040 – ELECTRICAL INSTALLATION AND MAINTENANCE WORKS

EXAMINATION STRUCTURE

For this Trade the following are trade-related courses:

193 – Building/Engineering Drawing.

The trade shall also be examined under the following subject grouping.

– Domestic and Industrial Installation (CEI 12, 13)

– Cable Jointing, Battery Charging and Repairs (CEI 14 & 15)

– Winding of Electrical Machines (CEI 16)

EXAMINATION SCHEME

041 – **Electrical Installation & Maintenance Works**

This subject grouping consists of two papers – Paper I and Paper II

PAPER I : This will consists of two sections, Section Aand Section B.

SECTION A: will comprise forty (40) multiple choice objective questions to be answered in 40 minutes. This section carries forty (40) marks.

SECTION B: will comprise nine (9) Essay questions which shall consist of three parts – 1, 2 & 3. Each part shall consists of three (3) questions. Candidates are to answer two (2) questions from each part in 2½ hours for 60 marks.

Questions shall be drawn from the three subjects – Domestic & Industrial Installation CEI 12 & 13, Cable Jointing CEI 14, Winding of Electrical Machines CEI 16.

PAPER II: This will comprise of two Practical questions for 3 hours. This paper will attract 100 marks.

041 – DOMESTIC AND INDUSTRIAL INSTALLATION

S/N	TOPICS/OBJECTIVE	CONTENT	ACTIVITIES/REMARK
1.	**Working Drawing** 1. Interpret the distribution system/ scale used in working diagram and identify all the electrical accessories required for a job from the drawing. 2. Draw electrical installation diagram of a living house and locate the position of the various accessories on a drawing. 3. generation, transmission and distribution system. 4. Safety precautions in electrical workshop. 5. First Aid treatment. 6. Tools and materials used for electrical installation.	1. Symbols in electrical engineering: i. switches ii. lamp holders iii. fluorescent iv. transformers v. resistors, inductors, capacitors etc. 2. Working diagrams scale. 3. Position of accessories on a drawing. 4. Electrical accessories: i. ceiling rose ii. joint boxes iii. lamp holders etc. 5. Distribution system. i. the grid system ii. the 415v/250v 6. Electrical installation diagram	1. Examine each of the symbols. 2. Emphasize correct used of electrical symbols 1. Measure the working diagram with the aid of scale rule. 2. Examine and locate the position of various accessories on a drawing. 3. identify and list electrical accessories needed for a job from the drawing. 4. Explanation of the distribution system from the drawing. 5. Briefly mention power stations: i. coal fired ii. nuclear iii. hydro-electric 6. Draw and explain electrical installation diagram from a living house.
2.	**Surface wiring** 1. Identify types and sizes of cables and conductors used for lighting, heating, etc, and use various types of wiring clips, gim pins etc. 2. State and explain relevant statutory regulations regarding surface wiring and apply the prevailing regulations of electrical Board of Nigeria, NEPA when carrying out surface wiring. 3. Installation of discharge lamps. 4. Installation of socket outlets in ring or radial circuits. 5. Installation of bells buzzers and relays luminous call system, burglar and fire alarm system.	1. Wiring clips, gimpins, rawl drills and rawl plugs. 2. Sizes of cables and conductor: 1mm^2, 1.5 mm^2, 2.3 mm^2, pvc flexible 3. Cable rating, maximum load demand, ambient temperature. 4. Plumb-line, chalk-line and spirit level. 5. Surface wiring: Considering diversity factor. – use of rawl plugs, rawl drills, the ball pein hammer or clipping hammer, trowel, clipping nails and so on. 6. I.E.E. Regulations for surface wiring. 7. Regulations of Electrical Board of Nigeria. 8. Tungsten, fluorescent, sodium cold and hot cathode mercury, neon etc. 9. Bathroom installation temporary installation.	1. Identify and demonstration of various types of wiring clips, gim pins, rawl drills. 2. Display wiring clips, gim pins, rawl plugs and rawl drills. 3. Identify and discuss the types and sizes of cable and conductors used for lighting heating, cooker circuit and socket outlets. 4. Display types and sizes of cables. 5. Explanation of cable rating, maximum demand and ambient temperature. 6. Explain and demonstrate the usage of plumb-line chalk-line and spirit level. 7. Demonstrtate and explain how to carry out simple surface wiring with the appropriate tools. 8. Explanation of relevant statutory I.E.E. Regulations of Electrical Board of Nigeria, NEPA, when carrying out surface wiring.

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3.	**Conduit wiring**	1. Conduit wiring: i. light gauge conduit ii. heavy gauge conduit iii. heavy gauge welded conduit. iv. Flexible metallic conduit. v. Non-metallic conduit. 2. Advantages and disadvantages sof conduit installation. 3. Steel and flexible conduit. 4. Stocks, taps and dies, Hacksaw. 5. Statutory regulations. 6. Cutting and threading of conduit pipes: i. hacksaw ii. stock and dies iii. reamer 7. Conduit accessories: i. running couplers ii. male and female bushes 8. Permissible radial length: 9. Surface and concealed conduit installation. 10. Drawing cables into a conduit system – the fish wire; block the fish wire. 11. Inspection and testing of a conduit installation – the statutory regulation 12. Maintenance of tools and equipment – the hacksaw, the reamer, the bending machine and bending block, the fish wire the standing vice etc.	1. Explanation of conduit wiring. 2. Explanation of the advantages and disadvantages of conduit installation. 3. Identification of various types of conduit components. 4. Display types of conduits available. 5. Examination of dies – types and usage of stocks, hacksaw, taps and dies. 6. Highlight and explain the relevant statutory regulations in conduit wiring. 7. Explain and demonstrate how to cut and thread conduit pipes using appropriate tools. 8. Demonstration of the use of various types of conduit accessories. 9. Demonstrate how to determine, set and bend permissible radial lengths. 10. Demonstrate how to carry out a simple surface and concealed installation highlighting and relevant regulations. 11. Carry out the drawing of cables into both surface and concealed conduit installation using fish wire. 12. Carry out the inspection and required tests of the conduit installation as required by the statutory regulations. 13. Demonstrate and emphasize proper maintenance of tools and equipment used on conduits.
4.	**Installation of Protective Devices** 1. Identify and select common types of protective devices e.g. circuit breakers and explain its working	1. Protective devices: i. Circuit breakers ii. Fuses iii. Voltages and current operation ELCBS 2. Fuses and circuit breakers i. working principles	1. Display and explain the functions of common types of protective devices. State where each is used. 2. a) Examine fuses and circuit breakers, sketch and label their

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	principles. State their application and uses in electrical installation or devices. 2. State the relevant regulations regarding various types of protective devices and install them observing statutory regulations.	ii. applications 3. Fusing factors, current rating of fusing and fusing current. 4. Earthing: i. earthing continuity conductor (ECC) ii. earthing lead iii. earth electrode iv. earthing clamp 5. IEE Regulations covering earthing and the protective devices. 6. Voltage and current earth leakage circuit breakers. i. their functions ii. statutory regulations sinvolved as regards to their installations.	main components. b) Discuss their working principles and their applications. 3. Calculate current rating of fuses, fusing factors, and fusing current. 4. Definiiton of earth continuity conductor, earthing lead, earth elecrtrode. 5. emphasize the IEE Regulations that deal with earthing and the protective devices quoting their sections in the I/EE regulationms booklet/textbook. 6. a) carry out the electrical connections of voltage and current operated ELCBs. To the supply authority. b) Discuss their functions and statutory regulations involved.
5.	**Inspection and Testing of Domestic Installation** Carry out polarity earthing and insulation resistance test using the appropriate instruments and methods stipulated in the prevailing statutory regulations.	1. Statutory safety regulations on inspection and testing. 2. Mechanical and electrical loose connections. 3. Polarity test – testing instruments 4. Earthing test – testing instrument e.g megger and regulations involved. 5. Insulation test – megger instrument. 6. Ring circuit test – verify the result using testing instrument. 7. Result of tests.	1. Highlight the safety regulations on inspection and testing. 2. a) Carry out inspection on all joints made in a simple wiring made on a wiring board. b) Demonstrate the tightening of all loose contacts. 3. Demonstrate the use of bell set and test lamp. 4. a) Demonstrate the use of megger instrument to test for the continuity of earthing system. b) Mention the regulation that govern earthing. 5. Carry out test with meger insulation resistance tester: i. between conductors; ii. between earth and conductors; iii. between conductors and frame body of kettle, refrigerator etc. 6. a) Verify results of all tests with the test instrument used.

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			b) State the ohmic value of readings obtained on the instruments.
6.	**Illumination**	1. Define illumination terms. 2. Explain cosine law, inverse square law, brightness, glare and photometry. 3. Solve mathematical problems in illumination. 4. Explain spacing/mounting height ratio. 5. Identify different types of lamps.	1. Apply simple lumen methods to solve calculations. 2. Explain coefficient of utilization, maintenance factors, depreciator on factor etc. 3. Show emergency light, shades and reflectors.
7.	**Installation of MICC Cable** 1. Identify MICC Cables, state its limitations, advantages and where they are used. 2. Select basic tools and materials, carry out simple MICC cable installation, observing the necessary statutory regulations.	1. MICC cables: iv. copper conductors v. insulation vi. outer sheath 2. Tools and materials used in MICC cable installation vii. ringing tool/stripping tool viii. side cutters ix. slip gland nut 3. Termination: x. compound xi. sealing pot xii. crimping pot xiii. compression ring etc. xiv. IEE regulations 4. Statutory regulations. 5. Advantages and disadvantages of MICC. 6. Simple MICC cable installations. 7. Inspection and testing.	1. Identification of MICC cables. 2. Selection of tools and materials used in MICC cable installation. 3. Demonstrate and explain the termination of MICC cable emphasizing the IEE Regulations and precautionary measures. 4. Emphasize relevant Statutory regulations. 5. Mention the limitation of MICC cables and its advantages and disadvantages. 6. Demonstrate how to carry out MI/CC cable installation observing the relevant regulations. 7. Carry out tests on the completed MICC installation applying statutory regulations.
8.	**Types of Industrial Installation** Interpret electrical working drawing and carry out simple surface and conduit wiring for industrial installation.	1. Interpretation of electrical working drawings. 2. Simple surface and conduit wiring for industrial installation. 3. Installation of MICC cable. 4. Safety measures in simple surface wiring.	1. Interpret the working drawings. 2. Carry-out simple surface and conduit wiring for industrial installations. 3. Install MICC cables – application of the safety measures when carrying out the work.
9.	**Installation of Ducts and Trunking** 1. Describe, identify the various types and state the advantages and disadvantages of ducts and trunking in industrial electrical installation. 2. Identify various tuypes	1. Ducts and trunking systems. 2. Advantages and disadvantages of ducts and trunking. 3. Identification of ducts and trunking e.g. Metallic and non-metallic. 4. Selection, identification of tools and equipment used for ducts and trunking – maintenance of ducts and trunking. 5. Types of bus-bar trunking.	1. Description of ducts and trunking systems. 2. Listing the advantages and disadvantages of ducts and trunking: i. Display different types of ducts and trunking. ii. Join lengths of ducts and trnking.

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	of bus-bar trunking and bend set, shapes, file and fabricate accessories used in connection with ducts and trunking using the appropriate tools and equipment.	6. Fabrication of ducts and trunking accessories. 7. Ducts and trunking joints. 8. Importance of earth continuity in ducts and trunking 9. Safety measures in ducts and trunking system.	3. Display charts showing tools and equipment. 4. Identification of busbar trunking and accurate marking out when cutting holes. 5. Demonstrate how to bend, set, shape, file and fabricate accessories used for ducts and trunking. 6. Carry out various types of joints that are applicatble to ducts and trunking. 7. Explanations on how it is necessary to provide earth continuity in all types of ducts and trunking. 8. List the necessary safety measures as pr9vided by prevailing statutory regulations.
10.	**AC and DC Machines** 1. Identify various types of DC motor and generator, describe their principle of operation and constructional features. 2. Differentiate between DC and AC motors, DC and AC generators and state their applications.	1. Operation of DC motor: i. Operation of DC generator ii. Operation of AC generator iii. Operation of AC motor iv. Operation of DC motor 2. Constructional features of DC and AC machines. 3. Differences between: a) DC and AC motors b) DC and AC generators 4. Types of DC motors and generators. 5. Applications of DC motors and generators. 6. Types of AC motors single phase, 3-phase motors e.g. squirrel cage motors wound motors, induction motors etc. 7. Application of AC motors and generators. 8. Principles of operations of polyphase machine.	1. Explantation of the operational principles of DC motor, AC motor. 2. Illustrate by means of charts the constructional features of DC and AC Machines (single phase). 3. Listing the differences between Dc and Ac motors, DC and Ac generators. 4. Explanation of the various types of DC motors and generators. 5. Listing of specific application of Dc motors and DC generators. 6. Identification of various types of Ac motors, squirrel cage, induction motors etc. 7. Listing the various applications of AC motors. 8. Explanation of the poly-phase machines.
11.	**Installation** 1. Lift, handle, mount and align AC and DC machines and equipment and identify various types of enclosures and connections in electrical machines. 2. Select suitable starter,	1. Types of enclosures and their applications. 2. Foundation for mounting machines and equipment. 3. Installation of AC and DC machines/ equipment. 4. Types of connections. 5. Sizes of cable for the appropriate machine installations.	1. Identification of types of enclosures. 2. Construct good foundation base for mounting machines. 3. Description on how to lift, handle and mount machines. 4. Explanations of the various

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	correct size of cable for machine installations.	6. Flexible conductors for machine installation and terminations. 7. Suitable starter for different motors e.g. Direction line, star-delta etc. 8. Explanations of the operational principles of starter. 9. Carry out test to investigate correct rotation and earth fault. 10. Explanation of safety measures and regulations. 11. Simple calculations on electrical machines.	types of connections e.g. star-delta etc. 5. Carry out the actual installation of machines using appropriate cables. 6. Demonstration on how to correctly terminate machines. 7. Selection of starter such as direct on line, star-delta and auto-transformers. 8. Operational principles of starters. 9. Test for correct rotation short circuit and earth fault. 10. Safety measures provided by statutory regulations.
12.	**Maintenance of Electrical Equipment and Machine** 1. Describe the types of maintenance, identify and operate various types of tools and equipment used for maintenance. 2. Identify various types and grades of lubricants and state their application. 3. Maintain machines or equipment following maintenance procedure specified by the manufacturers and test to ensure that the maintained parts of machines or installation is in working condition.	1. Types of maintenance. 2. Maintenance procedure for machines and equipment. 3. Types and grades of lubricants 4. Application of appropriate types of lubricants. 5. Various types of tools and equipment used for maintenance e.g. grease gum, oil can, screw driver etc. 6. Constructional features of electrical equipments e.g. cookers, heaters, irons and state the functions of the equipment parts. 7. Maintenance procedures as specified by manufacturers.	1. Description of the types of maintenance. 2. Explanation of procedures of each type of machines. 3. Identification of types of grades of lubricants. 4. ?Explanations on the needs for applying lubricants. 5. Identification of correct tools and equipment for maintenance of machines. 6. Description of functional parts of equipment e.g. cooker, heater, iron etc. 7. Description of the various systematic maintenance procedures.
13.	**Repairs to Electrical Machines, Equipment and Installation** 1. Identify and explain causes of breakdown and faults and determine the fault by noise symptoms. 2. Apply trouble shooting techniques, tools and equipment to diagnose and effect repair of faulty parts.	1. Causes of breakdown 2. Identification of faults – interpretation of circuit diagram. 3. Trouble shooting techniques, tools and equipment for effective repairs. 4. Use of circuit diagram in installation. 5. Trouble shooting techniques. 6. Tools and equipment to effect repairs of faulty parts. 7. Performance test of machines and equipment.	1. Identification of causes of breakdown. 2. Interpretation of circuit diagrams of equipment and machines – voltage test using meter. 3. Application of appropriate tools and equipment to repair faulty parts. 4. Testing the correct performance of machines and equipment. 5. Emphasize on Visual inspection; voltage test using meters; current test using meters; continuity test using meters.

CABLE JOINTING

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14.	**Joints and Termination of Cables** 1. Identify and use all tools and materials related to cable jointing termination. 2. Recognize and identify various types of conductors and insulating materials. State the advantages and disadvantages of the different conducting materials.	1. Tools and materials used in cable jointing e.g. soldering bit, blow lamp, strippers; soldering lugs, electric, soldering iron, propane gas, pot and ladle, pliers, types of flux; soldering lead and sizes of cables. 2. Types of insulating materials e.g. pvc rubber etc. 3. Types of conductor e.g. copper, aluminum etc. 4. Cutting of cable ends, strip insulation and tape joints on completion. 5. Fixing of appliances and accessories into their terminal. 6. uses of the sizes of cables, lugs and glands. 7. Making the simple joints e.g. Tee joint, Britannia joint, married joint, scarf joint, tee twist joint, telescope joint and tee married joint.	1. Sketch the diagram of the tools and materials used in cable jointing and where to use them. 2. Identification of different types of insuslating materials. 3. Identification of different types of conductors. 4. State the advantages and disadvantages of the different conducting materials. 5. Description of how to insulate joints. 6. Description of the methods of shaping conductors to avoid terminal. 7. Demonstrate the method involved in fixing appliances and accessories into their terminal. 8. Application of sizes of cable lugs and glands. 9. Demonstrate the methods of making simple joints with their diagrams.
15.	**Soldering and Brazing** 1. Demonstrate the use of blow-lamp and pot and ladle for soldering big sizes of cables. 2. Select sizes of thin cable ends and solder lugs and carry out soldering and brazing exercise on joints.	1. Types of conductor materials e.g copper, aluminium etc. 2. Operation and maintenance of blow lamps. 3. Sizes of cable and lugs. 4. The use of pot and ladle in soldering big sizes of cable 5. Effect of heat transfer of conductor. 6. The use of heat sink. 7. Importance of heat sink. 8. Soldering and brazing exercises on joints. 9. Electrical Continuity of joints.	1. Discuss the advantages and disadvantages of conductor materials. 2. Explanation of methods involved in operating blow lamps. 3. Identify different sizes of cables and suitable lugs. 4. with diagram, discuss the method involved in the use of pot and ladle for soldering big sizes of cable. 5. Discuss the significance of heat transfer of conductors. 6. Explanation of the various methods of heat transfer. 7. Explanation of the functions of heat sink. 8. Demonstrate the method of soldering and brazing exercise on joints. 9. Explanation methods of testing electrical continuity.
16.	**Armoured Cables** 1. Recognize various types	1. Types of armouring materials. 2. Reasons why armouring necessary.	1. Identify different types of armouring materials with

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	of armouring materials, explain its necessary and state its application. 2. Join and terminate armoured cables at intermediate positions and describe with aid of diagram its constructional features.	3. Application or armouring cable. 4. Constructional features of armoured cable. 5. Joints on armoured cables.	diagram. 2. Discuss the importance of armouring. 3. Application of the armouring cable. 4. Show the constructional features of armoured cable with diagram. 5. Explanation of the process of jointing armoured cables. 6. Discuss the methods of terminating armoured cable.
17.	**Underground Cable Installation** 1. Select appropriate types of cables for underground cable to site and prepare trench to appropriate depth for cable laying. 2. Make cable joints/ termination, solder underground cable joints and identify various materials and tools used for joints and termination in underground cables.	3. Types of cables for underground electrical installation work e.g. sheeted cable, screened or H-type cable, HSL-type cable (screened lead), single and three cord 1342 KV oil filled cable, external gas pressure and gas pressure impregnated cable, PVC armoured PIL. 4. Conveying cables to sites 5. Preparation of trench to appropriate dept for cable laying. 6. Laying of cables in trench. 7. Materials and tools used for joints and termination in underground cables e.g. gland boxes, pot and ladle, plumbers metal, gas/blow lamps. 8. Making of cable joints termination e.g. Tee, straight final terminations. 9. Soldering of underground cables. 10. Types of tapes used in underground works. 11. IEE regulations and its relevance to underground cable work. 12. Continuity of wire and installation resistance of cable. 13. Working principle of some instruments and their applications in cable jointing e.g. bridge megger, slide wire instrument, loop tester, temperature tester, pressure tester, current injection tester. 14. Skin effect and dielectric stress.	1. Identify different types of cables used for underground electrical installation work and explain when and where to use them. 2. Demonstrate the system of conveying underground cable to site. 3. Explain the method of preparing trench to appropriate depth for cable laying. 4. Explanations of trenches dimensions. 5. Draw some of the material and tools used for joints and termination in underground cables. 6. Demonstrate the method of making cable joints/termination. 7. Explanation of the appropriate method of soldering to be used. 8. Interpret the meaning of soldering underground cable joints. 9. Mention different types of types used in underground. 10. Application of relevant IEE regulation to underground work. 11. Discuss the working principle of some instruments used in cable jointing. 12. Explain the methods of determining skin effect and dielectric stress. 13. Emphasize the importance

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			of IEE regulation in relation to underground cable work.
18.	**Installation of Overhead Wires** 1. Identify cable/wires, tools and equipment used in overhead distributions/ transmission. 2. State the uses and prepare different types of stray wires. 3. Draw lines with appropriate tension and state the uses of different types of cross-arms used in high tension transmission.	1. Tools cable/wire and equipment used in overhead distribution/ transmission e.g. draw vice, safety belt, ladder, insulators. 2. Conveying and erecting of poles to site e.g. erect at appropriate poles span and firmly in the ground. 3. Types of stray wires. 4. Uses of stray wires. 5. Tools used for drawing overhead cables e.g. draw vice. 6. Cross arms used in high tension, transmission 7. Joints and terminations, and electrical continuity with necessary statutory regulations should be observed.	1. Emphasize the advantages of using this equipment tools. 2. Sketch the diagrams of this common tools and equipments used in overhead distribution/ transmission. 3. Discuss the system involved from the time of conveying poles to the time the pole will be erected firmly in the ground. 4. Identify different tuypes of stray wires. 5. Demonstrate the preparation of different types of stray wires and methods of securing poles with them. 6. Discuss methods of drawing lines with appropriate tension. 7. explain the importance of using different types of cross-arm in high tension transmission. 8. Demonstrate the making of proper joints and terminations in ensuring electrical continuity. 9. Emphasis should be placed on the necessary statutory regulations in making proper joints and terminations.
19.	**Data and Communication Cabling Methods**	1. Identify different types of data communication cables e.g. computer cables, fibre optics and co-axial cable. 2. Mention areas where they are used and explain the use of each. 3. Cable terminator, connect a small PABX.	1. Demonstrate the use of data communication cable information technology. 2. Identify and differentiate communication data cables.
20.	**Cells** 1. Identify types of cells. 2. Explain the working principles of primary and secondary cells. 3. Identify the various parts of the cell.	1. Types of cells e.g. primary and secondary cells. 2. Working principles of primary and secondary cells. 3. Primary and secondary cells. 4. Construction of a simple cell battery.	1. Draw and identify all the parts of the cell 2. Construct a simple cell or battery. 3. Explanation on how the primary and secondary cells function.

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	4. Construct a simple cell or battery.		4. Demonstrate the construction of battery by simple experiment.

WINDING OF ELECTRICAL MACHINES (CEI 16)

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21.	**Statutory Regulations** Apply the prevailing statutory regulations and safety precautions in an electrical workshop.	1. Statutory regulations as sit concerns: i. the use of conductors ii. soldering of terminals iii. setting of winding machines iv. handling of cable drums v. use of liquid varnish and oven 2. General safety precautions in an electrical workshop. 3. Definition of winding and electrical machines.	1. Enumerate all the statutory regulations. 2. Observe the necessary safety precautions in an electrical workshop. 3. Emphasize the safety of personnel and prevention of danger to tools and materials.
22.	**Tools and Equipment** Identify and use tools and equipment.	Tools and equipment used for winding jobs: i. hammers ii. screw iii. drivers iv. spanners v. crimping vi. tools vii. hacksaws viii. knives ix. mallets x. growlers xi. work benches xii. winding machines etc.	1. Identify tools and equipment used for winding. 2. Select appropriate tools and equipment and use them for winding jobs. 3. Emphasize the correct selection of appropriate tools and equipment. 4. Emphasize the necessary precautions to be observed in winding jobs.
23.	**Winding Drawings** Prepare and interpret simple wave and lap winding drawings and state the application of each type of winding drawing.	1. Preparation and interpretation of simple wave winding drawings. 2. Preparation and interpretation of simple lap winding drawings. 3. Application of wave winding and simple lap winding drawings. 4. Determination of coil span per pitch, per phase, per pole. 5. Position of coil ends on commutator/slip rings for fixed brush in a developed winding diagram.	Prepare and interpret winding drawings.
24.	**Dismantling** Dismantle machines and identify front and back shields. Fix the positions of the brushes and determine types of winding/connections.	1. Record of the necessary data from main plate. 2. Front and back shields. 3. Systematic dismantling of machines. 4. Types of winding/Connection and gauge of winding factor. 5. Brush fixing.	1. Explain the methods of collecting and recording necessary data from the main plate. 2. Differentiate between front and back shield. 3. Demonstrate how to dismantle and assemble machines for rewinding using extractor. 4. Identify types of winding/connection and gauge of winding factor. 5. Locate position of brushes. 6. Emphasize the use of extractors.
25.	**Rewinding of Machines** 1. Describe and list the classes of winding	1. Types of conductors in winding. 2. Winding insulation materials. 3. Classes of insulation materials.	1. List different types of conductors used in winding.

	insulating materials and identify various types of conductors used in winding. 2. Prepare and fix the winding coils in their slots, test for continuity and earthing, apply varnish and test the completed work.	4. Construction of winding formers. 5. preparation and fixing of winding coils in their slots 6. Insulation of slots 7. connection of winding coils using the prepared data. 8. Continuity and earthing. 9. Application of varnish and dry in oven	2. Description of classes of insulation materials. 3. Explanation of classes of insulating materials. 4. Sketch and explain how winding formers are constructed. 5. Demonstrate how to prepare and fix winding coils in their slots. 6. Use the prepared data to connect winding. 7. Carry out test on the continuity and earthing of the rewinding machines. 8. Demonstrate how to apply varnish and dry in oven. 9. Carry out test on the completed work.
26.	**Armature, Commutator and Slip Ring** Skim armature, slip ring, undercut and determine the effectiveness of commutator.	1. The effectiveness of a commutator. 2. Skim armature commutator, slip ring. 3. Undercutting of commutators.	Determine commutator effectiveness. Demonstrate how to skim armature commutator and slip ring, and undercutting of commutator.
27.	**Final Inspection and Testing** 1. Inspect for good ball bearing and other parts of machine. 2. Test for continuity using megger or bridge megger. 3. Test-run the machine ensuring correct rotation. 4. Test the voltage and current with avometer and the speed with tachometer, ensuring they correspond with manufacturers specifications.	1. Inspection of good ball bearing. 2. Systematical assembling of machine, fixing the end shield in their proper position. Maintenance of machine, application of grease to the appropriate parts. 3. The use of megger or bridge megger in testing for continuity and insulation. 4. Test running of machine. 5. Testing of voltage and current with avometer, speed with tachometer.	1. Identification of different parts of machines by inspection. Detect bad ball bearing. 2. Fix the end of shield in their proper positions. Apply grease to the appropriate parts. 3. Use megger or bridge megger to test for continuity and insulation resistance of a machine. 4. Carry out the test-run of machine ensuring correct rotation. 5. Demonstrate the use of avometer to test for voltage and current and the use of tachometer to test for the speed of machine bearing in mind that these corresponds with the manufacturers specification. 6. Emphasis should be on the proper positioning of the shields.