ELECTRICITY AND ELECTRONICS (866)

The syllabus is not intended to be used as a teaching syllabus, or to suggest teaching order. It is expected that teachers will wish to develop the subject in their own way.

In the examination, questions will be aimed more at testing the candidates' understanding of fundamental principles, and the application of these principles to problem situations, than to their ability to remember a large number of facts. Some questions will include simple calculations.

An experimental approach to the subject is envisaged and it is assumed that candidates will spend adequate time on individual experimental work. Questions may be set requiring descriptions of experimental procedures. Candidates should also know how to exhibit the results of experiments graphically and how to make deductions from graphs, e.g. from intercepts and gradient in the case of straight-line graphs, deductions by interpolation.

Candidates will be expected to be conversant with SI units.

CLASS XII

There will be two papers in the subject:

Paper I - *Theory: 3 hours…… 80 Marks*

Paper II - *Project Work ……. 20 Marks*

PAPER I (THEORY): 80 MARKS

1. Distribution of electric power. Idea of a simple distribution system. Mention of the local power system should be made.

   Overhead and underground cables: advantages and uses. D.C and A.C distribution systems: D.C 2 wire system, 3 wire system; AC distribution transformer (3 phase 3 wire system, 3 phase 4 wire system).

2. The D.C. generator and motor. Use of split-ring commutators; constructional features. Shunt series and compound field connections and their characteristics. Starting of D.C. motors. Ideas on back e.m.f.

   Single loop D.C. generator (circuit diagram); parts of a practical generator, lap and wave windings of armature conductors; armature reactions, commutation and period of commutation (T_c), use of interpoles, emf equation $E_g = \frac{\varphi PN}{60} \times \frac{Z}{A}$ *(derivation not required); types of generators; Excitation of poles: Self-excited and separately excited; generator construction: shunt, series & compound types; no-load and load characteristics, voltage, current and power equations, critical resistance; causes of failure to build up voltage for generators, applications and simple numericals.*

   Motors: Working principle of a DC motor; voltage equation; significance of back emf; D.C motor characteristics. Types of D.C motor constructions- shunt, series and compound; necessity of motor starter and protective devices; power equation applications, uses and numericals.

3. The A.C. motor. Ideas on A.C. motors (single phase only). The rotating field. Methods of shunting: capacitance start, split phase start. Single-phase induction motor types.

   A.C. motors (single phase only); idea of rotating magnetic field: split phase start, capacitor start single phase induction motor types. Uses of AC motors.

4. Wires, cables and electrical wiring. Construction of various types in domestic and industrial use. (Solid and stranded cables – how insulated and protected. Flexes). Selection of cable sizes, voltage drop and simple calculation on current-carrying capacity. (Linking of size of cables and flexes with maximum current flow particularly in relation to the circuits below. Regulation B 23 (voltage drop). Brief description of the wiring systems. Simple circuitry. (Separation of lighting and power circuits. Layout of lighting circuits. Switch in phase line. Dual switching of lamps. Layout of power circuits - ring and spur/ *tree systems.)* types - limitations). Introduction to rules and regulations, both local and that of I.E.E. (Sequence of equipment). Effects of overloading. Protection of circuits and individuals by (a) fuses and trips, (b) earthing of metal, (c) mechanical protection of cables. Regulations for bathrooms. Commonsense appreciation of dangerous practices (Simple testing).

   Different types of insulations used in cables; Vulcanised Indian Rubber (VIR), Tough Rubber Sheathed (TRS), Poly Vinyl Chloride (PVC).

5. Electrical accessories. Structure and uses of various types of switches, power outlets, lamp holders, ceiling roses and junction boxes. (Familiarity with these is expected - detailed knowledge of structure is not required). Where and how they are used.

   Structure and uses of switches; types: quick break knife switch, main switch, metal clad switch, air break switch, tumbler switch, piano-key switch, finger touch switch; essential qualities of a switch and its position in circuits and layouts; power outlets – Plug and Sockets; lamp holders types: bracket holder, batten holder, pendant holder, angle holder. Ceiling roses; junction boxes. Where and how they are used.

6. Introduction to electronics. Concept of electron flow. Common components employed in electronic circuits; resistors, capacitors and inductors; their structure, types and uses.

   Concept of electron flow; passive components employed in electronic circuits. Types of Resistors: wire wound, carbon composition type, variable type (potentiometers, rheostat); colour code. Types of Inductors: air core, iron-core, ferrite core inductors. Types of Capacitors: fixed and variable types. Fixed type: electrolytic capacitor, non-electrolytic (paper capacitors, mica capacitor, ceramic capacitors); variable type - ganged capacitors, their structure, types, voltage equations and uses.

7. Diodes. Thermionic diode; semiconductor diode. Structure of vacuum diode and semiconductor diode.

   Thermionic diode: construction, operation characteristics of vacuum diodes; A.C and D.C plate resistances, space charge, space charge limiting region.

   Semiconductor diodes: bonds in semiconductors, crystal structure of Germanium and Silicon; effect of temperature on semiconductor; concept of hole current; intrinsic and extrinsic semiconductors; doping, n-type, p type semiconductors, energy band diagrams; majority and minority charge carries; properties of p-n junction diode, forward bias and reverse bias diagrams and graphs; volt-ampere characteristics of p-n junction. Definitions of the following: break down voltage, knee voltage, maximum forward current, Peak inverse voltage (PIV), maximum power rating.

8. Power supply for electronic apparatus. Mains transformer. The diode; half wave, full wave and bridge rectifiers, voltage doubler. Filters; RC filters, chokes, bleeder resistance and its functions.

   Mains transformer; semiconductor diodes as half wave rectifier, full wave rectifier, bridge rectifier. Forward resistance, forward current, reverse current, derivation for: d.c (average current I_{dc}). Root mean square (rms) current (I_{rms}), efficiency of rectification (η); advantages, disadvantages and uses, ripple factors; simple numericals.

   Voltage doublers: Types of filters: RC filter, choke Input (I/P) filter, π-section filter. Input (I/P) and Output (O/P) graphs. Zener diode for voltage stabilisation, importance of series Resistor in the stabilization circuit, simple numericals. Chokes, bleeder resistors and their functions.

9. Vacuum triode. Structure of the vacuum triode valve. The control grid. Triode valve characteristics. Triode parameters; anode resistance, mutual conductance and amplification factors; relationship between the above parameters. Triode as a voltage amplifier. Bias voltage, cathode resistor and cathode bypass capacitor.

   Structure of the vacuum triode, control grid, triode value characteristics, grid cut off voltage. Plate characteristics, mutual characteristics; vacuum tube constants (Triode parameters), relationship between them, simple numericals. Triode as voltage amplifier: bias voltage, cathode resistor and cathode bypass capacitor; current in vacuum, causes of tube failure. Significance of vacuum in tubes.

10. Semiconductor Transistors. The junction transistor: PNP and NPN types. Introduction to various methods of construction; their characteristics including handling procedures and precautions.

    Self-explanatory.

11. Transistor amplifier. Introduction to the common-base, common emitter and common collector amplifiers. Comparison of the voltage, current and power gains and input and output resistances (elementary approach only). Phase relationship. Bias stabilization.

    Modes of connections: Common-Base (CB), Common-Emitter (CE), Common-Collector (CC) amplifiers: current amplification factors ($\propto$, β and γ) and their relationship. Simple numericals on the above.

    I/P and O/P characteristics, comparison of the voltage, current and power gain, I/P & O/P resistance (elementary approach only). Phase relationship, bias stabilization, single stage RC coupled amplifier circuit, bias circuit, emitter bypass capacitor, transistor current equation $\Delta I_E = \Delta I_B + \Delta I_C$. *Phase reversal in CE mode.*

12. The amplifier. A typical amplifier voltage and power amplification. Matching of the power output stage to a speaker.

Voltage Amplifier (RC Coupled) circuit; Power amplifier circuit, impedance matching of the power (O/P) stage to the speaker; advantages, disadvantages, frequency responses (qualitative), Applications. Differences between transistors and tubes.

13. Apparatus for reproducing and recording sounds. Range of hearing, recording and reproducing.

    Characteristics of microphones; types of microphones: carbon, crystal, moving-coil and ribbon types. The common types of gramophone pick-ups. The earphone, crystal and magnetic tapes. The moving-coil loudspeakers; permanent magnet. Electrostatic speaker.

    Construction, working, advantages and disadvantages of the above.

14. Common types of electronic measuring instruments. Valve voltmeters, transistorized voltmeter, signal generator, oscilloscope, use and care of the above instruments.

    Simple circuit diagrams of the above instruments are expected.

    Valve voltmeters (VTVM), transistorized voltmeter, signal generator, oscilloscope (CRT); uses of Oscilloscope to measure: (a) the peak value of an 'ac' voltage; (b) the frequency of an electrical signal; (c) the time interval (can be used as a clock). Multimeter used as voltmeter, ohm-meter and ammeter.

PAPER II (PROJECT WORK): 20 Marks

In addition to the syllabus prescribed above, candidates are also required to be assessed in Project Work. The Project work will be assessed by the subject teacher and the Visiting Examiner appointed locally and approved by CISCE.

All candidates will be required to have completed **two** projects from any topic/s covered in theory.

Mark allocation for *each* project (10 marks) *:

Criteria		Marks
1.	Title of the Project and Introduction	1
2.	Content	3
3.	Presentation and originality	2
4.	Conclusion/Comments/Summary	1
5.	Viva- Voce (Visiting Examiner)	3
TOTAL		**10**

List of suggested assignments for Project Work:

1. Electrical accessories (any five), meters and equipment (any three) used in the laboratory (along with precautions to be observed).

   Accessories (tools) used in Laboratory: Soldering gun, soldering stand, solder (lead), nose plier, wire stripper, line tester, tag-board, breadboard, general purpose printed circuit board (PCB).

   Meters and equipment: DC milliammeter, AC milliammeter, DC Voltmeter, AC voltmeter, Digital Multimeter, Variable DC power supply, Fixed DC power supply, Audio signal generator, Cathode Ray Oscilloscope (CRO).

2. Electrical Cables, their types, uses and specifications. *(Any 5 types, with one use and important specifications).*

3. Measuring the values of different types of:

   (i) resistors using colour code

   (ii) capacitors using code number .

   Writing the procedure to measure the values of resistances, capacitances and inductances using multimeter.

4. Different types of switches (any five), circuit protecting devices and their specifications.

   Switches: single-pole, single-throw (SPST), single-pole, double-throw (SPDT), double-pole, single-throw (DPST), double-pole, double-throw (DPDT), Rotary switch, Push Button switch, relay. Miniature circuit breaker (MCB), fuse, fuse holder (show samples), switch action (continuity and discontinuity using multimeter) Specifications; current and voltage ratings.

5. Distribution of electric power (D.C and A.C distribution) using overhead and underground cables along with their advantages and uses.

6. V-I Characteristics of a semiconductor diode (PN), its types and use of any one type of semiconductor diode.

7. V-I Characteristics of a Zener Diode and its use as a voltage regulator.

8. Half wave and Full wave rectifier (either centre-tapped or bridge type) with/without filter circuit.

9. Electrical accessories (Power outlets, lamp holders, ceiling roses and junction boxes) their structure and uses.

10. Simple circuitry of lighting and power circuits (domestic use), their layout and limitations, following IEE regulations.
11. Principle, construction and working of DC motor with explanation of any one type of DC motor.
12. Characteristics of DC generator and DC motor.
13. Types of microphones (any two) giving their construction, working and uses with diagrams.
14. Types of loudspeakers (any two) giving their construction, working and uses with diagrams.
15. Construction and working principle of power supply including common faults, causes, testing and repair.
16. Multimeters and their types including functions of any one type of multimeter.
17. Transistor Audio Power Amplifiers (any two types), their advantages, disadvantages and uses.
18. Principle, construction, working and uses of Cathode Ray Oscilloscope.
19. Identify a diode, a transistor, a LED, a resistor, an IC (integrated circuit), and a capacitor from a assorted collection of given items and an analog multimeter.
20. Prepare a working model on **any one** of the following and prepare a brief report highlighting the components used, circuit diagram and a step-by-step procedure:
    (i) Automatic Traffic Signal System using suitable combination of logic gates
    (ii) Basic gates (OR, AND, NOT) using NAND gates
    (iii) FM Radio Receiver
    (iv) Fire Alarm System
    (v) Electronic Lock
    (vi) Stepper Motor Controller
    (vii) Water Level Indicator
    (viii) Mobile Charger

NOTE: No question paper for Project work will be set by CISCE.

SAMPLE TABLE FOR PROJECT WORK

S. No.	Unique Identification Number (Unique ID) of the candidate	PROJECT 1					PROJECT 2					TOTAL MARKS
		A	B	C	D	E	F	G	H	I	J	
		Teacher	Visiting Examiner	Average Marks (A + B ÷ 2)	Viva-Voce by Visiting Examiner	Total Marks (C + D)	Teacher	Visiting Examiner	Average Marks (F + G ÷ 2)	Viva-Voce by Visiting Examiner	Total Marks (H + I)	(E + J)
		7 Marks	7 Marks	7 Marks	3 Marks	10 Marks	7 Marks	7 Marks	7 Marks	3 Marks	10 Marks	20 Marks
1												
2												
3												
4												
5												
6												
7												
8												
9												
10												

*****For breakup of the 7 Marks to be awarded separately by the Teacher and the Visiting Examiner, please refer to the table giving the criteria for mark allocation for *each* project.

NOTE: VIVA-VOCE (3 Marks) for each Project is to be conducted only by the Visiting Examiner and should be based on the Project only.