NATIONAL VOCATIONAL

TRAINING INSTITUTE

TESTING DIVISION

REGULATIONS AND SYLLABUS

FOR

GENERAL ELECTRICAL

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	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.	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 rational of this syllabus is to establish the level of knowledge and skills required by mechanics over a wide range of applications, including the development of an ability to diagnose faults, recommend by means of rectifying these faults and to test and analyze the performance of the vehicle after repairs or modification has been completed.

B. OBJECTIVES

The objectives of this course are to give the apprentices a systematic training both theoretically and practically. It is expected that much emphasis will be laid on the practical aspect of the training during in-school and on-the-job training. About 60% could be allocated to practical training centres and other institutions approved by the National Vocational Training Institute.

This training syllabus is prepared to serve as a guide for employers, instructors and other parties concerned with training in the preparation of their individual programmes. It is necessary that training become effectively planned and controlled as effectively as possible so that apprentices derive much benefit from their training.

C. THE COURSE COMPONENTS

- Trade Theory
- Science and Calculation
- Trade Drawing
- General Paper
- Trade Practical

EXAMINATION: The candidates would be examined in the FIVE components listed in 'C' 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 SKILLS REQUIREMENT

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

E. ENTRY TO THE COURSE

Minimum education : Must have passed JHS or SHS examination. 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 Trade 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:

i) Distinction
ii) Credit
iii) Pass
iv) Referred/Failure

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

I 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) compulsory.

J. 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

K ACKNOWLEDGEMENT

NVTI wishes to acknowledge the preparatory material done by the team of Experts, which have been incorporated into this syllabus.

Government's desire to improve the lot of Technical/Vocational Training, which led to the preparation of this syllabus, is hereby acknowledged.

TRADE TECHNOLOGY/REGULATION

TASK	CRITICAL SKILLS	SUB - SKILLS	INSTRUCTIONAL GUIDE	EVALUATION
1.0 Trunking	1.1 Types of trunking and its accessories. 1.2 Application of types of trunking 1.3. Segregation of system 1.4 Outline of IEE regulations requirements on trunking. 1.5 State the advantages and disadvantages of trunking in industrial installation.	1.1.1 How to bend, set shape, file and fabricate accessories 1.1.2 How to join lengths of trunking using rivets screws or adhesives. 1.1.3 Accessories tools used in trunking system.	Identify trunking with explanation. - Demonstrate how to perform joints	State suitale application of types od trunking. Write down the steps for fabricating accessories State purpose of trunking containing separate compartment Give 2 advantages and 2 disadvantages of trunking
2.0 Armoured Cables	List types of armoured cable 2.1 The construction of low voltage armoured cable. 2.2 The necessity for armouring a cable. 2.3 The application of types of armoured cable.	2.1.1 With the aid of diagrams explain the constructional features types of armoured cable. 2.1.2 Joiningarmoured cables. 2.1.3 Terminatingarmoured cable. 2.1.4 Applying all relevant safety procedures.	- Demonstrate how to Join and terminate armoured cables. Explain the need and its application.	Describe with the aid of a diagrams the construction of low voltage armoured cable State two applications of armoured cable Explain
3.0 MICC	3.1 The construction of MICC and method of Termination	3.1.1 Terminating MICC using cable glands. Testing of termination. 3.1.2 The applications of MICC cable 3.3 Advantages and disadvantages of m I .C.C cable. 3.4 Precautions to be observed on the use of M.I.C.C	- Demonstrate how to Terminate	Explain MICC cable. State three applications of MICC cable State advantages and disadvantages of M. I. C.C. State precautions on the use of M.I.C.C

TASK	CRITICAL SKILLS	SUB - SKILLS	INSTRUCTIONAL TECHNIQUES	EVALUATION
4.0 Earthing System	4.1 Definition of Earth 4.2. Definition of Earthing 4.3 Definition of name parts of earthing system 4.4. Definition of resistance area. 4.6Theimportance of an earthing system. 4.7. Types of Earthing system IT, TT, TNC, TNCS 4.8Howearthing system can prevent electric shock. 4.9Advantages and disadvantages of types of Earthing system 4.10 Earth leakage protection by Earth leakage circuit breaker, precautions/ IEE Regulations to be observed on • potential/ voltage operated E. L. C. B. • Residual / current operated E.L.C.B.	4.1.1 The use of the earth circuit protective conductor and earthing conductor 4.1.2 Types of earth electrodes, rod plate and lattice plate. 4.1.3 Connection of the CPC through Earthing conductor toearth rod. (earth electrode) 4.1.4 Process of burying earth electrode using charcoal dust and salt.	- Demonstrate how to install any earth electrode. - Demonstrate the process of buryingtype of earth electrode	Define • Earth • Earthing • Circuit protective conductor • Earthing conductor • Earth electrode Differentiate between earth rod ,plate and lattice plate State suitable application of types of earth electrode Describe any process of buring types of earth electrode. State IEE Regulation requirement on earthing. Solve by calculation effectiveness/ ineffectiveness of earthing.
5.0 Transformers	5.1 The relationship between primary and secondary windings with respect to primary and secondary voltage.	5.1.1 items to be earthed 5.1.2 List basic IEE Regulation requirement of earthing 5.1.3 Determine by calculation the effectiveness/ineffectivess of earthing 5.1.4 Identify types of Eath leakage circuit breaker.	Discuss the functions of a transformer. Explain transformation ratio $\frac{V1}{V2} = \frac{N1}{N2} = \frac{I2}{I1}$ Solve problems using above formula	State the functions of a transformer List types of transformer Solve problems (2) given below V1, N1 and N2 Find N2, given I1, I2 and N1.

		5.1.5 Explain with the aid of diagram the principles of operation of types of earth leakage circuit breaker. • Voltage/ potential operated earth leakage circuit • Residual/ current operated earth leakage circuit breaker 5.1.6 . Importance of earth leakage circuit breaker 5.1.7. Application of types of earth leakage circuit breaker. 5.1.8. Advantages and Disadvantages of • Voltage/ potential operation earth leakage circuit breaker • Residual/ current operation earth leakage circuit breakers 5.1.9 Type of transformers. Double wound transformer (eg. Core and shell). 5.1.10 Terminal markings for primary and Secondary wndling. 5.1.11 Connecting transformers to power source. 5.1.12 Measuring secondary voltages.	Explain Volt per turn. Use formula below to solve problems, volt per turn = Winding voltage / No. of turns Discuss transformer construction (core and shell)	

		5.1.13. Losses in transformer 5.1.14. Calculation of transformer efficiency 5.1.15. Calculation of voltage Regulation 5.1.16.Rating of transformer 5.1.17. Application of transformer 5.1.18. IEE Regulation regarding the use of transformers		
6.0 A.C. Machines	6.1 The construction and principles of operation of AC machines. 6.2 Types of AC Motors (Single phase and three phase). 6.3 Types of motor enclosure and their uses. 6.4 Application of types of 3-phase and single phase motors 6.5. Outline of IEE regulation relating to D/C Machine	6.1.1 The construction and operation of each motor (n single and three phase) 6.1.2 Parts of each motor. 6.2.1 Terminal markings for starting and running windings 6.2.2 Terminal markings for both star and delta connected motors. 6.2.3 How to reverse the direction of each motor.	- Discuss various types with the aid of diagrams or charts explain the functions of each parts	Name three components of a 3-phase motor Describe the construction of 3-phase motors and types of a single-phase motor State how motors are classified Identify method of identifying terminal marking of motors Explain with the aid of diagram method of reversing direction of rotation of 3 – phrase and single phase motors

TASK	CRITICAL SKILLS	SUB - SKILLS	INSTRUCTIONAL TECHNIQUES	EVALUATION
7.0 Starting Arrangement of A.C. Machine	7.1 The principles of operation of the magnetic starter. 7.2 The principles of operation of overload relays. 7.3 The purpose of an inter locking system both (mechanical and electrical) 7.4. Methods of starting 3-phase and single phase motors	7.1.1 Types of push buttons. (e.g. Start and stop buttons) 7.1.2 The direct-on-line (D.O.L) starting. 7.2.3 The Star – Delta Starting 7.2.4 Auto transformer starting 7.2.5 Rotor resistance starter 7.2.6The Remote Control System to an existing normal starter.	- Demonstrate with the aid of sketch	Differentiate between D.O.L and star-Delta starting State purpose of D.L star delta Auto transformer and rotor resistance starter Sketch wiring diagram of types of starter Describe principles od operation od D. O.L starter star Delta starter Explain method od connecting remote control for motor
8.0 DC Machines	8.1 The construction and operation oftypes of DC motors and D.C Generator	8.1.1 The advantages and disadvantages of DC motors (various) 8.1.2 Motor Rating. 8.1.3 The construction of a D.C generator. Parts e.g. shunt,series and compound. 8.1.4 Identify parts of D.C machine 8.1.5. Explain the functions of armature,commutator armature shaft yoke, main poles, Brushes interpoles	- Through discussion, explain the principles of operation of types of D.C motors List some advantages and disadvantages of the D.C motor and explain them Discuss the various motors	State 2 advantages and 1 advantage of D.C. motor What is a separately executed machine? Differentiate between shunt – wound and serried wound machine

TASK	CRITICAL SKILLS	SUB - SKILLS	INSTRUCTIONAL TECHNIQUES	EVALUATION
8.0		8.1.6. Explain armature reaction 8.1.7. Characteristics of types of D.C generator and D.C Motor. 8.1.8 Calculate generated and output voltage of D.C generator using the formula VT (Terminal Voltage) = Vg (generator Voltage)- (Ia Ra + Vb) Determine D.C Generator Armature Current using the formula Ia (Armature Current) (Armature Current) = I L + I f 8.1.9 Calculate Back emf and terminal voltage od D.C motors using the formula. VT (terminal Voltage)= Eb (Back emf) + (IaRa +Vb) 8.2.1 Methods of starting DC motors (shunt, series and compound). 8.2.2 Application of types of D.C motors and generator 8.2.3Types of motor starters.		

TASK	CRITICAL SKILLS	SUB - SKILLS	INSTRUCTIONAL TECHNIQUES	EVALUATION
		8.2.4 Types of fault in D.C generators and D.C motors 8.2.5 Causes of fault in D.C generators and D.C motors 8.2.6. Method of rectifying faults in D.C generators and D.C motors 8.2.7 Obersvation of the IEE regulation for motors		
9.0 Inspection and Testing	9.1 The sequence of testing and inspection. 9.2 Types of fault on motor and associated wiring. List types of fault in motor, possible causes of fault and method of testing/renotifying the fault.	9.1.1 Testing for short or open circuit faults, motor field coils and armature windings. 9.2.2 Checking bearing lubrication oil motors. 9.2.3 Checking alignment on motors. 9.2.4 Types of motor stators.	- Discuss and apply statutory Regulations. - Carry out visual inspections of an installation. - Demonstrate bearing lubrication. - Discuss method of tracing fault in motors and method of rectifying the fault.	- State 4 types of test required to be made on electrical installation. Write down the sequence of steps for testing. - State the importance of types of test made seguenciat. With the aid of diagram, Describe method of carrying out continuity test earthing test, insulation resistance test and polarity test on motor and wiring . State the purpose of • Continuity rest • Installation resistance test earth insulation resistance test and a • Polarity test. Describe method of carrying out continuous test, Earthing test installation resistance test and Polarity test.

TASK	CRITICAL SKILLS	SUB - SKILLS	INSTRUCTIONAL TECHNIQUES	EVALUATION
10.0 Three – Phase Supply System	10.1 The advantages of 3 phase supply over single phase supply. 10.2 The difference between 3-phase sinusoidal wave form and single phase sinusoidal wave form.	10.1.1 Connecting load to 3 phase supply for balance loads condition. 10.2.1 How power can be measured on 3 phase star connected load using watt meter. (Balance and unbalance). 10.2.2 How power can be measured on 3 phase delta connected load.	- Sketch the 3 phase wave form (balanced) - Explain the processes involved in measuring power in - star - delta connectedload. With the aid of a sketch, discuss	Give three advantages of 3-phase supply over single phase supply - Describe method of measuring power in 1 single phase and three phase circuit.
11.0 Lighting	11.1 The High Pressure Mercury vapour lumps 11.2 Sodium lamp	11.1.1 Tracing hidden faults. 11.1.2 Wire circuit for sodium lamps. 11.1.3 Tracing fault on sodium circuit. 11.1.4 Solving problems involving spacing – mounting height ratio. 11.1.5 Terms: - Emergency lighting - Shades - Reflectors	- Describe using sketch the mercury vapour pressure lamp - Discuss the Emergency lighting shades,and Reflectors.	Differentiate between mercury vapour pressure lamp and sodium lamp Explain an Emergency lighting. Explain maintain and non –maintain emergency lighting. Differentiate between shades and reflectors
12.0 Fire and Burglar Alarm system	12.1 Types of detectors and fire alarm systems. E.g heat and smoke detectors. Open and closed circuit types	12.1.1 Component parts of fire alarm system eg. Sounders call points , Indicator board silencing switches .	- Demonstrate the use of the fire and burglar alarm and the wiring system.	State two advantages of open burglar system Describe the principle of operation of a close burglar alarm alarm system.

TASK	CRITICAL SKILLS	SUB - SKILLS	INSTRUCTIONAL TECHNIQUES	EVALUATION
12.0		12.1.2 Segregation of fire alarm circuits 12.1.3 Suitable wiring system Eg. M. I. C. C P.V. Insulated cables in metal conduit duct trunking and pvcarmoured cables 12.1.4 Power supply equirment for fire alarm. 12.1.5 Wiring open and close burglar alarm system. 12.1.6Principles of each device, and the advantages and disadvantages.		
13. 0 Selection of conductors/ cable sizes	13.1. Factors determining of conductors cables. selection 13.2. Rating of protective device 13.3 Correction factors 13.4 Permissible voltage drop 13.5. Suitable IEE Tables and columns 13. 6. Actual voltage drop	13.2. Define • Designed current • Ambient temperature • Grouping • Thermal insulation • Type of protective device • Disposition of cable • Permissible voltage drop 13.2.2. Use of IEE Regulations Tables	Explain terms applied ins selection of conductors/ cable sizes using real objects Demonstrate steps to be followed when selecting cable size to be used for a particular situation	• Solve problems given • Supply voltage power • Length of run of cable • Type of protection • Ambient temperature • Grouping Thermal insulation

TASK	CRITICAL SKILLS	SUB- SKILLS	INSTRUCTIONAL TECHNIQUES	EVALUATION
13.0		13.2.3 Explain contents of IEE Tables • Cross-sectional area of conductors • Type of insulation • Length of run for IV drop 13.2.4 Method of calculating cable sizes/ conductors • Find designed current • Apply relevant correction factors • Selection of suitable protective device rating • Determine actual voltage drop using $\frac{mV/A/m \times Ib \times L}{1000}$	Check if actual voltage drop is below the permissible voltage drop to confirm suitability of cable size	• Type of cable • Determine the • Designed current rating Size of protective device Correction factors. • Required current rating • Permissible voltage drop. Actual voltage drop and Suitable size of cable

PRINCIPLES FOR CERTIFICATE II

TASK	CRITICAL SKILLS	SUB - SKILLS	INSTRUCTIONAL TECHNIQUES	EVALUATION
1.0 Electromagnetic Induction	1.1 Electromagnetic induction 1.2 Magnetizing force 1.3 Magnetic flux and flux density 1.4 Explain Hysteresis 1.5 Explain Eddy currents 1.6 Explain induced emf 1.7 B. H. loop for a ferromagnetic material 1.8 Self and mutual inductance 1.9 Magnetic screening 1.10 Importance of magnetic screening	1.1.1 Define electromagnetic induction 1.1.2 The Lenz's law 1.1.3 Solve problems on magnetizing force 1.1.4 Solve problems on magnetic flux and flux density 1.2.1 Define units of self and mutual Inductance. Explain self induced emf and mutual induced emf 1.2.2 Solving problems on self and mutual inductance	Explain Farady's Law of Electromagnetic induction Explain Hysteresis and eddy current, induced emf with the aid of diagram. Using the formular E = BLV, explain B, L, V and state their units Explain with diagram to trainee Solve problems	Define lenz's law Given L. N. I Determine the magneting force Given I. A . Determine flux density (B) Given e, B and L, solve for V and State the unit
2.0 Reactance in AC Circuit	2.1 Factors affecting inductance in AC. 2.2 Factors affecting capacitance in AC circuits.	2.1.1 Factors affecting i) Frequency ii) Inductance – core type air-core and no turns. 2.1.2 Factors affecting capacitance	Discuss factors affecting frequency inductance(core type, air core and number of turns) Discuss factors as frequency, capacitance (MO of plates, size of plate)	List factors upon which inductance depends State factors upon which capacitance depends.
3.0 Resistance, Inductance and Capacitance in AC	3.1 Determining Impedance phasors, currents, voltage in series and parallel connection.	3.1.1 Solve more problems involving resistance, inductance and capacitance connected in series and parallel.	- Use impedance triangle, voltage triangle and current triangle. Explain and discuss	Calculate - Impedance of circuit - The current in a circuit - Pd across resistor and inductor. Draw a phase or diagram for the above circuit.

PRINCIPLES FOR CERTIFICATE II

TASK	CRITICAL SKILLS	SUB - SKILLS	INSTRUCTIONAL TECHNIQUES	EVALUATION
4.0 Power factor Improvement	4.1 Determining equivalent capacitance required to improve capacitance 4.2. Importance od improving power factor 4.3 Calculating power factor using impedance triangle voltage triangle, power triangle and current triangle	4.1.1 Define power factor 4.1.2Using two branch circuit to determine graphically overall power factor and capacitance required to improve power factor. 4.1.2 Using of active and reactive components.	Two branch circuit used to determine Explain effects of low power of factor Explain method of installing capacitors for power factor improvement	Define power factor State effects of low power factor State three methods of improving power factor Use circuit shown to determine the overall power factor Calculate size of capacitance for power factor improvement
5.0 Scalar and Vector Quantities	5.1 Differentiate between scalar and vector quantities	5.1.1 Define scalar quantity. 5.1.2 Define vector quantity. Find the resultant forces acting at right angles to one another using vector diagram / Pythagoras theorem	Explain the difference between scalar and vector with lines	Explain What is a scalar quantity? Explain Vector quantity List two examples of a vector quantity
6.0 Illumination	6.1 Differentiate between a) Illumination b) Luminos intensity, Luminous flux lumen	6.1.1 Define each of the following: Illumination, Luminous intensity, Luminous flux (lumen). 6.1.2 Distinguish between each of the above.	Use various lamps to explain the terms	Define i. Illumination ii. Luminous intensity iii. Luminous flux

PRINCIPLES FOR CERTIFICATE II

TASK	CRITICAL SKILLS	SUB - SKILLS	INSTRUCTIONAL TECHNIQUES	EVALUATION
7.0 Inverse square law Cosine law, Brightness Glare and Photometry	7.1 Cosine law, brightness, glare and photometry	The inverse square law using sketches to Illustrate 7.1.1 The cosine law using diagrams. The horizontal luminous and mean spherical luminous intensity. Applying inverse square law and cosine law to determine illumination on a working plane 7.1.2 Applying simple lumen method formula $N = \frac{E \times A}{Q \times CU \times MF}$ 7.1.3 Coefficient of utilization. 7.1.4. Maintenance factor 7.1.5 Application to domestic and industrial installation.	Solve illumination problems using i. Inverse square law ii. Cosine law Solve problems using the lumen method formula Discuss the coefficient of utilization in respect of domestic and industrial installation.	Differentiate between brightness and glare State i. Inverse square law ii. Cosine law Explain i. Coefficient of utilization ii. Maintenance factor
8.0 Generators and Motors	8.1 The principle of operation of generators a) DC motor b) DC generator c) AC motor (single phase) d) AC generator (single phase) 8.2 The difference between motor and generator 8.3. Generator and motor characteristics 8.4 Types of generator and motor connections	8.1.1 Define motors. 8.1.2 Define Generator 8.1.3 Describe construction of P.C. -Motor Generator. 8.1.4 Label parts and types 8.2.1 Main difference between motors and generator. 8.2. 2Method used to supply current to the field coils	- Use charts Explain lap winding and wave winding Solving simple problems involvingE.m.f. generated in a winding. Explain and discuss with trainee solving problems. Use chart / real object to explain D.C Generator and motor characteristics	Differentiate a D.C generator and a D.C. motor Explain the construction of a D.C. generator. If a machine has 4 pairs of poles, what is the number of parallel pairs with a) Lap winding Wave winding

PRINCIPLES FOR CERTIFICATE II

TASK	CRITICAL SKILLS	SUB - SKILLS	INSTRUCTIONAL GUIDE	EVALUATION
8.0	8.5 Application of types of generator and motor 8.6 Generated emf and output voltage 8.7 Define back emf 8.8. Define armature reaction 8.9. Explain torque 8. 10. Describe method of starting D.C shunt motor . 8.11. Explain types of protection. 8.12. Reversing direction of rotation Reversing either the field or armature connection	8.2.3Method of field winding connection 8.2.4 Purpose of starter 8.2.5 Face place starter 8.2.6 No volt protection 8.2.7. Over current protection 8.2.8. Generators and motor characteristics	Demonstrate method of calculation of armature current and generator voltage Field current and line current Solving problems involving back emf	Solve problem of emf generated in armature winding (Lap and Wave Using formula $\frac{2\Phi Np}{60} \times \frac{Z}{C}$ 2 For a wave winding 2p for a lap winding
9.0 Three phase AC Generators	9.1 The principle of operation of 3 phase AC generators 9.2 Types of a.c generators 9.3 Advantages of a.c generator	9.1.1 3 phase AC generator. 9.1.2 Parts of AC generators. 9.1.3 Function of part of a.c generators 9.1.4The principle of operation using wave form. 9.2.1 Sketching 3 phase sinusoidal wave form. 9.2.2 Comparing single phase and three phase sinusoidal wave forms.	Discuss the distribution of magnetic flux due to 3-phase currents Using sketches explain the differences (R, Y, and B)	Display chart / real object and List types of A. C generators Identify the part of A.C generator Explain the function of EACH generator using real object/ chart

PRINCIPLES FOR CERTIFICATE II

TASK	CRITICAL SKILLS	SUB- SKILLS	INSTRUCTIONAL TECHNIQUES	EVALUATION
9.0	9.2 The difference between 3 phase sinusoidal wave form and single phase sinusoidal wave form. 9.3 The line and phase voltages in star connected system(b) and between line and phase current in delta connected system with balanced loads. 9.4 Describe measurement of Power factor	9.3.1 Relationship of line and phase voltages and currents in Delta connected system as VL = Vph IL =√3 x Iph 9.3.2 Relationship of line and phase voltages and currents star connected system and VL = √3Vph and IL = Iph. 9.4.1 How power factor can be measured using Ammeter, Voltmeter and Wattmeter.	Solving problems in star and Delta connections making use of the voltage and current relations Demonstrate the measurement of power factor using Ammeter, Voltmeter, Wattmeter	State application of EACH of the following types of generator Stationary field involving armature Stationary armature revolving Calculate the current in EACH line of 4 wire system of supply and in delta connected supply Explain with the aid of diagram method of measuring power factor using ammeter voltmeter and wattmeter
10.0 A.C motor	10.1 Rotating magnetic field 10.2 Representation of three emf 10.3. Method of connecting three phase to produce three phase system	10.1.1. Sketch i. Waveform ii. Phaso diagram iii. Star connection 10.1.2. Relationship between star and delta connection 10.1.3 Identify types ofA.C Motor	Using chart/ chalk board illustration. Explain rotating magnetic field Identify three phase voltage	Explain rotating magnetic field as applied in ac motor Define synchronous speed - slip speed. State the relationship between star and delta connection

PRINCIPLES FOR CERTIFICATE II

TASK	CRITICAL SKILLS	SUB- SKILLS	INSTRUCTIONAL TECHNIQUES	EVALUATION
10.0 A.C motor	10.4. Types od A.C motor 10.5. Types od A.C Motor 10.6. Application od 3 – phase motor and single phase motors 10.7. Advantages od 3-phase motors and single phase motors 10.8 A.C motors rating 10.9 Outline of IEE regulations concerning electric motors	10.1.4 describe the construction and principles of aperction of types of a.c motor 10.1.5 Synchronous 10.1.6. indention and single phase motor eg split phase start capcitory start 10.1.7. Explain i. Synchronous speed ii. Slip in slip speed 10.1.7 Calculate synchronous speed using formula $Ns = \frac{f \times 60}{p}$ Or $Ns. = \frac{60x\ 2f}{p}$ 10.1.8 Calculate percentage slip using the formula $\% slip = \frac{Ns - Ns}{Ns} \times 100$ 10.1.9 Describe characteristics output of types of 3 phase and single phase motor 10.1.10 Means of isolation of supply 10.1.11 Protection against excess current 10.1.12. Protection against automatic starting. 10.0.13. Means of stopping and starting of motors	Display types of ac motors for identification With the aid of sketches explain the construction of synchronous motor Split phase motor Capacitor start Demonstrate method of finding - synchronous slip speed . - slip speed	Calculate synchronous speed and slip speed State advantage of 3 phase motors over single phase motors State application of EACH of the following types of motor • Synchronous motor • Induction motor • Split phase motor • Capacitor start motor • Explain f reason or AC motors rated in KVA Solve problem involving synchronous speed slip speed Percentage slip. With the aid of sketch explain the characteristics of types of 3 phase and single phase motors Explain reason for A.C motors rated in KVA

PRINCIPLES FOR CERTIFICATE II

TASK	CRITICAL SKILLS	SUB - SKILLS	INSTRUCTIONAL TECHNIQUES	EVALUATION
11.0 Transformers	11.1 Describe losses in transformers.	11.1.1 Define losses 10.1.2 Categorize the losses (Fixed and Variable) 10.1.3 Determining fixed losses and variable. 10.1.4 Solving problems on efficiency. 10.1.5 Solving problems involving current, voltages and No of turns.	Explain losses in transformer using illustration Demonstrate method of finding i. Losses ii. Current iii. Voltage iv. No of turns	Explain i. Iron losses ii. Copper losses in transformer Calculate losses and efficiency in transformers
12.0 Stroboscopic Effect	12.1 Stroboscopic effect. 12.2 Mitigating stroboscopic effect	12.1.1 Define stroboscopic effect 12.2.1 Circuit used to mitigate the effect for a) single phase supply b) three phase supply	With real object or sketches discuss the effects of stroboscopic Illustrate method od preventing stroboscopic effects	- 3 phase supply system - single phase supply system. Explain the effect of stroboscopic where moving machinery and used in industry.
13.0 Electronics	13.1 Electrical and electronic symbols in use	13.1.1 Names and symbols of electronic components. a) resistors, inductors, capacitors, diodes, transistors, thyristors, triac, diac, light dependent, resistors (LDRs), light emitted diodes (LED) photo diodes, photo transitors, photo thyristor, thermionic valves.	Use principle of operation to construct darkness. Operate or light operated switch	Explain the purpose of • Light emitted doodes • Light dependant resistors • Photo transistor • Photo thyroster.

PRINCIPLES FOR CERTIFICATE II

TASK	CRITICAL SKILLS	SUB - SKILLS	INSTRUCTIONAL TECHNIQUES	EVALUATION
	13.2 The principle of operation of LDRs, photodiodes transistor diodes thyristors, LED. Photo transistor etc. 13.3 Recognize simple logic circuit of AND, OR NOT, NOR, NAND and EX-OR 13.4 Explain the construction of Integrate circuit (IC).	13.2.1 The principle of operation using characteristic graph where necessary. 13.3.1 Drawing symbol for the gate. 12.2.3 Drawing the truth table 13.2.3 Drawing the timing diagram 13.4.1 The construction of IC . 13.4.2. Types of integrated circuit (ic) 13.4.3. Advantages of integrated circuit (IC) 13.4.4 Application ofintegrated circuits	Identify using real objects or chart and sketching symbols Description	- Show how the component can be used to produce light or darkness operated switch. Sketch truth table for AND OR NOT, NOR, NAND Make a labeled diagram for logic network for a NAND gate and NOTgate Describe two types integrated circuit List advantage of integrated circuit State application of integrated circuit.

PRACTICALS FOR CERTIFICATE II

TASK	CRITICAL SKILLS	SUB - SKILLS	INSTRUCTIONAL TECHNIQUES	EVALUATION
1.0 Trunking	1.1 The illustration of trunking system. 1.2 The installation of bushertrunking. 1.3 The installation of vertical and horizontal trunking.	1.1.1 Installing PVC and metallic trunking both vertical and horizontal lines with the help of the marking outs. 1.2.1 Determining the size of Trunking.	- Practical demonstration of the trunking including cutting, rewiring and joining. Demonstration	Sketch marking out of electrical layout - Trainees should cut and join a trunking at an angle of 90^{o} List tools and materials for trunking wiring system Demonstrate method of erecting trunking Demonstrate method of laying cables
2.0 Armoured Cable	2.1 The installation of PVC armoured cable.	2.1.1 Installing PVC armoured cable and terminate into terminals using cable lugs. 2.1.2 Preparing different types of armoured cable for terminating and jointing	- Demonstration - Selection site to visit.	- Trainee to write a report on visit to ECG/VRA.
3.0 MICC	3.1 The installation MICC cable using cable glands.	3.1.1 Terminating the MICC cable using cable glands	- Practical demonstration on MCC termination.	- Trainee should prepare MICC for termination
4.0 Earthing System	4.1 How to prepare the ground soil for earthing system.	4.1.1 Burying earth electrode ground soil. 4.1.2 Labeling the part earthing conductor termination to the earth electrode according to the IEE Regulation	- Demonstrate the installation of earthing system - Site visits	- Trainee should sketch method of preparing soil for earthing

PRACTICALS FOR CERTIFICATE II

TASK	CRITICAL SKILLS	SUB - SKILLS	INSTRUCTIONAL TECHNIQUES	EVALUATION
5.0 Transformers	5.1 Types of transformer e.g.core and shell types.	5.1.1 Primary and secondary wind windings. 5.1.2 The Iron Core 5.1.3 Identify Terminal markings for primary and	- illustration - Explanation - Demonstration	List types of transformer Identify parts of transformer Identify transformer terminal markings
TASK	CRITICAL SKILLS	SUB - SKILLS	INSTRUCTIONAL GUIDE	EVALUATION
		Secondary windings. 5.1.4 Connecting transformers to power source. 5.1.5 Measuring the secondary voltage .	- Demonstration on identification. - Connecting to supply	Demonstrate methods of connecting transformer to power source Method of measuring primary and secondary voltage
6.0 AC Machine	6.1 Types of AC machine(Single phase three phase). 6.2 Fault of electromagnetic constructors and their functions. 6.3 Identify types of push on controls e.g. start and stop buttons	6.1.1 Dismantling and identifying parts of AC motors (Single phase/three phase) 6.1.2 Recording name plate data from various machines. 6.1.3 Terminal markings for starting and running (single phase). 6.1.4 Terminal marking for both startor (3 phase). 6.1.5 Assembling motors. 6.1.6 Connecting a direct on line starters 6.1.7 Connect forward and reverse starter. 6.1.8 Testing for short circuit and open circuit fault.	- Practical demonstration on AC motors and generator. - Connecting a direct on line starter and star delta starter.	Demonstrate method of • Direct on line starter • Star delta starter • Forward and reverse starter • Carry out method of testing • i. short circuit and open circuit fault in A/C Machines

PRACTICALS FOR CERTIFICATE II

TASK	CRITICAL SKILLS	SUB - SKILLS	INSTRUCTIONAL TECHNIQUES	EVALUATION
7.0 DC Machines	7.1 Types of DC motors 7.2 Identify types of DC generators	7.1.1 Methods of starting DC motors. 7.1.2 Methods of starting DC Generators. 7.1.3 Recording names, plate frame for various machines. 7.1.4 Dismantling DC generator or dynamo. 7.1.5 Assembling the generator 7.1.6 Testing for short or open circuit faults for a motor fields and armature. 7.1.7 Checking bearing lubrication and alignment	- Practical demonstration on DC motors and generators	- Trainees to dismantle and assemble a DC motor.
8.0 Lighting System	8.1 Identify the High Pressure Mercury Vapor lamp and sodium lamp	8.1.1 Trace Hidden fault. 8.1.2 Wire circuit for sodium lamps. 8.1.3 Trace Hidden faults on sodium lamp.	- Practical demonstration on mercury and sodium lamps	Make labeled diagram of mercury vapour lamp List possible faults in high mercury Vapor/ sodium lamp and State method of rectifying EACH type of fault List tools and materials required

PRACTICALS FOR CERTIFICATE II

TASK	CRITICAL SKILLS	SUB – SKILLS	INSTRUCTIONAL GUIDE	EVALUATION
9.0 Fire and Burglar Alarm Systems	9.1 Types of alarm system eg heat and smoke detectors	9.1.1 Wiring open and close fire alarm circuits. 9.1.2 Wiring open and close burglar alarm systems 9.1.3 Installing fire alarm	- Practical demonstration on fire alarm circuits	- Trainee should draw a single circuit of fire alarm system (open/close circuit types)
10.0 Electronicsi	10.1 Determining the characteristics of a semi-conductor diode. 10.2 Determining the characteristics of a zener diode, travel diodes, thyristor, field effect transistors, triac, diacs, injunction transistors, Bipolar Transistors 10.3 The oscilloscope 10.4 The power supply units 10.5 Lighting diameter.	10.1.1 Connecting diodes in a circuit for half wave and full wave (Bridge and bi-phase). 10.1.2 Smoothing the Rectified DC output wave form. 10.1.3 Measuring the output voltage by using oscilloscope. 10.1.4 Block diagram of a power supply unit and the function of each unit . 10.1.5 Connecting a lighting diameter using a triac as the controlling device. 10.1.6 Constructing a simple thyristor s DC motor controller board circuit.	- Practical demonstration of a diode	- Trainee should connect circuit and state their observations - Trainee should perform tests including - DC voltage - frequency response - Deduce gain 1 power. - Trainees should perform tests

PRACTICALS FOR CERTIFICATE II

TASK	CRITICAL SKILLS	SUB - SKILLS	INSTRUCTIONAL GUIDE	EVALUATION
		10.1.7 Determining by experiment the characteristics of a MPN, PnP transistors, zener diodes, turnel diodes, thyristors, field effect transistors, triacs, diacs. 10.1.8 Constructing simple common emitter audio amplifier on a circuit board. 10.1.9 Integrated circuit (IC) experiment using LM386 audio amplifier.	- Practical demonstration of the transistor and integrated circuit (IC)	Produce simple common emitter audio amplifier on a circuit board Construct integrate circuit for Audio amplifer
11.0 Underground Cable	11.1 How to solder join underground cables armoured cables. 11.2 Joining and terminatingarmoured cables. 11.3 How to repair damaged underground armoured cables. 11.4. Recommended cable for underground wiring 11.5. Acceptable depth for underground wiring system 11.6. Method of marking underground cable	11.1.1 Prepare trench for laying underground cable. 11.1.2 Laying cable in prepared trench using appropriate methods jacks, roller and winches 11.1.3 Purpose of laying underground cable deep enough 11.1.4. Selection of suitable cable for underground wiring labeling of underground wiring system	- Demonstrate how to solder/join underground armoured cable. - Demonstrate how to jack armoured cable. - Demonstrate how to dig and prepare trench for laying under ground cable. - Demonstrate how to lay cable in prepared trench for laying cable. - visit site Illustrate method of labeling underground cables	List four types of cables recommended for underground wiring system. State IEE regulation requirement for the acceptable depth for burying underground cables List tools required for joining underground cables Demonstrate method of joining underground cables

PRACTICALS FOR CERTIFICATE II

TASK	CTRITICAL SKILLS	SUB-SKILLS	INSTRUCTIONAL GUIDE	EVALUATION
12. 0 Electrical layout	12.1 Identify electrical layout 12.2 Explain electrical layout 12.3 Interprete the scales used in drawing electrical layout 12.4 Locate the positions of he types of accessories on an electrical layout drawing 12.5 Identify types od electrical symbols 12.6. Prepare estimate from electrical layout for a project 12.7 Importance of studying building plans	12.1.1. Prepare legend. 12.1.2 Draw single line diagram 12.1.3 Draw wiring diagram 12.1.4.Indicate of no of cables on conduit rout e trunking route * Surface wring route. 12.1.5 Interprete line diagram on electrical layout 12.1.6. Explain electrical circuit and labeling of an electrical circuit from consumers unit to destination.	Demonstrate method of sketching electrical layout Freehand sketching Using scales Method of labeling types of circuit	With the aid of a building plan make an electrical layout indicating suitable position of accessories Switches 13A switched socket outlet Consumer's unit lamps Make building plans using scales Illustrate suitable positions of distribution units for single and 3 phase supplyS on an electrical layout

TRADE DRAWING CERTIFICATE TWO (2)

NO.	TASK	CRITICAL SKILLS	SUB-SKILLS	INSTRUCTIONAL TECHNIQUE
1.0	THE USE AND APPLICATION OF SCALE	1.1 By calculation method determine scale factor (conversion of actual dimension to a given scale)	1.1.2 Reading of tape dimensions. Measure dimensions example • Classroom • Workshop 1.1.3 Conversion of actual measurement to the following scale: • 1:100 • 1:80 • 1:50 Enlargement and reduction of sizes using given scale for • Classroom • Workshop	Demonstrate to trainees how to determine scale factor and how to convert actual measurement to a drawing, using a given scale
2.0	LAYOUT DIAGRAM FOR BUILDING	2.1 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	2.1.2 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) d. Draw the ground floor plan of a room with a given measurement in metres using the following scale.	Facilitator explains to trainees the various sections sections of a ground floor plan using …….drawing and real object Facilitator guides the trainee to draw the plans using a scale rule or by calculation method

TRADE DRAWING CERTIFICATE TWO (2)

NO.	TASK	CRITICAL SKILLS	SUB-SKILLS	INSTRUCTIONAL TECHNIQUE
			1:100 1:80 1:50 e. 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	LAYOUT DIAGRAMS OF TRUNKING AND CONDUIT RUNS ON A BUILDING PLAN	3.1Preparation of a Layout Diagram	3.1.2 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	
	3.2 Conduit trunking runs on a layout diagram 3.3 Circuiting of lighting and power	3.2.1 Draw conduit/trunking runs on a layout diagram using fibrous tip pens instead of pencil 3.3.1 Draw circuiting of lighting and power using the conduit and trunking runs as the layout 3.3.2 Label Circuits and mark the number cables and the sizes of cables at each section	facilitator demonstrates how to draw circuits for lighting and power and mark the number of cables and the size of cables at each section and guides trainees to do same	

TRADE DRAWING CERTIFICATE TWO (2)

NO.	TASK	CRITICAL SKILLS	SUB-SKILLS	INSTRUCTIONAL TECHNIQUE
	3.4 Determination of: a. Total load b. Size of supply cable c. Size of main switch	on of the run of conductor or trunking. 3.4.1 Calculate the a. Total load b. Size of supply cable c. Size or rating of the main switch	Guide trainees to calculate and select the size of main switch and supply cable	
4.0	Three-phase electric motors	4.1 Star and delta connection of motor windings at the motor terminal	4.1.2 a) Draw the terminal block of a three-phase motor b) Draw motor windings connected in star c) Draw motor windings connected in Delta	Demonstrate to trainees how to Draw the terminal block of a three-phase motor, motor windings connected in star
5.0	ELECTRIC MOTOR CONTROL CIRCUIT	5.1 Introduction to Symbols	5.1.2 a) Contacts i) normally open ii)normally closed b) Switches i) Push buttons ii) pressure switch iii) limit switch c) coils i) contactor coil d) Indicator lights e) Relay i) thermal overload ii) Magnetic overload	Facilitator assists trainees to draw symbols related to motor control circuits

TRADE DRAWING CERTIFICATE TWO (2)

NO.	TASK	CRITICAL SKILLS	SUB-SKILLS	INSTRUCTIONAL TECHNIQUE
		5.2 Direct on line starter control a. Control circuit b. Power circuit	5.2.1 a) i. Use the symbols to develop a control circuit. ii. Read and interpret control circuit b) Draw the power circuit c) Draw power and control circuit d) Draw the following controls 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	
6.0	STAND BY SUPPLY	6.1 Draw the wiring circuit of a change over switch to control standby and main supply	6.1.2 a) List the main parts: i. Change over switch ii. Generator iii. Main supply b) Develop the following diagrams i. Block diagram ii. Single line diagram iii. Wiring diagram	Facilitator demonstrates to trainees how to Draw the wiring circuit of a change over switch to control standby and main supply
7.0	TPN Equipment	7.1 Internal arrangement of three-phase equipment	7.1.2 Draw the internal arrangement of: a. TPN Main switch, b. TPN energy meter c. TPN consumer unit d. TPN Distribution board	
8.0	Power distribution	8.1 Balancing of loads	8.1.2 Balance various single-phase loads on three-phase 4-wire system	