials and equipment - Ensuring appropriate use of PPE - Ensuring to follow OHS rules and regulations - Ensuring proper disposal of waste D4.02 Performing IR test of CT and PT Knowledge - Purpose of IR test of CT and PT Skills - Using IR tester - Analytical skills Attitude, safety and environmental concern - Effective time management - Having integrity and work ethics - Efficient use of materials - Proper handling and storage of tools, materials and equipment - Ensuring appropriate use of PPE - Ensuring to follow OHS rules and regulations - Ensuring proper disposal of waste - Ensuring selection of correct test voltage D4.03 Performing ratio test of CT Knowledge - Purpose of ratio test		

	• Current transformation ratio • Consequences of open CT secondary Skills • Using ratio test kit • Interpreting circuit diagram/manual • Analytical skills Attitude, safety and environmental concern • Effective time management • Having integrity and work ethics • Efficient use of materials • Proper handling and storage of tools, materials and equipment • Ensuring appropriate use of PPE • Ensuring to follow OHS rules and regulations • Ensuring proper disposal of waste D4.04 Performing polarity test of CT Knowledge • Identification of CT polarities • Purpose of polarity test Skills • Using polarity tester • Analytical skills Attitude, safety and environmental concern • Effective time management • Having integrity and work ethics • Efficient use of materials • Proper handling and storage of tools, materials and equipment • Ensuring appropriate use of PPE • Ensuring to follow OHS rules and regulations • Ensuring proper disposal of waste D4.05 Performing winding resistance test of CT Knowledge • Purpose of winding resistance test Skills • Using Multimeter • Interpreting CT name plate details • Analytical skills • Numeracy skills Attitude, safety and environmental concern • Effective time management • Having integrity and work ethics • Efficient use of materials • Proper handling and storage of tools, materials and equipment • Ensuring appropriate use of PPE
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	• Ensuring to follow OHS rules and regulations • Ensuring proper disposal of waste D4.06 Performing IR test of Circuit breaker Knowledge • Purpose of IR test Skills • Using IR tester • Analytical skills Attitude, safety and environmental concern • Effective time management • Having integrity and work ethics • Efficient use of materials • Proper handling and storage of tools, materials and equipment • Ensuring appropriate use of PPE • Ensuring to follow OHS rules and regulations • Ensuring proper disposal of waste D4.07 Performing Contact Resistance Measurement (CRM) Test Knowledge • Purpose of CRM test Skills • Using CRM test kit • Analytical skills Attitude, safety and environmental concern • Effective time management • Having integrity and work ethics • Efficient use of materials • Proper handling and storage of tools, materials and equipment • Ensuring appropriate use of PPE • Ensuring to follow OHS rules and regulations • Ensuring proper disposal of waste
Learning Conditions	Learning Materials • CBLM • Hand-outs • Audio-visuals • Reference books • Manuals • LMS • Google classroom Learning Facilities and Infrastructure • Classroom with adequate facilities • Library • IT lab • Workshop

	Materials • Wires, anti-rust spray, battery and Markin cloth Tools • Screwdriver, wrenches, discharge rod and spanners Instrument • Polarity tester, IR tester, ammeter/clamp-on meter, CRM test kit and Multimeter Equipment • LA, CT, PT, CVT, circuit breakers, testing kit/auto transformer and ladder PPE • Safety gloves, safety boots, safety helmet, safety goggles, safety harness, mouth mask and reflective vest
Instructional Methodologies	The trainer shall use <i>inter alia</i>, the following instructional methods: • Lecture • Interactive discussion • Demonstration • Industrial visit/training • Guided practice • Group practice with project-based learning • Individual practice with problem-based learning
Method of Assessment	The trainer shall use <i>inter alia</i>, the following assessment methods: • Practical observation • Oral/viva-voce • Written test • Assignment • Project work

MODULE 5
ON
CARRYING OUT INSTALLATION AND MAINTENANCE OF PLC

MODULE INFORMATION

Occupation	Industry Electrical Technician
Competency Area	Carry out installation and maintenance of PLC
Module Title	Carrying out installation and maintenance of PLC
Module Code	7411- L3-M5
Module Description	This module is structured to provide the learners with knowledge, skills and right attitude required to perform installation, basic programming and maintenance of PLC
Nominal Duration	84 Hours
Qualification Level	Certificate Level 3
Pre-requisite	Completed Module 7411-L3-M4
Learning Outcome	1. Perform installation of PLC system 2. Program basic PLC circuits 3. Perform maintenance of PLC system

Module Title	Carrying out Installation and maintenance of PLC		
Module Code	7411-L3-M5		
Learning Outcome 1	Perform installation of PLC		
Duration	Theory: 6 hours	Practical: 24 hours	Total: 30 hours
Assessment Criteria	• PLC hardware is installed as per standard procedures • PLC unit is connected with input and output device as per the standard procedures • Connection of PLC module with input and output device is tested as per standard procedures • PLC software is installed as per the standard procedures • Communication between PLC and programmer is established as per standard procedure		
Contents	E1.01 Installing PLC hardware Knowledge • Introduction to automation • Types of industrial control system • Introduction to PLC • History of PLC • Types of PLC's • Advantages & disadvantages of PLC • Application of PLC • Components of PLC and its functions • PLC Architecture • Scan cycle • Memory mapping of PLC • CPU specifications • Types of I/O devices • Types of I/O modules Skills • ICT skills • Using Multimeter • Communication skills Attitude, safety and environmental concern • Effective time management • Having integrity and work ethics • Efficient use of materials • Proper handling and storage of tools, materials and equipment • Ensuring appropriate use of PPE • Ensuring to follow OHS rules and regulations • Ensuring proper disposal of waste		

	E1.02 Connecting PLC unit with input and output devices Knowledge • Types of sensors • Wiring of sensors with input module • Specification of I/O modules Skills • ICT skills • Using Multimeter • Communication skills Attitude, safety and environmental concern • Effective time management • Having integrity and work ethics • Efficient use of materials • Proper handling and storage of tools, materials and equipment • Ensuring appropriate use of PPE • Ensuring to follow OHS rules and regulations • Ensuring proper disposal of waste E1.03 Testing connection of PLC module with input and output devices Knowledge • Process of testing I/O devices • General Rules and Guidelines for Operating S7-200 Programmable Controller • Electrical Configuration • Prerequisites for Commissioning Skills • ICT skills • Using Multimeter • Communication skills Attitude, safety and environmental concern • Effective time management • Having integrity and work ethics • Efficient use of materials • Proper handling and storage of tools, materials and equipment • Ensuring appropriate use of PPE • Ensuring to follow OHS rules and regulations • Ensuring proper disposal of waste • Ensuring to provide correct interface cable and port • Ensuring to provide correct addressing and programming E1.04 Installing PLC software Knowledge • Introduction to PLC Software's • Operating System and Hardware Requirements
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	Skills • ICT skills • Using PLC software • Communication skills Attitude, safety and environmental concern • Effective time management • Having integrity and work ethics • Efficient use of materials • Proper handling and storage of tools, materials and equipment • Ensuring appropriate use of PPE • Ensuring to follow OHS rules and regulations • Ensuring proper disposal of waste E1.05 Establishing communication between PLC and Programmer (PC) Knowledge • Communications Parameters Skills • Using PLC software • ICT skills • Communication skills • Control wiring skills Attitude, safety and environmental concern • Effective time management • Having integrity and work ethics • Efficient use of materials • Proper handling and storage of tools, materials and equipment • Ensuring appropriate use of PPE • Ensuring to follow OHS rules and regulations • Ensuring proper disposal of waste
Learning Conditions	Learning Materials • CBLM • Hand-outs • Audio-visuals • Reference books • Manuals • LMS • Google classroom Learning Facilities and Infrastructure • Classroom with adequate facilities • Library • IT lab • Workshop

	Materials - wires, screw, communication cable, MCB, push button, limit switch, sensor, wooden board, push button box, contactor, indicator lamp, indicator box, din rail, fuse, terminal block and relay Tools - Pliers, wire stripper, screwdriver set, Allen key set and electrician knife Instrument - Multimeter Software - PLC software Equipment - PLC, CPU, Human Machine Interface (HMI), Switching Mode Power Supply (SMPS) and Computer PPE - Safety gloves, safety boots, safety helmet, safety goggles, safety harness, mouth mask and reflective vest
Instructional Methodologies	The trainer shall use <i>inter alia</i>, the following instructional methods: - Lecture - Interactive discussion - Demonstration - Industrial visit/training - Guided practice - Group practice with project-based learning - Individual practice with problem-based learning
Method of Assessment	The trainer shall use <i>inter alia</i>, the following assessment methods: - Practical observation - Oral/viva-voce - Written test - Assignment - Project work

Module Title	Carrying out Installation and maintenance of PLC		
Module Code	7411-L3-M5		
Learning Outcome 2	Program basic PLC circuit		
Duration	Theory: 6 hours	Practical: 30 hours	Total: 36 hours
Assessment Criteria	• DOL starter is programmed as per the standard procedures • Forward-reverse starter is programmed as per the standard procedures • Counter circuit is programmed as per the standard procedures • Automatic star-delta starter is programmed as per the standard procedures		
Contents	E2.01 Programming DOL starter Knowledge • Binary numbers • Logic gates and its applications • Operation of limit switch and sensor • Types of PLC programming language • Types of relay Skills • Interpreting drawing • ICT skills • Using PLC software • Using Multimeter • Communication skills • Analytical skills Attitude, safety and environmental concern • Effective time management • Having integrity and work ethics • Efficient use of materials • Proper handling and storage of tools, materials and equipment • Ensuring appropriate use of PPE • Ensuring to follow OHS rules and regulations • Ensuring proper disposal of waste • Ensuring to provide correct interface cable and port • Ensuring to provide correct addressing and programming E2.02 Programming forward-reverse starter Knowledge • Application of forward-reverse starter Skills • Interpreting drawing • ICT skills • Using PLC software • Using Multimeter • Communication skills		

	- Analytical skills <i>Attitude, safety and environmental concern</i> - Effective time management - Having integrity and work ethics - Efficient use of materials - Proper handling and storage of tools, materials and equipment - Ensuring appropriate use of PPE - Ensuring to follow OHS rules and regulations - Ensuring proper disposal of waste - Ensuring to provide correct interface cable and port - Ensuring to provide correct addressing and programming E2.03 Programming counter circuit <i>Knowledge</i> - Definition of counter circuit - Types of counter - Working principle of counter circuit - Application of counter circuit - Time chart <i>Skills</i> - Interpreting drawing - ICT skills - Using PLC software - Using Multimeter - Communication skills - Analytical skills <i>Attitude, safety and environmental concern</i> - Effective time management - Having integrity and work ethics - Efficient use of materials - Proper handling and storage of tools, materials and equipment - Ensuring appropriate use of PPE - Ensuring to follow OHS rules and regulations - Ensuring proper disposal of waste - Ensuring to provide correct interface cable and port - Ensuring to provide correct addressing and programming E2.04 Programming automatic star-delta starter <i>Knowledge</i> - Operation of star-delta starter - Application of star-delta starter - Types of timer <i>Skills</i> - Interpreting drawing - ICT skills - Using PLC software
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	• Using Multimeter • Communication skills • Analytical skills <i>Attitude, safety and environmental concern</i> • Effective time management • Having integrity and work ethics • Efficient use of materials • Proper handling and storage of tools, materials and equipment • Ensuring appropriate use of PPE • Ensuring to follow OHS rules and regulations • Ensuring proper disposal of waste • Ensuring to provide correct interface cable and port • Ensuring to provide correct addressing and programming
Learning Conditions	Learning Materials • CBLM • Hand-outs • Audio-visuals • Reference books • Manuals • LMS • Google classroom Learning Facilities and Infrastructure • Classroom with adequate facilities • Library • IT lab • Workshop Materials • Wires, MCB, push button, limit switch, sensor, timer, wooden board, push button box, communication cable, contactor, indicator lamp, terminal block, indicator box and relay Tools • Pliers, wire stripper, screwdriver set, Allen key set and electrician knife Instrument • Multimeter Software • PLC software Equipment • PLC, CPU & modules, adjustable power supply and PC PPE • Safety gloves, safety boots, safety helmet, safety goggles, safety harness, mouth mask and reflective vest

Instructional Methodologies	The trainer shall use <i>inter alia</i>, the following instructional methods: • Lecture • Interactive discussion • Demonstration • Industrial visit/training • Guided practice • Group practice with project-based learning • Individual practice with problem-based learning
Method of Assessment	The trainer shall use <i>inter alia</i>, the following assessment methods: • Practical observation • Oral/viva-voce • Written test • Assignment • Project work

Module Title	Carrying out Installation and maintenance of PLC		
Module Code	7411-L3-M5		
Learning Outcome 3	Perform maintenance of PLC system		
Duration	Theory: 3 hours	Practical: 15 hours	Total: 18 hours
Assessment Criteria	• Components of PLC system is inspected as per the standard procedures • Periodic maintenance is performed as per the standard procedures • PLC system is troubleshoot as per the standard procedures		
Contents	E3.01 Inspecting components of PLC system Knowledge • Components of PLC system and its function Skills • Observation skills • Analytical skills • Using PLC software • Using Multimeter • Communication skills Attitude, safety and environmental concern • Effective time management • Having integrity and work ethics • Efficient use of materials • Proper handling and storage of tools, materials and equipment • Ensuring appropriate use of PPE • Ensuring to follow OHS rules and regulations • Ensuring proper disposal of waste E3.02 Performing periodic maintenance Knowledge • Types of maintenance • Importance of periodic maintenances of PLC Skills • Computer application skills • Using PLC software • Using Multimeter • Communication skills Attitude, safety and environmental concern • Effective time management • Having integrity and work ethics • Efficient use of materials • Proper handling and storage of tools, materials and equipment • Ensuring appropriate use of PPE • Ensuring to follow OHS rules and regulations • Ensuring proper disposal of waste		

	E3.03 Troubleshooting PLC system Knowledge • Types of PLC faults • Causes, symptoms and remedies of PLC system failure Skills • ICT skills • Using PLC software • Using Multimeter • Observation skills • Communication skills • Analytical skills Attitude, safety and environmental concern • Effective time management • Having integrity and work ethics • Efficient use of materials • Proper handling and storage of tools, materials and equipment • Ensuring appropriate use of PPE • Ensuring to follow OHS rules and regulations • Ensuring proper disposal of waste
Learning Conditions	Learning Materials • CBLM • Hand-outs • Audio-visuals • Reference books • Manuals • LMS • Google classroom Learning Facilities and Infrastructure • Classroom with adequate facilities • Library • IT lab • Workshop Materials • PLC software, wires, MCB, push button, limit switch, sensor, wooden board, push button box, communication cable, terminal block, indicator box, contactor, indicator lamp and relay Tools • Pliers, wire stripper, screwdriver set, Allen key set and electrician knife Instrument • Multimeter Equipment • PLC, CPU & modules, adjustable power supply and PC

	PPE • Safety gloves, safety boots, safety helmet, safety goggles, safety harness, mouth mask and reflective vest
Instructional Methodologies	The trainer shall use <i>inter alia</i>, the following instructional methods: • Lecture • Interactive discussion • Demonstration • Industrial visit/training • Guided practice • Group practice with project-based learning • Individual practice with problem-based learning
Method of Assessment	The trainer shall use <i>inter alia</i>, the following assessment methods: • Practical observation • Oral/viva-voce • Written test • Assignment • Project work

ANNEXURE

Annex I: Time Distribution

Annex I: Time Distribution					
	Learning outcomes	Tasks	Theory (hours)	Practical (hours)	Total (hours)
A: Carry out industrial wiring	A1 Install motor starter	A1.01 Perform control and power cable ferruling & tagging	2	4	6
		A1.02 Construct DoL starter	2	10	12
		A1.03 Construct forward reverse starter	2	16	18
		A1.04 Construct jogging control circuit	2	10	12
		A1.05 Construct star-delta starter	3	15	18
		A1.06 Construct auto transformer starter	1	5	6
		A1.07 Install soft starter	2	4	6
		A1.08 Install VFD	2	10	12
	Sub Total Duration		16	74	90
	A2 Install standby power supply	A2.01 Install Diesel Generator	2	4	6
		A2.02 Install battery backup supply	1	5	6
		A2.03 Commission standby power supply	1	5	6
	Sub Total Duration		4	14	18
	A3 Perform power cable jointing and termination	A3.01 Prepare cable trench	2	10	12
		A3.02 Lay power cable	2	10	12
		A3.03 Perform XLPE power cable termination	2	16	18
		A3.04 Perform LT power cable jointing	2	16	18
		A3.05 Perform XLPE power cable jointing	2	32	34
	Sub Total Duration		10	84	94
	Total Duration (A)		30	172	202
B: Carrying out maintenance of electric motors and	B1 Perform motor and generator inspection	B1.01 Perform pre-start inspection of generator	4	8	12
		B1.02 Perform inspection of generator on load	2	10	12
		B1.03 Perform pre-start inspection of induction motor	2	4	6
		B1.04 Perform inspection of induction motor on load	2	10	12

generators	Sub Total Duration		10	32	42
	B2 Test motor and generators	B2.01 Perform continuity test	2	4	6
		B2.02 Perform IR test	1	5	6
		B2.03 Perform no load test	1	5	6
		B2.04 Perform on load test	2	10	12
		B2.05 Perform winding polarity test	1	5	6
		B2.06 Perform winding resistance test	1	5	6
	Sub Total Duration		8	34	42
	B3 Perform motor servicing and rewinding	B3.01 Disassemble motor	1	5	6
		B3.02 Remove winding	2	10	12
		B3.03 Prepare winding coil	6	30	36
		B3.04 Insert motor winding coil	6	30	36
		B3.05 Apply varnish on winding	1	5	6
		B3.06 Assemble motor	1	5	6
	Sub Total Duration		17	85	102
	B4 Perform servicing of generator	B4.01 Replace oil/fuel filter	2	4	6
		B4.02 Change coolant	1	5	6
		B4.03 Replace air filter	2	2	4
		B4.04 Replace carbon brush	2	10	12
		B4.05 Maintain battery	2	4	6
		B4.06 Service thermostat	2	4	6
		B4.07 Clean fuel tank	2	2	4
	Sub Total Duration		13	31	44
	Total Duration (B)		48	182	230
C: Carrying out maintenance of transformers and its accessories	C1 Monitor transformer	C1.01 Inspect breather assembly	2	4	6
		C1.02 Inspect conservator and OLTC oil level	2	4	6
		C1.03 Inspect for abnormal noise in transformer	2	4	6
		C1.04 Inspect bushings	2	4	6
		C1.05 Inspect OTI & WTI pocket oil level	2	4	6
		C1.06 Inspect buchholz relay oil level	2	4	6
		C1.07 Inspect WTI and OTI temperature	2	4	6
		C1.08 Inspect leakage of transformer oil	2	4	6

	C1.09 Inspect arching horn	2	4	6
	C1.10 Check healthiness of earthing (s)	1	5	6
Sub Total Duration		19	41	60
C2 Perform functional test of transformer protection devices	C2.01 Perform Buchholz relay test	3	9	12
	C2.02 Perform pressure relief device test	3	9	12
	C2.03 Perform Winding Temperature Indicator (WTI) test	3	9	12
	C2.04 Perform Oil Temperature Indicator (OTI) test	3	9	12
	C2.05 Perform Magnetic Oil Gauge (MOG) test	3	9	12
	C2.06 Perform On Load Tap Changer test	3	9	12
	C2.07 Perform oil surge relay test (OSR) test	3	9	12
Sub Total Duration		21	63	84
C3 Service transformer	C3.01 Replace bushings	2	10	12
	C3.02 Maintain arc-horn gap	2	4	6
	C3.03 Filter transformer oil	2	4	6
	C3.04 Top-up transformer oil	2	4	6
	C3.05 Change transformer oil	3	3	6
	C3.06 Regenerate/replace silica gel	2	4	6
	C3.07 Change breather	2	4	6
	C3.08 Inspect valves condition	2	4	6
	C3.09 Change the gaskets	2	4	6
	C3.10 Tighten terminal connection	2	4	6
Sub Total Duration		21	45	66
C4 Perform transformer tests	C4.01 Perform breakdown voltage test of transformer oil	2	4	6
	C4.02 Perform IR, DAR & PI test of transformer windings	2	10	12
	C4.03 Perform Ratio Test	2	4	6
	C4.04 Perform winding resistance test	2	4	6
	C4.05 Perform Tan-Delta Test	2	4	6
	C4.06 Perform DGA test	2	4	6
Sub Total Duration		12	30	42
Total Duration C		73	179	252

D: Carry out maintenance of control system and protective switchgears	D1 Monitor control and protective switchgears	D1.01 Inspect oil level of PT/CVT & CT	2	10	12
		D1.02 Inspect the SF6 gas level of CB	2	4	6
		D1.03 Inspect LA & surge monitor	2	4	6
		D1.04 Inspect air pressure of pneumatic operated CB	2	4	6
		D1.05 Inspect condition of CB tripping and closing coil of CB	2	4	6
		D1.06 Inspect condition of isolator and earth switch	2	4	6
		D1.07 Inspect AVR	2	4	6
	Sub Total Duration		14	34	48
	D2 Perform functional test of control and protective switchgears	D2.01 Test CB closing and tripping	2	10	12
		D2.02 Test CB operating mechanism	2	10	12
		D2.03 Test isolator and earth switch	2	10	12
	Sub Total Duration		6	30	36
	D3 Service control & protective switchgears	D3.01 Replace tripping and closing coil of CB	2	10	12
		D3.02 Replace electromechanical relays	3	9	12
		D3.03 Refill SF6 gas	2	10	12
		D3.04 Replace LA and surge monitor	2	10	12
	Sub Total Duration		9	39	48
	D4 Perform testing of switchgears	D4.01 Perform IR test of LA	2	4	6
		D4.02 Perform IR test of CT and PT	1	5	6
		D4.03 Perform ratio test of CT	1	5	6
		D4.04 Perform polarity test of CT	1	5	6
		D4.05 Perform winding resistance test of CT	1	5	6
		D4.06 Perform IR test of CB	1	5	6
		D4.07 Perform contact resistance measurement test	1	5	6
	Sub Total Duration		8	34	42
	Total Duration		37	137	174
E: Carryout installation and maintenance of PLC	E1 Perform installation of PLC	E1.01 Install PLC hardware	2	4	6
		E1.02 Connect PLC unit to input and output device	1	5	6
		E1.03 Test connection of PLC modules with input and output devices	1	5	6
		E1.04 Install PLC software	1	5	6
		E1.05 Establish communication between PLC and Programmer	1	5	6
	Sub Total Duration		6	24	30

	E2 Program PLC circuit	E2.01 Program DoL Starter	2	10	12
		E2.02 Program forward-reverse starter	1	5	6
		E2.03 Program counter circuit	1	5	6
		E2.04 Program automatic star delta starter	2	10	12
	Sub Total Duration		6	30	36
	E3 Perform repair and maintenance of PLC system	E3.01 Inspect components of PLC system	1	5	6
		E3.02 Perform periodic maintenance	1	5	6
		E3.03 Troubleshoot PLC system	1	5	6
	Sub Total Duration		3	15	18
		Total Duration E	15	69	84
	Grand Total Duration(hours)		203	739	942

Annex II: Assessment Sample

Unit of competency	Drive Light Vehicle
Unit Code	8322-U4-L2
Module Title	Driving Light Vehicle
Module Code	8322-U4-L2-M1
Time Duration	45 min *
Problem or Project: Drive Light Vehicle	
Introduction: Perform pre-operating procedures before starting the vehicle. Drive light vehicle under different environment conditions following standard traffic rules and defensive driving techniques. Perform post operating procedures after parking the vehicle.	
Observation: (How will you be assessed as Competent?) Your performance will be assessed based on the following criteria: • Performance of pre and post operating procedures as per standard practices; • Application of standard procedures while starting the LMV; • Demonstrating the driving skills in different road condition using the system of vehicle control (SOVC); • Demonstrating your adherence to RSTA Rules, Defensive Driving; • The final outcome of your driving skills	
Note: For Assessor/Institute for preparation for assessment. Materials and Equipment for 1 candidate • LMV in good running condition with all necessary vehicle documents Roles and responsibilities of assessors (before/during and after assessment) • Identify in advance the different road environment (rough road, town, simulated night and poor light condition, highway) • During assessment let the candidate demonstrate moving off, reversing, overtaking, and parking.	

Assessor/ Observation Check List

Unit of competency	Drive Light Vehicle		
Unit Code	8322-U4-L2		
Module Title	Driving Light Vehicle		
Module Code	8322-U4-L2-M1		
Problem/Project: Drive Light Vehicle			
Candidate's Name:			
Place of Assessment:		Date of Assessment:	
A. During the demonstration of skills did the candidate do following:	Marks allocated	Marks received	Remarks
1. Check mirror settings, fluid level, tire pressure and required documents.	4		
2. Start LMV according to the procedure of standard starting procedure (Cockpit Drill)	2		
3. Move off and steer LMV wearing seat belts and without stalling the engine*	3		
4. Reverse LMV safely without stalling the engine*	3		
5. Park LMV safely in the centre of given parking area following standard parking procedure	2		
6. Drive LMV on the highway according to the road conditions following the road safety signs.	2		
7. Drive LMV in towns according to the traffic signs and signals.	2		
8. Drive LMV on 4WD safely (if necessary and available)	1		
9. Giving pass and overtake the vehicle safely according to the road and weather condition *	3		
10. Stop LMV safely in a given area according to standard stopping procedure	1		
B. Is the job outcome correct in the following areas?			
Caused no accidents and damages to the vehicle.*	5		
Total marks obtained	28		
The Candidate's performance	Satisfactory:		
	Not Satisfactory:		

Note: The questions marked with * are the critical questions which the trainees must be able to answer. Otherwise, they will be rated unsuccessful even if they perform well in the practical exam. The mark P is for the psychomotor domain level (P1- Simple Routine Assignment; P2- Questions related to Simple Routine Assignment and P3- Questions not related to Simple Routine Assignment)

Oral Questions checklist:

Unit of competency		Drive Light Vehicle		
Unit Code		8322-U4-L2		
Module Title		Driving Light Vehicle		
Module Code		8322-U4-L2-M1		
Problem/Project: Drive Light Vehicle				
Candidate's Name:				
Place of Assessment:		Date of Assessment:		
Questions (and its domain level) to be answered by the trainee / candidate:	Key Answer	Marks allocated	Marks obtained	Remarks
Why do you keep the vehicle in start mode for a few minutes before moving? (Verifying observations) (C1)				
In case of accidents who will you contact first? (contingency questions) (C2)				
While entering intersection, before how many seconds do you have to give signal? (verifying observations) (C3)				
Total Marks Obtained				
The candidate's performance was:		Satisfactory:		
		Not Satisfactory:		
Assessor's Name:		Signature:		

Note: The questions marked with C describes the cognitive level of the questions. C1- Remembering; C2- Functional Understanding and C3- Problem Solving.

Written questions checklist:

Unit of competency		Drive Light Vehicle	
Unit Code		8322-U4-L2	
Module Title		Driving Light Vehicle	
Module Code		8322-U4-L2-M1	
Problem/Project: Drive Light Vehicle			
Candidate's Name:			
Place of Assessment:		Date of Assessment:	
Questions (and its domain level) to be answered by the trainee/ candidate:	Key Answer	Marks Allocated	Marks Obtained
1. List down three types of parking. (Short Answer Question) (C1)	Angle, Straight and	1	

Annex III: Module Recognition

This is to verify that

Mr/Ms.....

has completed module on

.....

Covering following learning outcomes:

1.
2.
3.

Instructor:

Head of the Department:

.....

.....

Signature:

Signature:

Date: / / (dd/mm/yyyy)
.....(dd/mm/yyyy)

Date: / /

Head of the Institute:

Trained Assessor (Institute)/Exam OC:

.....

.....

Signature:

Signature:

Date: / ... / (dd/mm/yyyy)

Date: / /(dd/mm/yyyy)

Annex IV: Lesson Plan
Lesson Plan

Course Title:		NC Level:
Module Code:		Duration:
Module Title:		
Learning Outcome:		
Skill/Task/Topic:		
Terminal Performance Objective:		
<i>(Note: Write narrative statement extracted from TPO of Task Sheet)</i>		
Enabling Objectives (Related knowledge):		
<i>By the end of the lesson learners will be able to:</i>		
- i) - ii) - iii)		
What (Content/Activity)	Who (T/L)	How (Methods/ Media)
Duration (Min.)	Questions	
<i>Introduction:</i>		
<i>Main body</i>		
<i>Conclusion</i>		
Projects/Problems:		

Instructional Resources Plan				
Skills/Task/Topic:				
No. of Trainees:				
Sl. No.:	Instructional materials/resources	Specifications	Qty.	Remarks
Prepared by :		Signature	Date:	
Revised by:		Signature	Date:	
Approved by:		Signature	Date:	

Task sheet

TS-1/4: Practical Plan

TS-1/4: Practical Plan			
Course Title:		N C Level:	
Module code:		Duration:	
Module Title			
Learning outcome			
Skills/Task Title:		Task no:	
Terminal Performance Objective: <i>Given:</i> <i>Cue:</i> <i>Who:</i> <i>What:</i> <i>Within:</i> <i>How well:</i> - - -			
Enabling Objectives (Related Skills): <i>By the end of a lesson, the learners will be able to:</i> i) ii) iii) iv)			
Activities	Who (T/L)	How (methods/ media)	Duration
Project/Assignment:			

TS-2/4: Tool and Equipment required:							
<i>Sl no.</i>	<i>Particulars</i>	<i>Specifications</i>	<i>Qty.</i>	<i>Remarks</i>			
Training Materials required:							
<i>Sl no.</i>	<i>Particulars</i>	<i>Specifications</i>	<i>Qty.</i>	<i>Rate</i>	<i>Amount</i>	<i>Remarks</i>	
TS-3/4: Performance Guide							
Skill/Task:					Date:		
Directions: Use the following performances criteria to rate the learner. Check YES/NO to indicate whether the learner performed each step as indicated or not?							
Sl. No:	Steps					Yes	No
Note: Critical steps: All * marked steps should be carried out very carefully. For a quality performance guide, all items should be checked "YES"							

TS-4/4: Instruction and Drawing***General Instructions for Trainees***

- i)
- ii)
- iii)
- iv)

Drawing (if any)**Safety Precaution**

- i)
- ii)
- iii)

Prepared by:**Signature****Date:****Revised By:****Signature****Date:****Approved by:****Signature****Date:**

Annex V: Course Plan
Institutes letter head and Logo

(Trade)YEAR PLAN- _____ Semester_____ (Year)

Trade: NC Level:			Schedule																																								Total Hours																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																				
Module Code	Module Title	Learning Outcome	Feb.				March				April				May				June				July				Aug.				Sept				Oct.				Nov.																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																								
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Prepared by:

Verified & Approved by:

Date:

Monthly/Weekly Plan

Month:

Trade:

Trainer:

Week	Monday	Tuesday	Wednesday	Thursday	Friday	Saturday	Sunday
Week 01							
Week 02							
Week 03							
Week 04							
Week 05							

Developed by:

Approved by:

Date



For more information please contact:

Technical Trainers Training and Resource Center (TTTRC), DWPSD

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