



NATIONAL VOCATIONAL TRAINING INSTITUTE

TESTING DIVISION

TRADE TESTING REGULATIONS AND SYLLABUS

TRADE: CONSTRUCTION ELECTRICAL

LEVEL: CERTIFICATE TWO

CERTIFICATE TWO

A. INTRODUCTION

- i. The review of this syllabus has been generally influenced by the demands of industries due to its continuous change as a result of technological advancement and the changing needs of society.

It was also influenced by the TVET reforms under the directions of the new educational reforms with the view to opening up further education and training opportunities to TVET graduates.

The certificate TWO syllabus is designed to respond to the following level descriptors:

QUALIFICATION	KNOWLEDGE LEVEL	SKILLS AND ATTITUDE:
Certificate II	<ol style="list-style-type: none">1. To demonstrate broad knowledge base with substantial depth in area(s) of study.2. To demonstrate a command of analytical interpretation of range of data.3. To present results of study accurately and reliably.	<ol style="list-style-type: none">1. Needs varied skills and competencies in different tasks under various contexts.2. Require a wide range of technical and supervisory skills.3. Would be employed in different contexts.

II. The course would enhance the Knowledge of trainees in the safe use of electrical tools, equipment and materials. Wiring systems, occupational drawing, Installation of earthing systems, sequence of supply control, installation of Protective devices, Inspection and testing, Lighting and Power circuits, trade drawing (circuit drawing), troubleshooting and repairs of electrical wiring and related equipment in building and other structures, Preparation of planning and estimating of materials, trade science and calculations and Relevant IEE – Regulations.

B. OBJECTIVES

On completion of this course, the trainee should be able to:

- i) Understand the importance of electrical safety precaution at workshop.
- ii) Identify and use of correct tools and equipment.
- iii) Perform surface wiring, conduit wiring system and Trunking System.
- iv) Read and interpret occupational drawing (Blue Print)
- v) Install earthing system.
- vi) Select and arrange supply control in correct sequence.
- vii) Select and Install different types of protective devices.
- viii) Carry out visual Inspection and testing.
- ix) Wire lighting and Power circuit.
- x) Interpret and draw circuit diagrams.
- xi) Know how to diagnose fault in electrical installation and equipment.
- xii) Know the need for estimating electrical project.
- xiii) Understand the importance of trade science and calculation.

C. THE COURSE COMPRISES:

- a) Trade Theory
- b) Trade Science and Calculation
- c) Trade Drawing
- d) General Paper
- e) Trade Practical

EXAMINATION: The candidates would be examined in the FIVE components listed above.

Practical work must be carefully planned to illustrate application of the theory and to provide maximum opportunity for shop practice, laboratory work and demonstration.

D. KNOWLEDGE AND SKILL REQUIREMENT

The prime objectives of the program is to provide knowledge and skills of the trade in a manner that will best meet the needs of the trade as well industries using electrical equipments

E. ENTRY TO THE COURSE

Minimum education: Must have passed JHS or SHS examination. Age – 16 years and above. However, the selection of the students for the course is within the discretion of the head of the institution.

F. ELIGIBILITY FOR ENTRY TO EXAMINATION

Candidates may enter for examination only as internal candidate that is those who at the time of entry to the examination are undertaking (or have already completed the course at an approved establishment).

G. EXTERNAL EXAMINERS

The practical work of candidates will be assessed by an external examiner appointed by the Testing Commissioner.

H. EXAMINATION RESULTS AND CERTIFICATES

Each candidate will receive record of performance given the grade of performance for the components taken. These are:

- a) Distinction
- b) Credit
- c) Pass
- d) Referred/Fail

Certificates would be issued to candidates who pass in all the components.

NOTE

All Technical and Vocational trainees who aspire to take advantage of the opportunities opened to them in the educational reforms should NOTE that for a trainee to progress to Certificate Two (2) a pass in Certificate One (1) is compulsory

I . APPROVAL OF COURSE

Institutions or other establishments intending to prepare trainees for the Examination must apply to:

THE COMMISSIONER
TESTING DIVISION
NVTI HEAD OFFICE
P. O. BOX MB 21, ACCRA

J. ACKNOWLEDGEMENT

NVTI wishes to acknowledge the preparatory material done by the team of experts, which have been incorporated into this syllabus: .Mr. Theophilus Kweku Arkhurst (H. N. D)

Mr. David Annan Tetteh (E.E.T. Part III)

Mr. William Matey (E.E.T. Part III, C.Ed)

K. RECOMMENDED TOOLS AND EQUIPMENT

1. Digital/Analogue A.V.O. Meter
2. Voltmeter
3. Ammeter
4. Wattmeter
5. Megger Tester
6. Oscilloscope
7. 3-phase Induction Motor
8. Single phase motor
9. Clamp-on-ammeter
10. Buchanan crimping tool
11. Set of screw drivers (star/flat)
12. Combination pliers
13. Side cutters
14. Long nose pliers
15. Spirit level
16. Drilling machine
17. Claw hammer
18. Hacksaw
19. Wirestripper
20. Adjustable wrench
21. 1/2" E.M.T. Bender
22. 1/16" x 1/4
23. Electrician folding knife
24. Jimlet
25. Allen wrench set
26. Speed bore drill set
27. Steel tape measure
28. Tool box
29. Chisel
30. Punch
31. Conduit bending machine
32. Cordless drilling machine
33. Bench vice

L. Recommended Text Books

1. AC/DC Principles (By Paul T. Shultz) Publishers
2. Electrical Wiring Residential (By: Ray C. Mullen) Publishers
3. Electrical Motors and Control System (By: Petruzella Publishers)
4. Electrical Installation and Practice
5. Electrical Principles and Technology (By:)
6. The Moltivate (By
7. Electricity (By: Herman Publishers)
8. Electrical Wiring Industrial (By: Smith Publishers)
9. Electrical Installation Work and Practice (By:...
10. IEE Regulations 16th Edition

CERTIFICATE TWO – TRADE THEORY

ITEM	TASK	CRITICAL POINTS	SUB POINTS	INSTRUCTIONAL TECHNIQUES
1.0.	POWER SUPPLY	<p>Trainees should be able to draw a complete block diagram for power supply unit.</p> <p>2. Describe the construction and principles of operation of a simple power supply unit.</p> <p>3. <u>Application</u>: of power supply unit</p> <p>Describe the P&N type of semi-conductor</p> <p>Describe the construction and operations of the following devices.</p> <p>a. Zener diode b. Rectifier diode c. Thyristor d. Transistor</p>	<p>Draw and labeled simple block diagram of a power supply unit</p> <p>Explanation on the make-ups and its operations</p> <p>Applications</p> <p>Applications of the following:</p> <p>a. Zener b. Rectifier c. Thyristor d. Transistor</p>	<p>Draw the power supply unit on board and explain to the trainees</p> <p>Explain the construction and operation to trainees</p> <p>Discuss with the trainees the applications or area of use.</p> <p>Explain the type to the trainees with its application</p>
2.0.	BASIC ELECTRONICS	<p>Trainees should be able to:</p> <p>1. Define and list types of resistors and their ratings</p> <p>2. Define and list types of capacitors</p> <p>3. Define and list types of semi-conductor materials</p>	<p>Definition and reading of resistor value by using the colour codings</p> <p>Definition and list types:</p> <p>a. Air b. Mica c. Paper</p> <p>Definition and list types</p> <p>a. Silicon b. Germanium</p>	<p>Explain the types and how to read values by the colour code</p> <p>Discuss with the trainees the types and its applications</p> <p>Explain the types its application to the trainees</p>

ITEM	TASK	CRITICAL POINTS	SUB POINTS	INSTRUCTIONAL TECHNIQUES
		<p>Explain the types of transformers</p> <p>2. Explain the use of transformers</p>	<p>Explanation on</p> <p>a. Double wound transformer</p> <p>b. Auto transformer</p> <p>Applications of the types:</p> <p>a. Double wound</p> <p>b. Auto transformer</p>	<p>Discuss types of transformers with the trainees</p> <p>Mention few areas of use to the trainees</p>
3.0.	TRANSFORMERS	<p>1. Explain the meaning of a transformer</p> <p>2. Describe the principles of operation of a transformer</p> <p>3. Construction of a transformer</p> <p>State types of faults in single phase motor</p> <p>Identify and rectify fault in a single phase motor</p> <p>Explain how the rotating magnetic field is produce</p> <p>Explain the characteristics of each type of motor</p> <p>a. Universal</p> <p>b. Slit phase</p> <p>c. Repulsion</p> <p>d. Shaded pole</p>	<p>Define and give a detail explanations</p> <p>Description and operation of a transformer</p> <p>Descriptions of a transformer</p> <p>State the following:</p> <p>a. Open circuit</p> <p>b. Short circuit</p> <p>c. Grounded winding</p> <p>d. Centrifugal switch</p> <p>e. Worn or tight bearing</p> <p>a. Open circuit test (multimeter)</p> <p>b. Short circuit test (multimeter)</p> <p>c. Grounded winding, insulation resistance tester</p> <p>Detail explanations</p> <p>Details explanations</p>	<p>Discuss the meaning of a transformer with trainees</p> <p>Explain to the trainees the construction and operations by using chart or real object</p> <p>Discuss with the trainees the various types of fault on a single – phase motor</p> <p>Explain to the trainees the various type of rectifying fault in a single phase motor.</p> <p>Explain to the trainees the rotating magnetic field is produce</p>

ITEM	TASK	CRITICAL POINTS	SUB POINTS	INSTRUCTIONAL TECHNIQUES
4.0.	SINGLE PHASE MOTORS	<p>Define a single phase motor and list the types</p> <p>Identify main parts of a single phase motor</p> <p>Explain how to test a capacitor</p> <p>List the types of capacitors</p> <p>Describe types of capacitors and state its application</p>	<p>Definition and types:</p> <ol style="list-style-type: none"> 1. Split phase 2. Permanent slip phase 3. Capacitor start 4. Shaded pole 5. Repulsion 6. Universal series <p>Identification:</p> <ol style="list-style-type: none"> a. Stator b. Rotor c. End shield d. Bearing e. Centrifugal <p>Explanation</p> <ol style="list-style-type: none"> 1. Connect instrument to it and read out the value directly 2. Charge the capacitor by connecting it to a supply and after disconnection. Short the ends of the capacitor. <p>List the types:</p> <ol style="list-style-type: none"> a. Paper b. Mica c. Ceramic d. Electrolytic <p>Description and application:</p> <ol style="list-style-type: none"> a. Paper b. Mica c. Ceramic d. Electrolytic 	<p>Discuss with the trainees the definition and the types</p> <p>Show part of a single-phase motor to the trainees</p> <p>Explain and demonstrate the testing of capacitors to trainees using real object.</p> <p>Explain types of capacitors to trainees</p> <p>Discuss types of capacitors with trainees using real objects</p>

ITEM	TASK	CRITICAL POINTS	SUB POINT	INSTRUCTIONAL TECHNIQUES
4.0.	SINGLE PHASE MOTORS	Solve problems involving capacitors connected in series and parallel	<u>Calculation:</u> Use formulars i.e.= $CT=1/C1 + 1/C2 + C3$ for series and $CT=C1+C2+3$ for parallel	Solve problems with trainees using the formular
5.0.	ELECTROSTATICS	Trainee should be able to: 1. Explain Electric – charge and electric field 2. Define a capacitor State the factors involving capacitance in an a.c. circuit Solve problems involving resistance and capacitance in an a.c. circuit	1. Define electro statics 2. The charge stoned in an electric field is measured in calombs that is the product of current flow and time which it flows $Q = IT (C)$ where I = current (A) T = Time (Sec) Q = Quantity (C) Define and state the unit <u>Statement:</u> a. The capacitance reactance decreases with increase in frequency a. Increase in reactance result in decrease in current Calculation a. Series circuit formular $Z= \sqrt{R^2 + Xc^2}$ Symbol = Zc Unit = Ohm (~)	Explain to the trainees electric charge and solve electric charge problems Explain the definition of capacitor to the trainees Explain the factors of capacitance in an a.c. circuit to the trainees Explain the methods of solving problems

ITEM	TASK	CRITICAL POINTS	SUB POINTS	INSTRUCTIONAL TECHNIQUES
		<p>Explain the meaning of a capacitance</p> <p>State the factors affecting inductance in an a.c. circuit</p> <p>Explain the meaning of impedance and solve problems involving resistance and inductance in an a.c. circuit</p> <p>Solve problems involving:</p> <p>a. Maximum value b. Average value</p> <p>c. Root Mean square</p> <p>Define the following:</p> <p>a. Inductance b. Inductive reactance in an a.c. circuit</p>	<p>1. Define capacitance and explain 2. Capacitance – Reactance Symbol = X_c Unit = Ohm (\sim) 3. Solve simple calculations on capacitance in an a.c. circuit 4. The phasor diagram of a pure capacitive load</p> <p><u>Statement:</u></p> <p>1. Circuit containing inductive load 2. Induced voltage in series connected inductive load 3. Inductive load in d.c. circuit</p> <p><u>Explanation:</u></p> <p>a. Impedance is the total opposition offered to the flow of electric current <u>Symbol = Z</u> <u>Unit = Ohm</u> Formular: $Z = \sqrt{R^2 + X_L^2}$</p> <p><u>Calculation</u></p> <p>a. Maximum value = $\frac{R.M.S.}{0.707}$ value</p> <p>a. <u>Average Value</u> $0.6637 \times$ maximum value</p> <p>Define and explain</p> <p>a. Measure the ability of a circuit to produce magnetic field and stored. b. The position of pure inductive circuit in an a.c. supply</p>	<p>Explain the meaning of capacitance and capacitive reactance to the trainees</p> <p>Explain to the trainees factors affecting inductance in an a.c. circuit</p> <p>Discuss the meaning of impedance with the trainees</p> <p>Discuss with the trainees how to solve the problems</p> <p>Explain the definition of inductance in an a.c. circuit Symbol = X_L Unit = Ohm</p>

TRADE THEORY – CERTIFICATE TWO

ITEM	TASK	CRITICAL POINTS	SUB POINTS	INSTRUCTIONAL TECHNIQUES
7.0.	REGULATION AND CODE OF PRACTICE	Demonstrate knowledge of the practical application of the following regulations i. Electricity supply Regulation 1988 ii. Electricity at Work Regulation 1988 iii. Health and Safety at Work Act 1974 iv. Regulations for Electrical Installation 1991 (IEE Reg. 16 th Edition) v. British Standard Code of Practice	Demonstrate knowledge of the appropriate regulation Electricity Supply Regulation 22 – 29 and 32 State the need for reference of the code of practice`	Discuss with trainees the code of practice. Electricity Supply Regulation 1988 and Health and Safety Act 1974 from Relevant I.E>E. Regulation
8.0	SPECIAL INSTALLATION	Identify risk: Eg. Petrol filling station Gas filling station Types of Wiring 1. MICC 2. Armoured cable 3. Metal conduit wiring Hazardous Areas: 1. Mines 2. Quarry 3. Swanmill Types of Wiring 1. MICC 2. Armoured cable 3. Metal conduit wiring		Explain to trainees the type of cable to be use for a special installation E.g. a. Hazardous Area b. Agriculture and horticulture areas

TRADE THEORY - CERTIFICATE TWO

ITEM	TASK	CRITICAL POINTS	SUB POINTS	INSTRUCTIONAL TECHNIQUES
		<p>Agriculture and Horticultural Installation</p> <p>State and explain ways of minimizing hazards and risk including:</p> <ul style="list-style-type: none"> i. Assessment of wiring ii Suitable equipment of cable to be use iii. Provision of reduced voltage supplies <p><u>Corrosive Environment</u></p> <p>Identify areas requiring special consideration due to the presence of corrosive atmosphere</p> <p><u>Protection Against Corrosion</u></p> <ul style="list-style-type: none"> 1. Application of protective technique such as paint, tape, gaskets, sheaths: need for preventive maintenance <p>Fire Alarm System (BS 5839)</p> <p>Describe and explain type of circuits</p> <ul style="list-style-type: none"> 1. Simple open circuit 2. Monitored open circuit 3. Close circuit 4. Close monitored circuit 	<p>Identify and describe type of cable and wiring for use in fir alarm circuit</p>	<p>Discuss with trainees the protection against corrosion with regards to type of protective device to be used</p> <p>Explain to the trainees the type of fire alarm system and their principle of operation and application</p>

ITEM	TASK	CRITICAL POINTS	SUB POINTS	INSTRUCTIONAL TECHNIQUES
		<p>Describe and identify types of call point</p> <ul style="list-style-type: none"> i. Manual break glass ii. Smoke detector iii. Temperature rise detector iv. Flame detector <p>Describe and identify types of warning devices</p> <ul style="list-style-type: none"> i. bell ii. horn iii. siren 		
9.0.	STAND BY SUPPLIES	<p>Recognize building and areas requiring the provision of standby supply.</p> <p>Types of standby supply:</p> <ul style="list-style-type: none"> i. dual supply ii. battery iii. standby generator 	<p>Draw circuit diagram to show transfer to show arrangement from mains supply to standby generator or battery (use of change over switch)</p> <p>Draw maintenance and non-maintained emergency supply</p>	<p>Explain with the trainees the importance of stand by supplies with the aid of circuit drawing or chalk board</p>
10.0	SELECTION OF CABLES	<p>Calculate for current carrying capacity of cable</p> <p>Calculate the size of cable up to 185mm²</p> <p>Consider grouping ambient temperature thermal insulation, class of protection.</p> <p>Determine the size of conduit and trunking to carry number of cables</p>	<p>Draw the cross sectional area of the following types of cables</p> <ul style="list-style-type: none"> i. XLPL cable ii. PVC armoured cable iii. PILSWA cable iv. MICC cable 	<p>Explain to trainees how to select for a cable for a particular work by means of calculations</p>

ITEM	TASK	CRITICAL POINTS	SUB POINTS	INSTRUCTIONAL TECHNIQUES
11.0	CONSUMERS DISTRIBUTION	<p>Explain and show methods of distribution in</p> <ol style="list-style-type: none"> i. domestic premises ii. commercial iii. industrial <p>Demonstrate knowledge of load centres and application of diversity. Explain discrimination between protective devices</p>		<p>Discuss with the trainees the distribution system at a 3-phase supply</p>
12.0	PROTECTION AND METERING	<p>State the application for current and voltage (PT) transformer on high voltage supply.</p> <p>Describe metering arrangement for:</p> <ol style="list-style-type: none"> i. domestic premises ii. commercial premises iii. industrial premises <p>Tariffs Explain the following tariff:</p> <ol style="list-style-type: none"> i. Flat rate ii. Block rate iii. Maximum demand <p>Method of Metering:</p> <ol style="list-style-type: none"> i. Single phase ii. 3-phase iii. on-peak system iv. off-peak system 	<p>Simple calculation of tariff</p>	<p>Explain to the trainees metering arrangement of the following:</p> <ol style="list-style-type: none"> a. Commercial b. Industrial c. Domestic <p>Discuss with the trainees the importance of tariffs:</p> <ol style="list-style-type: none"> a. Block rate b. Maximum rate c. Flat rate

ITEM	TASK	CRITICAL TASK	SUB TASKS	INSTRUCTIONAL TECHNIQUES
13.0	EARTHING	<p>Describe and explain earth fault loop impedance Describe the installation and testing of earth electrodes.</p> <p>Explain the following types of earthing system: i. TT ii. TNC iii. TNCS</p>		
14.0	PROTECTION OF BUILDING AGAINST LIGHTING (P 326 1965)	<p>Determine the number of air terminations electrode and down conductors required</p> <p>Describe bonding of extraneous metal work. Explain use of building structure in lieu of down conductors.</p> <p>Describe testing the resistance of earth of protecting electrode and measurement of soil resistance</p>		Explain to the trainees the advantage and importance of protection of building against lighting.
15.0	PLANT AND PLANT MAINTENANCE	<p>Describe fixing requirement for transformer, switch gears and motors</p> <p>Identify and describe correct methods for lifting and moving equipment.</p> <p>Describe maintenance requirements for switch gear, transformer rotating machines</p>	<p>Making foundation for electrical plant.</p> <p>Method of handling plant.</p> <p>Explain planned maintenance routine systematic and use of inspection list and manufacturers recommendation</p>	

ITEM	TASK	CRITICAL TASK	SUB TASKS	INSTRUCTIONAL TECHNIQUES
16.0	INSTALLATION OF LIGHTING SYSTEM	Select and describe suitable luminaries for <ol style="list-style-type: none"> i. office block ii. drawing office iii. hospitals iv. road lighting v. stock yard vi. car parts State application for <ul style="list-style-type: none"> Incandescent Fluorescent Halogen Mercury vapour lamp Sodium vapour lamp 	 Draw the circuit diagram of the listed lamps	Discuss with the trainees how to select for a suitable wiring for a particular building.
17.0	TESTING AND INSPECTION	Describe methods of visual inspection and electrical test of installation; <ol style="list-style-type: none"> i. earth test ii. insulation resistance test iii. ring circuit test 	Steps to be taken and equipment or instrument needed to conduct the following test. <ol style="list-style-type: none"> a. Earth test b. Insulation resist test c. Polarity test d. Ring circuit test 	Explain with the trainees the sequence of inspection and testing of an installation
18.0	ESTIMATING AND PLANNING	Assess labour, materials and plant based upon information from <ol style="list-style-type: none"> i. drawing ii. specification iii. measurement taken on site 	Steps to be taken and equipment or instrument needed to conduct the following test. <ol style="list-style-type: none"> a. Earth test b. Insulation resist test c. Polarity test d. Ring circuit test 	Explain with the trainees the sequence of inspection and testing of an installations

ITEM	TASK	CRITICAL TASK	SUB TASKS	INSTRUCTIONAL TECHNIQUES
		<p><u>Planning</u> Knowledge in preparation of schedules. Use of catalogue for the following: a. Ordering b. equipment c. distribution d. materials for a particular area Recognize the need plan phase deliveries of materials to suit site conditions and contract progress</p> <p>Show understanding the building specification: i. building utilization ii. building construction iii. electrical installation work iv. wiring system v. Application of IEE Regulation</p>		
19.0	SITE SUPERVISION	Introduction to specification, related drawing bill of quantity and contract condition	Explain with the aid of chart the site record and procedures	Explain to the trainees how to prepare for bill of quantity and contract condition
20.0	EMPLOYMENT LEGISLATION AND INDUSTRIAL AGREEMENT	Method of dealing with and reporting accident, labour relation, employment protection, Act, Trade Union, Industrial agreement	Explain the following methods: a. Labour Relation b. Employment protection c. Industrial agreement	Discuss with the trainees method of a. reporting accident b. labour relation c. Employment protection Act.

ITEM	TASK	CRITICAL TASK	SUB TASKS	INSTRUCTIONAL TECHNIQUES
21.0	DC MOTOR	Define a D.C. motor Describe construction of D.C. motor Explain principle of operation of D.C. motor. Describe types of D.C. motor i. shunt ii. series iii. compound	Explain speed control of D.C. motor Draw the starter for D.C. motor Perform calculation example $E_b = V - I_a R_a$ $E_b = \frac{2T}{60} I_a$	Discuss with the trainees how the speed or rotation can be achieved. Application of d.c. motors Advantages and disadvantage Discuss the types by mean of the enclosures

CERTIFICATE TWO – TRADE DRAWING

ITEM	TASK	CRITICAL TASK	SUB TASKS	INSTRUCTIONAL TECHNIQUES
1.0.	LAYOUT DIAGRAM FOR BUILDING	Introduction to ground floor plan of a building a. Single room b. 2-bedroom with an open valendar c. 2-bed room and a hall	Identify the following sections associated with building construction a. Windows Doors Partition wall Columns etc. b. Swinging direction of doors: i. Single ii. Double c. Draw the following ground floor plan i. Single room ii. 2-bedroom with an open porch iii. 3-bedroom and a living room (hall)	Facilitator explain to trainee the sections of a ground floor plan usingdrawing and real object Facilitators guides the trainee to draw the plans using a scale rule or by calculation method
2.0.	USE AND APPLICATION OF SCALE	Enlargement and reduction of a scale	a. Draw the ground floor plan of a room with a given measurement in metres using the following scale. 1:100 1:80 1:50 b. Reproduction of drawing i. Enlargement ii. Reduction	Facilitator guides the trainee to draw the plan using a scale rule or by calculation method
3.0.	PROJECT WORK	Preparation of a Layout Diagram	a) Draw a layout diagram of 2-bedroom house 3-bedroom house 2-bedroom self contain flat 3-bedroom self contain flat b) Insert architectural symbols or lighting and accessories on a layout diagram	

CERTIFICATE TWO – TRADE DRAWING

ITEM	TASK	CRITICAL TASK	SUB TASKS	INSTRUCTIONAL TECHNIQUES
		<p>Conduit trunking runs on a layout diagram</p> <p>Circuiting of lighting and power</p> <p>Determination of:</p> <ul style="list-style-type: none"> a. Total load b. Size of supply cable c. Size of main switch 	<p>Draw conduit/trunking runs on a layout diagram using fibrous tip pens instead of pencil</p> <ul style="list-style-type: none"> a) Draw circuiting of the lighting and power using the conduit and trunking runs as the layout b) Label Circuits and mark the number cables and the sizes of cables at each section on of the run of conductor or trunking. <p>Calculate the</p> <ul style="list-style-type: none"> a. Total load b. Size of supply cable c. Size or rating of the main switch 	<p>Guide trainee to calculate and select the size of main switch and supply cable</p>
5.0	ELECTRIC MOTOR CONTROL CIRCUIT	<p>Introduction to</p> <ul style="list-style-type: none"> a. Symbols 	<ul style="list-style-type: none"> a. Manual push button b. Electronic chemical device 	

CERTIFICATE TWO – TRADE DRAWING

ITEM	TASK	CRITICAL TASK	SUB TASKS	INSTRUCTIONAL TECHNIQUES
6.0	ELECTRIC MOTOR CONTROL CIRCUIT	Introduction to Pilot Control Device	a) List the following pilot control devices <ul style="list-style-type: none"> i. Limit switch ii. Pressure switch iii. Float switch iv. Sensor v. Inter locking System (Electrical Mechanical) b) Explain the importance of the listed devices in (a) above in electric motor control circuit c) 2-wire control 3-wire control	
		Direct on starter control a. Control circuit b. Power circuit	a) <ul style="list-style-type: none"> i. Interpret the symbol to develop a control circuit ii. Use the symbol to develop a control circuit. iii. Read and interpret control circuit b) Draw the power circuit c) Draw power and control circuit d) Draw the following controls <ul style="list-style-type: none"> i. One start/stop push button ii. Two start/stop push button iii. One start/two stop push button iv. Two start/two stop push button v. One start/stop push button with alarm trip contact 	

CERTIFICATE TWO – TRADE DRAWING

ITEM	TASK	CRITICAL TASK	SUB TASKS	INSTRUCTIONAL TECHNIQUES
		<p>Forward and Reverse Direction</p> <p>Star Delta Starter</p>	<p>Draw the wiring diagram using the following:</p> <ul style="list-style-type: none"> a) Control circuit b) Interlocking system <ul style="list-style-type: none"> i. Electrical ii. Push button c) Power circuit <p>Draw the wiring diagram using the following:</p> <ul style="list-style-type: none"> a) Control circuit b) Power circuit 	
7.0	STAND BY SUPPLY	Draw the wiring circuit of a change over switch to control standby and main supply	<ul style="list-style-type: none"> a) List the main parts: <ul style="list-style-type: none"> i. Change over switch ii. Generator iii. Main supply b) Develop the following diagrams <ul style="list-style-type: none"> i. Block diagram ii. Single line diagram iii. Wiring diagram 	
8.0.	POWER SUPPLY UNIT	Draw the diagram of a simple rectified power supply unit	<ul style="list-style-type: none"> a) List the main parts <ul style="list-style-type: none"> i. Transformer ii. Rectification unit iii. Filtering unit b) Develop the following diagrams <ul style="list-style-type: none"> i. Block diagram ii. Circuit diagram using <ul style="list-style-type: none"> 1 – diode 2 – diode 4 – diode 	

CERTIFICATE TWO – TRADE SCIENCE AND CALCULATION

ITEM	TASK	CRITICAL POINTS	SUB POINTS	INSTRUCTIONAL TECHNIQUES
1.0.	ELECTROMAGNETIC INDUCTION	Explain the following: a) Self inductance b) Mutual inductance c) Induced emf in a coil d) Stored magnetic energy e) Definition of unit of inductance	Explanation of electromagnetism its i. effect ii. application Perform simple calculation e.g. $E = L \times \frac{di}{dt}$	
2.0.	ELECTROSTATIC	Explain the following: a) The parallel plate capacitor b) Electric field strength c) Electric flux density d) Stored electrostatic energy in a capacitor e) Definition of unit of capacitance	Explanation of charge and discharge capacitor construction, material and application of a capacitor Perform calculation involve: i. units of capacitance ii. series connection iii. parallel connection iv. series and parallel combination v. stored electrostatic energy e.g. $\text{Energy} = \frac{1}{2} CV^2$	
3.0.	MAGNETIC CIRCUIT	Explain the following: a) Type of magnetic material b) Properties of common magnetic materials c) Laminate magnetic system	Explanation of energy loses: i. Eddy current lose ii. Hysteresis lose Understanding of reasons for lamination	

ITEM	TASK	CRITICAL POINTS	SUB POINTS	INSTRUCTIONAL TECHNIQUES
4.0.	TRANSFORMER	Explain the following: a. Composite construction of transformer b. Relationship between primary and secondary i. turn ii. current iii. voltage	Perform calculation on transformation ratio a) Transformer efficiency b) Transformer regulation State the use of transformers Example: i. Discharge lighting ii. Motor starting iii. Power factor improvement	
5.0.	TRANSIENT	Explain the following component in d.c. circuit. a. Inductance b. Capacitance c. Inductance and resistance d. Capacitance and resistance Explain and define time constant Show the growth and decay curve of current in L-R circuit Show charge and discharge curve in -R circuit	Perform calculation involving time constant. Example Inductive circuit Time constant $T = L/R$ (s) <u>Capacitive circuit</u> Time constant $T = CR$ (s)	
6.0.	THEORY	a. R – L in series and in parallel b. R-C in series and in parallel c. R-L-C in series d. R-L.C. in parallel e. Impedance and phase angle f. Constant related phasor diagram	Transposition and evaluation of formulae e.g. $X_L = 2\pi fL$ $X_C = \frac{1}{2\pi fL}$ $Z^2 = R^2 + X_L^2$ $Z^2 = R^2 + X_C^2$	

ITEM	TASK	CRITICAL POINTS	SUB POINTS	INSTRUCTIONAL TECHNIQUES
7.0.	POWER IN A.C. CIRCUIT	<p>Explain power in a.c. single phase circuits.</p> <p>Define active power, react. We power and apparent power.</p> <p>Draw power triangle Power factor correction and its advantages and effect of over correction</p>	<p>Transposition and evaluation of formulae. $KW = KVA \times \text{KW} \times \text{Cos } \emptyset$ $KVA^2 = KW^2 + KVA^2$</p> <p>Calculation on power factor Measurement of power, power factor in a single phase a.c. circuit using voltmeter, ammeter and wattmeter</p>	
8.0.	POLYPHASE A.C. CIRCUIT	<p>Explain the principles of 3 phase a.c. generator.</p> <p>Explain the provision of single phase, 3-phase 4-wire system from a 3-phase generator</p>	<p>Explanation of the concept of the following polyphase system</p> <ol style="list-style-type: none"> 3 phase 4-wire star connection system 3-phase 3-wire delta connection system voltage and current relationships in star and delta connections Perform the related calculation eg. <p>Delta Connection $I_p = \frac{I_L}{\sqrt{3}} \quad V_p = V_L$</p> <p>Star connection $I_p = I_L \quad V_p = \frac{V_L}{\sqrt{3}}$</p> <p>$P = V_L I_L \text{Cos } \emptyset$</p>	

ITEM	TASK	CRITICAL SKILLS	SUB SKILLS	INSTRUCTIONAL TECHNIQUES
9.0	SINGLE PHASE MOTOR	<p>Define single phase motor Explain the construction of the following types of single phase motor</p> <ul style="list-style-type: none"> i. Capacitor start ii. Capacitor start iii. Capacitor start/run iv. Shaded pole v. Repulsion vi. Universal <p>Identify main parts of single phase motor. Eg.</p> <ul style="list-style-type: none"> a. Rotor b. Stator c. Bearing d. Centrifugal switch e. End shield 	<p>Explanation of principles of operation of listed single phase motors and their respective application. E.g.</p> <ul style="list-style-type: none"> i. Refrigerators ii. Vacuum cleaners etc. 	Show to trainees part of single phase motor
10.0	3-PHASE MOTORS	<p>Define 3-phase motor Explain the construction of the following types of 3-phase motor.</p> <ul style="list-style-type: none"> i. Squirrel cage induction motor ii. Double cage induction motor iii. Slip ring (wound rotor) induction motor <p>Identify main parts of 3-phase motor example</p> <ul style="list-style-type: none"> i. rotor ii. startor iii. end shield iv. frame 	<p>Explanation of principles of operation of listed motor Draw the starter connector of 3-phase motor</p> <ul style="list-style-type: none"> i. direct-on-line starter ii. auto transformer starter iii. star delta starter <p>Explain method of reversing direction of rotation</p> <p>State application of the listed motors</p>	Discuss with trainee the operation of 3-phase motor

ITEM	TASK	CRITICAL POINTS	SUB POINTS	INSTRUCTIONAL TECHNIQUES
11.0.	INSTRUMENTS	Explain the construction operation and use of the following instruction. i. Moving coil ii. Moving iron iii. Thermcouple iv. Megger v. Ohmmeter	Perform calculation on i. shunt resistor ii. series resistor (multiplier) Extension of instrument range	Illustrate using charts for the construction
12.0.	RESISTANCE MEASUREMENT	Explain principle and application in cable fault location Measurement of resistance using i. Ohmmeter ii. Voltmeter and Ammeter Location of fault using murray loop test	Calculate location of fault using murray loop test. Determination of an unknown resistor using balanced bridge	
13.0	ILLUMINATION	Explain defuse and apply the terms used in illumination: i. luminous flux ii. luminous intensity iii. lumens iv. illumination v. coefficient of illustration vi. maintenance factor	Calculate illumination by: i. inverse square law ii. cosine law iii. luminous flux method Explain co-efficient of utilization	Facilitator Explain the terms used in illumination Assist trainee to apply lumen formula

ITEM	TASK	CRITICAL POINTS	SUB POINTS	INSTRUCTIONAL TECHNIQUES
14.0	ELECTRONICS	Explain D.C. power suppliers Explain Voltage stabilization	Draw circuit diagram and describe the operation of: 1. half-wave 2. full-wave 3. bridge circuit include smoothing circuit	Discuss rectification action with trainees

CERTIFICATE TWO - PRACTICAL

ITEM	TASK	CRITICAL SKILLS	SUB SKILLS	INSTRUCTIONAL TECHNIQUES
1.0	CONDUIT INSTALLATION	<p>SURFACE Select materials and accessories</p> <p>Concealed Conduit</p> <p>Conduit in Deck</p> <p>Identify and select materials for Sodium lamp conduit eg. Choke/Ballast/Transformer capacitor, igniter</p>	<p>Mark-out positions of accessories chisel or drill mark out point on the cement wall</p> <p>Chisel make-out position</p> <ul style="list-style-type: none"> • Fix conduit box with cement • Erect conduit • Secure conduit with cement plaster <p>Lay conduit on deck secure conduit with nails and binding wire on the formwork.</p> <p>Connect and investigate sodium lamp circuit</p>	<p>Perform the exercise by selecting the tools and materials for the following work with the trainees</p> <ul style="list-style-type: none"> • Mark out position for chiseling or drilling • Fix conduits with its accessories. (Box) • Secure conduit with cement plaster <p>Wire a complete circuit for a sodium vapour lamp with the trainees</p>
2.0.	DISTRIBUTION SYSTEM	<p>Install temporary distribution system for</p> <p>i. light</p> <p>ii. socket outlet</p>	<p>i. Identification of number of ways in 3-phase d.b. e.g. 4-way, 6-way</p> <p>ii. Connect tone single unit 3-phase distribution board</p>	<p>Connect final sub circuit to a distribution board (3-phase system)</p>

CERTIFICATE TWO - PRACTICAL

ITEM	TASK	CRITICAL SKILLS	SUB SKILLS	INSTRUCTIONAL TECHNIQUES
3.0	METERING	Identify and select the following energy meter i. 3-ph KVAR meter ii. 3-phase KVA meter iii. 3-phase KW meter Appreciate the use of prepaid energy meter	Wire and connect the following meter: i. 3 phase KVAR meter ii. 3 phase KVA iii. 3 phase KW meter Appreciate the connection of prepaid energy meter	Explain and display the different types of energy meters and their uses. 3-phase kvar meter 3-phase kvar meter 3-phase kva meter
4.0.	ST AND BY SUPPLIES	Install change over switch	Wire single phase change-over switch wire three phase change over switch Connect standby generator to change over switch	Connect change over switch to a generator and E.C.G. supply with the trainees
5.0.	TERMINATION OF CABLES	<u>MICC Cable</u> Explain sealing of MICC cable using the following: i. Sealing pot ii. Sealing compound iii. Disc iv. Cable sleeves Explain terminating MICC cable using the following: i. gland nut ii. gland body iii. compress ring <u>Armoured Cable</u> Explain terminating PVC armoured cable using i. Cable hug ii. Ferrule etc.	Select tools and materials for sealing MICC cable i. Crimping tool ii. Ringing tool iii. Stripping tool 1. Terminate PVC armoured cable into switch box 2. Prepare i. T joint ii. Straight joint	Perform the actual connection in sequence with the trainees

CERTIFICATE TWO - PRACTICALS

ITEM	TASK	CRITICAL SKILLS	SUB SKILLS	INSTRUCTIONAL TECHNIQUES
6.0.	WIRING SYSTEM	Explain the construction <ul style="list-style-type: none"> • Rising mains • Under floor trunking • Overhead busbar system 	<u>Rising mains</u> Install vertical trunking and lay-in cables <u>Underfloor trunking</u> Create a duct in floor and lay-in trunking Overhead busbar suspend trunking on girder and lay-in cables	Demonstrate or perform the following exercise with the trainees <ol style="list-style-type: none"> a. Under floor trunking b. Overhead busbar system c. Rising motors system
7.0.	INSTALLATION OF DISCHARGE LAMPS	Identify and select materials for H.P.M. VL circuit e.g choke/ballast, capacitor etc.	Connect and investigate H.P.M.V. lamp circuit Test the circuit	Perform the sequence of connection on the H.P.M.V. lamp
8.0	PROJECTION AGAINST LIGHTENING	Identify and select materials for protection against lighting <ul style="list-style-type: none"> • Down conductor • Earth electrode • spikes 	Wire and connect accessories for lightning system using <ul style="list-style-type: none"> • Down conductor • Earth electrode spikes • Test complete earthing system 	Demonstrate the arrangement or the sequence of connection with the trainees
9.0.	INSPECTION AND TESTING	<u>Polarity Test</u> Identify and select apparatus for the test <ul style="list-style-type: none"> • Voltage indicator • Low reading ohmmeter <u>Insulation Resistance Test:</u> Identify and select apparatus for insulation resistance test e.g. (insulation tester megger) <u>Inspection of Installation</u> Check any fix equipment for correct operation e.g. <ol style="list-style-type: none"> i. Switch ii. Circuit breaker etc. 	<u>Method 1</u> Main switch and light switch close Connect voltage indicator for the test <u>Method 2</u> <ul style="list-style-type: none"> • Main switch open, fuse remove and light switch close • Connect ohmmeter for the test <u>Test for Conductor</u> <u>Insulation resistance</u> <ol style="list-style-type: none"> 1. between conductors 2. between conductor and earth Make a careful visual examination of the installation with respect to: <ol style="list-style-type: none"> i. types and size of switches in position ii. earth continuity conductor and bonding connected where applied 	Perform the following test and inspection <ul style="list-style-type: none"> • test • Continuity test • Insulation – Resistance Test Demonstrate and explain the following test by means of instrument <ol style="list-style-type: none"> a. Insulation Resistance test b. Continuity

ITEM	TASK	CRITICAL SKILLS	SUB SKILLS	INSTRUCTIONAL TECHNIQUES
11.0.	INSTALLATION OF MOTORS AND CONTROLS	<p>Design and construct a template Select material for motor foundation</p> <p><u>Motor Controls</u> Identify and select motor starter e.g. 1. direct-on-line starter 2. auto transformer starter 3. star/delta starter</p>	<p>Prepare foundation using 1. rawl bolt (expansion bolt) 2. rag bolt</p> <p>Use real object Mount motor on slide rail</p> <p>Wire and connect the following type of starter 1. direct-on-line starter 2. auto transformer starter 3. star/delta starter</p>	<p>Demonstrate the sequence of connection to the following motor starters with the trainees. a. D.O.L starter b. Auto transformer starter c. Star/Delta Starter</p>
12.0	ELECTRONICS	<p><u>Rectifier</u> Identify and select electronic device for simple power supply unit using 1. diode 2. capacitor 3. transformer</p> <p>Stabilized Power Supply Unit Identify and select electronic device for stalibized power supply unit using: 1. rectifier diode 2. capacitor 3. zener diode 4. resistor</p>	<p>Design and construct simple power supply unit using: 1. one diode 2. two diode 3. four diode</p> <p>design and construct simple power supply unit using 1. one diode 2. two diode 3. four diode</p> <p>Test the completed circuit</p>	<p>Wire a simple stabilized power supply unit by using the following components a. Diodes b. Capacitor c. Transformer</p>