3.1 FUNDAMENTALS OF ELECTRICAL ENGINEERING

	L	P
Periods/week	5	3

RATIONALE

For a diploma holder in electrical engineering, it becomes imperative to know the fundamentals of the subject in order to grasp the knowledge of the field. This subject will provide acquaintance with various terms knowledge of fundamental concepts of electricity, magnetism and various principles related to it.

DETAILED CONTENTS

1. (a) Application and Advantages of Electrical Energy (04 Periods)

- Different forms of energy
- Advantages of electrical energy
- Uses of electrical energy

(b) Basic Electrical Quantities

- Basic concept of charge, current, voltage, resistance, power, energy and their units
- Conversion of units of work, power and energy from one form to another

2. DC Circuits (12 Periods)

2.1 Ohm's law, resistances in series and parallel

2.2 Kirchhoff's laws and their applications in solving electrical network problems

2.3 Network theorems such as Thevenin's theorem, superposition theorem Maximum power and transfer theorem and Norton's theorem

3. Batteries (15 Periods)

3.1 Basic idea about primary and secondary cells

3.2 Working principle, construction and applications of Lead acid, Nickel Cadmium and Silver Oxide Cells

3.3 Capacity and efficiency of lead acid battery

3.4 Charging methods used for lead acid accumulator

3.5 Care and maintenance of a lead acid battery

3.6 Grouping of cells in series and parallel (simple numerical problems)

3.7 Testing of lead Acid battery for fully charged conditions and their specifications

3.8 Application of lead acid battery

3.9 Idea about batteries used in UPS

4. Magnetism and Electromagnetism: (08 Periods)

4.1 Introduction to electromagnetism, Magnetic field around a straight current carrying conductor and a solenoid and methods to find its direction, force between two parallel current carrying conductors.

4.2 Force on a conductor placed in the magnetic field

4.3 Series magnetic circuits, simple problems

4.4 Concept of hyteresis, loop and hysteresis loss.

5. Electromagnetic Induction: (10 Periods)

5.1 Faraday's Laws of electromagnetic induction

5.2 Lenz's law

5.3 Fleming's Right and Left Hand Rule

5.4 Principle of self and mutual induction

5.5 Principle of self and mutually induced e.m.f. and simple problems

5.6 Inductances in series and parallel

5.7 Energy stored in a magnetic field

5.8 Concept of eddy currents, eddy current loss

6. AC Fundamentals (06 Periods)

6.1 Concept of a.c. generation (single phase and three phase)

6.2 Difference between a.c and d.c

6.3 Concept of alternating current and voltage, equation of instantaneous values, average value, r.m.s value, form factor, power factor etc.

6.4 Concept of phasor and phase difference

6.5 Representation of alternating sinusoidal quantities by vectors

6.6 Phasor algebra (addition, subtraction, multiplication and division of complex quantities)

7. AC Circuits (15 Periods)

7.1 AC through pure resistance, inductance and capacitance

7.2 Alternating voltage applied to RL,RC and RLC series and parallel circuits (impedance triangle, phasor diagram and their solutions)

7.3 Concept of susceptance, conductance and admittance

7.4 J-notation and its application in solving problems in ac circuits

7.5 Power in pure resistance, inductance, capacitance and series RL, RC, RLC circuits

7.6 Active and reactive components of current and their significance

7.7 Power factor and its practical significance

8. Poly-Phase Systems (10 Periods)

8.1 Advantages of 3 phase over single phase system

8.2 Star and delta connections (derive relationship between phase and line voltages, phase and line currents in star delta connections

8.3 Power in 3 phase circuits and measurement by two wattmeter method

8.4 Measurement of power and power factor of a 3-phase load by two wattmeter method using balanced/unbalanced load.

LIST OF PRACTICALS

1. (a) Determination of voltage-current relationship in a dc circuit under specific physical conditions and to draw conclusions (to verify ohm's law)

   (b) Filament lamp

   - Measure the resistance of a cold lamp filament with the help of calculations.
   - Measure the current drawn by the lamp at different voltages from zero to 220 volts and the resistance of lamp at different voltages, plot a graph between current and voltage

2. (a) To verify that $R_t = R_1+R_2+\ldots$ where R_1, R_2 etc. are resistances connected in series

   (b) To verify $\frac{1}{Rt} = \frac{1}{R_1} + \frac{1}{R_2} + \text{- - - - - -} + \frac{1}{R_m}$

   Where R_1, R_2 etc. are resistances connected in parallel

3. Verification of Kirchhoff's current and voltage laws applied to DC circuits

   a) To construct a circuit arrangement consisting of resistances in series, parallel combination
   b) Identification of node points in the circuit
   c) To see that algebraic sum of currents at node point is zero
   d) To see that algebraic sum of emfs and voltage drops in a closed loop is zero

4. To observe the a.c and d.c wave shapes on CRO.

5. To find ratio of inductance values of a coil having air /iron core respectively and to see the effect of introduction of a magnetic core on coil inductance

6. To construct an RL and RC circuit and to measure

a) Impedance of the circuit
b) Phase angle between voltage and current
c) Construct impedance triangle

7. Measurement of power and power factor of a single phase RLC circuit. To calculate KVA and KVAR

8. Measurement of power and power factor of a 3-phase circuit by using 2- wattmeter method using induction motor as a load and to calculate KVA and KVAR

9. Testing a battery for its charged condition i.e testing of gravity

Note: The results should be verified analytically also.

INSTRUCTIONAL STRATEGY

Basic electrical engineering being a fundamental subject need to be handled very carefully and in a manner such that students develop clear understanding of principles and concepts and develop skill in their application in solving related problems. Teacher may lay emphasis on laboratory experiments and give lot of tutorial work to students in order to given them an opportunity in mastering the basics in solving related problems.

RECOMMENDED BOOKS

1. Fundamentals of Electrical Engineering by Sahdev, Uneek Publication, Jalandhar
2. Basic Electrical Engineering by PS Dhogal, Tata McGraw Hill Education Pvt. Ltd., New Delhi
3. Electrical Science by VK Mehta, S Chand and Co., New Delhi
4. Electrical Engineering by DR Arora, Ishan Publications, Ambala
5. Electrical Technology by JB Gupta, SK Kataria and Sons, New Delhi
6. Electrical Technology by BL Theraja, S Chand & Co., New Delhi
7. Electrical Science by S. Chandhni, R Chakrabarti and PK Chattopadhyay. Narosa Publishing House Pvt. Ltd., New Delhi
8. Basic Electrical Engineering by Mool Singh, Galgotia Publication Pvt. Ltd., New Delhi
9. Principles of Electrical Engineering by BR Gupta, S Chand & Co., New Delhi
10. Handbook of Electrical Engineering by SL Bhatia, Khanna Publishers, New Delhi

SUGGESTED DISTRIBUTION OF MARKS

Topic	Time Allotted (Periods)	Marks Allocation (%)
1	04	05
2	12	15
3	15	15
4	08	10
5	10	15
6	06	05
7	15	20
8	10	15
Total	**80**	**100**

3.2 ELECTRICAL AND ELECTRONICS ENGINEERING MATERIALS

	L	P
Periods/week	4	2

RATIONALE

A diploma holder in Electrical Engineering will be involved in maintenance, repair and production of electrical equipment and systems. In addition, he may be required to procure, inspect and test electrical and electronic engineering materials. Knowledge of various types of materials will be needed in order to execute the above mentioned functions. He may also have to decide for an alternative when a particular material is either not readily available in the market or its cost becomes prohibitive.

DETAILED CONTENTS

1. Classification (03 Periods)

   Classification of materials into conducting, semi conducting and insulating materials through a brief reference to their atomic structure and energy bands

2. Conducting Materials (12Periods)

   2.1 Introduction
   2.2 Resistance and factors affecting it such as alloying and temperature etc
   2.3 Classification of conducting material as low resistivity and high resistivity materials,
   Low resistance materials

   a. Copper- General properties as conductor: Resistivity, temperature coefficient, density, mechanical properties of hard-drawn and annealed copper, corrosion, contact resistance. Application in the field of electrical engineering

   b. Aluminium - General properties as conductor: Resistivity, temperature coefficient, density, mechanical properties of hard and annealed aluminium, solderability, contact resistance. Applications of aluminium in the field of electrical engineering

   c. Steel - General properties as conductor: Resistivity, corrosion, temperature coefficient, density, mechanical properties, solderability, Applications in the field of electrical engineering

   Introduction to bundle conductors and its applications

   Low resistivity copper alloys: Brass, Bronze (cadmium and Beryllium), and their practical applications with reasons for the same

   2.4 Applications of special metals e.g. Silver, Gold, Platinum etc.
   2.5 High resistivity materials and their applications e.g., manganin, constantin, nichrome, mercury, platinum, carbon and tungsten, Tantalum
   2.6 Superconductors and their applications

3. Review of Semi-conducting Materials (05 Periods)

Semi Conducting material such as Germanium, Silicon, Carbon-their atomic structure/application/against , pure and impure semi conductors and their use for making electronic devices. Material used for special purpose semiconductor, diode, contacts, power transistor, substrate, integrated circuits and power handling devices.

4. Insulating materials; General Properties (12 Periods)

4.1 Electrical Properties
Volume resistivity, surface resistance, dielectric loss, dielectric strength (breakdown voltage) dielectric constant

4.2 Physical Properties
Hygroscopicity, tensile and compressive strength, abrasive resistance, brittleness

4.3 Thermal Properties
Heat resistance, classification according to permissible temperature rise. Effect of overloading on the life of an electrical appliance, increase in rating with the use of insulating materials having higher thermal stability, Thermal conductivity, Electro-thermal breakdown in solid dielectrics

4.4 Chemical Properties
Solubility, chemical resistance, weatherability

4.5 Mechanical properties, mechanical structure, tensile structure

5. Insulating Materials and their applications (13Periods)

5.1 Plastics

a. Definition and classification
b. Thermosetting materials:
Phenol-formaldehyde resins (i.e. Bakelite) amino resins (urea formaldehyde and melamine - formaldehyde), epoxy resins - their important properties and applications

c. Procedure of preparation of plastic (PVC)

d. Thermo-plastic materials:
Polyvinyl chloride (PVC), polyethelene, silicons, their important properties and applications

5.2 Natural insulating materials, properties and their applications

a. Mica and Mica products
b. Asbestos and asbestos products
c. Ceramic materials (porcelain and steatite)
d. Glass and glass products
e. Cotton
f. Silk
g. Paper (dry and impregnated)
h. Rubber, Bitumen

i. Mineral and insulating oil for transformers switchgear capacitors, high voltage insulated cables, insulating varnishes for coating and impregnation
j. Enamels for winding wires
k. Glass fibre sleeves

5.3 Gaseous materials; Air, Hydrogen, Nitrogen, SF6 $^{\text{their}}$ properties and applications

6. Magnetic Materials (11 Periods)

6.1 Introduction - ferromagnetic materials, permeability, B-H curve, magnetic saturation, hysteresis loop including coercive force and residual magnetism, concept of eddy current and hysteresis loss, curie temperature, magnetostriction effect, method of reduction of eddy current loss and hysteresis loss

6.2 Soft Magnetic Materials

a) Alloyed steels with silicon: High silicon, alloy steel for transformers, low silicon alloy steel for electric rotating machines
b) Cold rolled grain oriented steels for transformer, Non-oriented steels for rotating machine
c) Nickel-iron alloys
d) Soft Ferrites

6.3 Hard magnetic materials - Tungsten steel, chrome steel, hard ferrites and cobalt steel, their applications

7. Special Materials (04 Periods)

Thermocouple, bimetals, leads soldering and fuses material, mention their applications

8. Introduction of various engineering materials necessary for fabrication of electrical machines such as motors, generators, transformers etc (04 Periods)

LIST OF PRACTICALS

1. A market survey of different Electrical and Electronics materials available in market will be conducted by students. They will submit a report, which will include names, types, specifications, identification, testing of components, manufacturing details and related cost.
2. Case study/data manuals of different wires/cables/fuses/sockets etc.. A report will be submitted by the students.

INSTRUCTIONAL STRATEGY

The teacher should bring different materials, electronic components and devices in the class while taking lectures and explain and make students familiar with them. Also he may give emphasis on practical applications of these devices and components in the field. In addition, the students should be given exercises on identification of materials used in various electronic gadgets etc .and be encouraged to do practical work independently and confidently.

RECOMMENDED BOOKS

Electrical and Electronic Engineering Materials by SK Bhattacharya, Khanna Publishers, New Delhi

Electronic Components and Materials by Grover and Jamwal, Dhanpat Rai and Co., New Delhi

Electrical Engineering Materials by Sahdev, Uneek International Publications

Electronic Components and Materials by SM Dhir, Tata Mc Graw Hill, New Delhi

Electrical Engineering Materials by PL Kapoor, Khanna Publishers, New Delhi

Electrical and Electronics Engineering Materials BR Sharma and Others, Satya Parkashan, New Delhi

Electrical and Electronics Engineering Materials DR Arora, Ishan Publications, Ambala City

Electrical Engineering Materials by Rakesh Dogra, SK Kataria and Sons, NEW Delhi

SUGGESTED DISTRIBUTION OF MARKS

Topic	Time Allotted (Period)	Marks Allocation (%)
1	03	05
2	12	20
3	05	05
4	12	20
5	13	25
6	11	15
7	04	05
8	04	05
Total	**64**	**100**

3.3 ELECTRONICS DEVICES AND CIRCUITS

	L	P
Periods/week	5	3

RATIONALE

At present, electronics gadgets are being extensively used in various manufacturing processes in industries, power system operations, communication systems, computers etc. Even for an electrical diploma holder, it is absolutely necessary to have a basic understanding of electronic components, their function and applications. This understanding should facilitate in operation and maintenance equipment, which are electronically controlled.

In this course, topics like semi-conductor theory, semi-conductor Diodes, Bipolar transistors, rectifiers, single stage and multistage amplifiers and field effect transistors have been included.

DETAILED CONTENTS

1. Introduction (04 Periods)

   1.1 Brief history of development of electronics
   1.2 Active and passive components

2. Semi-conductor Theory (10 Periods)

   2.1 Atomic structure, crystalline structure
   2.2 Energy band theory of crystals, energy band structure of insulator, semiconductor and conductor, generation and recombination of electron hole pairs. Energy band structure of Silicon and Germanium
   2.3 Concept of Doping, intrinsic and extrinsic semiconductors
   2.4 Effect of temperature on intrinsic and extrinsic semiconductors

3. Semiconductor Diodes (14 Periods)

   3.1 PN Junction, mechanism of current flow in PN junction, drift and diffusion currents, depletion layer, potential barrier, effect of forward and reverse biasing in a PN junction. Concept of junction capacitance in forward and reverse biased conditions. Breakdown mechanism
   3.2 Ideal diode, Semiconductor diode characteristics, static and dynamic resistance
   3.3 Use of diode as half wave and full wave rectifiers (centre tapped and bridge type), ripple factor, rectifier efficiency
   3.4 Operation of filter circuits
   3.5 Diode ratings/specifications
   3.6 Various types of diodes such as zener diode, varactor diode, Schottky diode, light emitting diode, tunnel diode, photo diode; their working characteristics and applications
   3.7 Use of zener diode for voltage stabilization

4. Bi-polar Transistors (10 Periods)

   4.1 Concept of junction transistor, PNP and NPN transistors, their symbols and mechanism of current flow
   4.2 Transistor configurations: common base (CB), common emitter (CE) and common collector (CC), current relation and their input/output characteristics; comparison of the three configurations

5. Transistor Biasing and Stabilization (12 Periods)

5.1 Transistor biasing, its need, operating point, effect of temperature on the operating point of a transistor and need of stabilization of operating point.
5.2 Different biasing circuits, limitations
5.3 Use of data book to know the parameters of a given transistor

6. Single-Stage Transistor Amplifiers (10 Periods)

6.1 Single stage transistor amplifier circuit in CE configuration, function of each component
6.2 Working of single stage transistor amplifier, physical and graphical explanation, phase reversal
6.3 Frequency response of a single stage transistor amplifier

7. Multi-Stage Transistor Amplifiers (08 Periods)

7.1 Need of multi-stage transistor amplifiers – different types of couplings, their purpose and applications.
7.2 RC coupled two-stage amplifiers, circuit details, working, frequency response, applications
7.3 Loading effect in multistage amplifiers
7.4 Elementary idea about direct coupled amplifier, its limitations and applications
7.5 Transformer coupled amplifiers, its frequency response.

8. Field Effect Transistor (FET) (06 Periods)

8.1 Construction, operation, characteristics and applications of a N channel JFET and P channel JFET
8.2 JFET as an amplifier
8.3 Types, construction, operation, characteristics and applications of a MOSFET
8.4 Comparison between BJT, JFET and MOSFET

9 Operational Amplifiers (08 period)

- Characteristics of an ideal operational amplifier and its block diagram
- Definition of differential voltage gain, CMRR, PSRR, slew rate and input offset current
- Operational amplifier as an inverter, scale changer, adder, subtractor, differentiator, and integrator

LIST OF PRACTICALS

1. a) Identification and testing of electronic components such as resistor, inductor, capacitor, diode, transistor and different types of switches used in Electronic circuits

b) Measurement of resistances using multimeter and their comparison with colour code values

2. V-I characteristics of a Semiconductor diode and to calculate its static and dynamic resistance
3. a) V-I characteristics of a zener diode and finding its reverse breakdown voltage
   b) Fabrication of a zener diode voltage stabilizer circuit using PCB
4. Observation of input and output wave shapes of a half-wave rectifier
5. Observation of input and output wave shapes of a full wave rectifier
6. Plotting input and output characteristics of a transistor in CB configuration
7. Plotting input and output characteristics of a transistor in CE configuration
9. To study the effect of coupling capacitor on lower cut off frequency and upper cut off frequency by plotting frequency response curve of a two stage RC coupled amplifier
10. To plot V-I characteristics of a FET
11. To use IC 741 (op-amplifier) as

    i) Inverter, ii) Adder, iii) Subtractor iv) Integrator

INSTRUCTIONAL STRATEGY

This subject gives the knowledge of fundamental concepts of basic electronics. The teacher should give emphasis on understanding of concepts and various term used in the subject. The students be made familiar with diodes, transistors, resistors, capacitors, inductors etc. and electrical measuring instruments etc. Practical exercises will reinforce various concepts. Application of Semiconductor Diodes, Transistors, Field Effect Transistors etc must be told to students.

RECOMMENDED BOOKS

1. Basic Electronics and Linear Circuit by NN Bhargava, Kulshreshta and SC Gupta, Tata McGraw Hill Education Pvt Ltd, New Delhi
2. Electronic Principles by SK Sahdev, Dhanpat Rai & Co., New Delhi
3. Principles of Electrical and Electronics Engineering by VK Mehta; S Chand and Co., New Delhi
4. Electronic Components and Materials by SM Dhir, Tata McGraw Hill Publishing Company Pvt Ltd, New Delhi
5. Principles of Electronics by SK Bhattacharya and Renu Vig, SK Kataria and Sons, Delhi
6. Electronics Devices and Circuits by Millman and Halkias; McGraw Hill

7. Principles of Electronics by Albert Paul Malvino; Tata McGraw Hill Education Pvt Ltd, New Delhi
8. Basic Electronics – Problems and Solutions by Albert Malvino and David J. Bates; Tata McGraw Hill Education Pvt Ltd, New Delhi
9. Basic Electronics by J.S. Katre, Sandeep Bajaj, Tech. Max. Publications, Pune
10. Analog Electronics by DR Arora, Ishan Publications, Ambala City
11. Analog Electronics by JC Karhara, King India Publication, New Delhi
12. Electrical Devices and Circuits by Rama Reddy, Narosa Pulishing House Pvt. Ltd., New Delhi
13. Electronic Devices and Circuits by Dharma Raj Cheruku and Battula Tirumala Krishna: Pearson Education (Singapore) Pvt Ltd., Indian Branch, 482 F.I.E Patparganj, Delhi- 92
14. Basic Electronics by JB Gupta, SK Kataria and Sons, New Delhi
15. Grob's Basic Electronics- A text Lab Manual (Special Indian Edition) by Schultz, Tata McGraw Hill Education Pvt Ltd, New Delhi

SUGGESTED DISTRIBUTION OF MARKS

Topic	Time Allotted (Period)	Marks Allocation (%)
1	04	05
2	10	10
3	14	20
4	10	10
5	12	15
6	10	10
7	08	10
8	06	10
9	06	10
Total	**80**	**100**

3.4 FUNDAMENTALS OF MECHANICAL AND CIVIL ENGINEERING

	L	T	P
Periods/week	5	-	3

RATIONALE

A diploma holder has to assist in activities of installation, operation and maintenance etc of different machines and equipment. These activities are not branch specific and instead require him to know basics of civil and mechanical engineering. The subject of Fundamentals of Mechanical and Civil Engineering has been included to impart basic knowledge of Civil and Mechanical engineering to the students.

DETAILED CONTENTS
PART-A

MECHANICAL ENGINEERING

Theory

1. Transmission of Power (20 Periods)

    1.1 Transmission of power through belt, rope drives and pulleys, gears and chains
    1.2 Different type of pulleys and their application
    1.3 Chain drives and its comparison with belt drive
    1.1 Gear drives, types of gears, simple gear trains and velocity ratio

2. Air Conditioning System (24 Periods)

    2.1 Basic principle of refrigeration and air conditioning
    2.2 Working of centralized air conditioner
    2.3 Concept of split air conditioner and its applications

3. Pumps - Types and their uses (06 Periods)

PART B

CIVIL ENGINEERING

Theory

4. Construction Materials (12 Periods)

    Properties and uses of various construction materials such as stones, bricks, lime, cement and timber along with their properties, physical/ field testing and uses, elements of brick masonry

5. Foundations (08 Periods)

    i) Bearing capacity of soil and its importance
    ii) Types of various foundations and their salient features, suitability of various foundations for heavy, light and vibrating machines

6. Concrete (06 Periods)

Various ingredients of concrete, different grades of concrete, water cement ratio, workability, physical/ field testing of concrete, mixing of concrete

7. RCC (04 Periods)

Basics of reinforced cement concrete and its use (elementary knowledge), introduction to various structural elements of a building

LIST OF PRACTICLES

1. Observe operation of a centrifugal pump and location of common faults
2. Decide the type of foundation too be used for various types of electrical machinery and installation. Prepare a foundation for installation of a motor/ generator.
3. Identify various types of drives used in an IC engines and describe their function
4. Observe operation of air conditioning system. Identify locations of faults.
5. Trace the various paths of hot gases, cool gases, control system in a split air conditioner model. Identify the possible location of faults/ malfunctioning.

INSTRUCTIONAL STRATEGY

Teachers should lay emphasis on basic principles and use charts in class, visits to Labs and industry may be arranged to demonstrate certain materials and practices.

RECOMMENDED BOOKS

Mechanical Engineering

1. General Mechanical Engineering by M. Adithan; TTTI, Chandigarh

2. Basic Civil and Mechanical Engineering by Jayagopal; Vikas Publications, New Delhi

3. IC Engines and Automobile Engineering by Dr.MP Poonia, Standard Publishers, New Delhi

4. Refrigeration and Air Conditioning by RK Rajput; SK Kataria and sons; Ludhiana

5. Theory of Machines by RS Khurmi and JK Gupta; S. Chand and Company Ltd., New Delhi

Civil Engineering

1. Textbook of Concrete Technology 2nd Edition by Kulkarni, PD Ghosh RK and Phull, YR; New Age International (P) Ltd., Publishers, New Delhi
2. Materials of Construction by Ghose; Tata McGraw Hill Publishing Co., Ltd., New Delhi
3. Civil Engineering Materials by TTTI, Chandigarh; Tata McGraw Hill Publishing Co. Ltd., New Delhi
4. Concrete Technology by Gambhir; Tata McGraw Hill Publishing Co., Ltd., New Delhi
5. Building Construction by J Jha and Sinha; Khanna Publishers, Delhi
6. Building Construction by Vazirani and Chandola; Khanna Publishers, New Delhi Delhi
7. Civil Engineering Materials by SV Deodhar and Singhai; Khanna Publishers, New Delhi Delhi
8. Soil Mechanics and foundation Engineering by SK Garg; Khanna Publishers, New Delhi Delhi

SUGGESTED DISTRIBUTION OF MARKS

Topic No.	Time Allotted (Period)	Marks Allotted (%)
1	20	17
2	24	27
3	06	06
4	12	25
5	08	10
6	06	08
7	04	07
Total	**80**	**100**

3.5 ELECTRICAL MEASURMENT AND MEASURING INSTRUMENTS

	L	P
Periods/week	5	3

RATIONALE

Diploma holders in Electrical Engineering have to work on various jobs in the field as well as in testing laboratories and on control panels, where be performs the duties of installation, operation, maintenance and testing by measuring instruments. Persons working on control panels in power plants, substations and in industries, will come across the use of various types of instruments and have to take measurements.

Instruments used to read and observe the general electrical quantities like current, voltage, power, energy, frequency, resistance etc and their wave shapes, have been incorporated in this subject. So the technician will know the construction and use of various types of electrical instruments.

DETAILED CONTENTS

1. Introduction to Electrical Measuring Instruments (07 Periods)

    1.1 Concept of measurement and measuring instruments
    1.2 Types of electrical measuring instruments – indicating, integrating and recording type instruments
    1.3 Essentials of indicating instruments – deflecting, controlling and damping torque

2. Ammeters and Voltmeters (Moving coil and moving iron type) (15 Periods)

    2.1 Concept of ammeters and voltmeters and difference between them
    2.2 Extension of range of voltmeters and ammeter
    2.3 Construction and working principles of moving Iron and moving coil instruments
    2.4 Merits and demerits, sources of error and application of these instruments

3. Wattmeters (Dynamometer Type) (06 Periods)

    Construction, working principle, merits and demerits of dynamometer type wattmeter, sources of error

4. Energy meter (Induction type) (08 Periods)

    Construction, working principle, merits and demerits of single-phase and three-phase energy meters

    4.1 Errors and their compensation

    4.2 Simple numerical problems

    4.3 Construction and working principle of maximum demand indicators

5. Miscellaneous Measuring Instruments (22 Periods)

5.1 Construction, working principle and application of Meggar, Earth tester, Multimeter, Frequency meter (dynamometer type) single phase power factor meter (Electrodynamometer type). Working principle of synchroscope and phase sequence indicator, tong tester (Clamp-on meter), signal generator, AC milivoltmeter, tachometer

5.2 Instrument Transformers: Construction, working and applications
a) CT
b) PT and their ratio and phase angle error

6. Electronic Instruments (10 Periods)

6.1 Cathode Ray Oscilloscope: Block diagram, working principle of CRO and its various controls. Applications of CRO

6.2 Digital multi-meter, basic principle, constructional brief, display system

7. LCR meters (07 Periods)

Study of LCR meter and its applications
Digital LCR and Q meter

8. Power Measurements in 3-Phase Circuits by (05 Periods)

(i) 2 wattmeter method in balanced and unbalanced circuits and simple problems
(ii) Three wattmeter method

LIST OF PRACTICALS

1. Use of analog and digital multimeter for measurement of voltage, current (a.c/d.c) and resistance.
2. To calibrate 1-phase energy meter by direct loading method.
3. To measure the value of earth resistance using earth tester.
4. To measure power, power factor in a single-phase circuit, using wattmeter and power factor meter and to verify results with calculations.
5. Measurement of power and power factor of a three-phase balanced load by two wattmeter method.
6. Measurement of voltage and frequency of a sinusoidal signal using CRO time base as well as Lissagous pattern and draw wave shape of signal.
7. Measurement of power in a 3 phase circuit using CT, PT and 3-phase wattmeter.
8. Use of LCR meter, digital LCR meter for measuring inductance, capacitance and resistance.
9. To record all electrical quantities from the meters installed in the institution premises.
10. To measure Energy at different Loads using Single phase Digital Energy meter.

INSTRUCTIONAL STRATEGY

After making the students familiar with measuring instruments, they should be made conceptually clear about the constructional features and make them confident in making connection of various measuring instruments. Teacher should demonstrate the application of each measuring instrument in laboratory and encourage students to use them independently.

RECOMMENDED BOOKS

1. Electrical Measurements and Measuring Instruments by Golding and Widdis; Wheeler Publishing House, New Delhi
2. Electrical Measurements and Measuring Instruments by SK Sahdev, Unique International Publications, Jalandhar
3. A Course in Electrical Measurement and Measuring Instruments by AK Sawhney and PL Bhatia; Dhanpat Rai and Sons, New Delhi
4. Electric Instruments by D. Cooper
5. Experiments in Basic Electrical Engineering by SK Bhattacharya and KM Rastogi, New Age International (P) Ltd., Publishers, New Delhi
6. Electronics Instrumentation by Umesh Sinha, Satya Publication, New Delhi
7. Basic Electrical Measurements by Melville B. Staut
8. Electrical Measurement and Measuring Instruments by JB Gupta, SK Kataria and Sons, New Delhi
9. Electrical Measurement and Measuring Instruments by ML Anand, SK Kataria and Sons, New Delhi

SUGGESTED DISTRIBUTION OF MARKS

Topic	Time Allotted (Period)	Marks Allocation (%)
1	07	10
2	15	20
3	06	05
4	08	10
5	22	25
6	10	10
7	07	10
8	05	10
Total	**80**	**100**

3.6 ELECTRICAL WORKSHOP PRACTICE

	L	P
Periods/week	-	6

RATIONALE

An electrical diploma holder will be required to inspect, test and modify the work done by skilled workers working under him. In addition, many a times, it will become necessary for him to demonstrate the correct method and procedure of doing a job. In order to carry out this function effectively, in addition to conceptual understanding of the method or procedure, he must possess appropriate manual skills. The subject aims at developing special skills required for repairing, fault finding, wiring in electrical appliances and installations.

DETAILED CONTENTS

1. Study of electrical safety measures as mentioned in the Electricity Rules and shock treatment including first aid

2. Types of wiring and to make different light control circuits in the following types of wiring Casing and capping, (PVC) conduct, baten wiring

3. Study of ISI standard for MCBs and ELCBs Conduct one test on MCB on above basis

4. Wiring of main distribution board with four outgoing circuits for light and fan loads including main switch and MCBs Types of wiring and to make different light control circuits in the following types of wiring.

   4.1 Casing and Capping (PVC) wiring
   4.2 Conduit wiring (surface/concealed)

5. Construction of distribution and extension board with two 5A sockets and two I5A sockets, a fuse and indicator with series test lamp provision controlled by their respective switches.

6. Testing of domestic wiring installation using meggar.

7. Fault finding and repair of a tube light circuit.

8. Carry out pipe/ plate earthing for a small house and 3 phase induction motor. Testing the earthing using earth tester.

9. Connection of single phase and three phase motors through an appropriate starter.

10. Winding/ rewinding of a fan (ceiling and table) and choke.

11. Repair of domestic electric appliances such as electric iron, geyser, fan, heat convector, desert cooler, room heater, electric kettle, electric oven, electric furnace and weighing machine.

Note: Students may be asked to study control circuit of a passenger lift, automatic milling machine, etc. using relays.