Electrical Engineering

4.1 ELECTRICAL MACHINES - I

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RATIONALE

Electrical machines is a subject where a student will deal with various types of electrical machines which are employed in industries, power stations, domestic and commercial appliances etc. After studying this subject, an electrical diploma holder must be competent to repair and maintain these machines and give suggestions to improve their performance. Practical aspects of the subject will make the students capable of performing various tests on the machines as per latest BIS specifications

DETAILED CONTENTS

1. Introduction to Electrical Machines (6 hrs)

    1.1 Definition of motor and generator
    1.2 Torque development due to alignment of two fields and the concept of torque angle
    1.3 Electro-magnetically induced emf
    1.4 Elementary concept of an electrical machine
    1.5 Comparison of generator and motor
    1.6 Generalised theory of electrical machines

2. DC Machines (24 hrs)

    2.1 Main constructional features, Types of armature winding
    2.2 Function of the commutator for motoring and generation action
    2.3 Factors determining induced emf
    2.4 Factors determining the electromagnetic torque
    2.5 Significance of types of machines
    2.6 Significance of back e.m.f., the relation between back emf and Terminal voltage
    2.7 Armature Reaction
    2.8 Methods to improve commutation
    2.9 Performance and characteristics of different types of DC motors
    2.10 Speed control of dc shunt/series motors
    2.11 Need of starter, three point dc shunt motor starter and 4 point starter
    2.12 Applications of DC motors
    2.13 Faults in dc machines and their retrospective
    2.14 Losses in a DC machine
    2.15 Determination of losses by Swinburne's test

3. Transformers (single phase) (24 hrs)

    3.1 Introduction
    3.2 Constructional features of a transformer and parts of transformer

3.3 Working principle of a transformer
3.4 EMF equation
3.5 Transformer on no-load and its phasor diagram
3.6 Transformer – neglecting voltage drop in the windings – Ampere turn balance – its phasor diagram
3.7 Mutual and leakage fluxes, leakage reactance
3.8 Transformer on load, voltage drops and its phasor diagram
3.9 Equivalent circuit
3.10 Relation between induced emf and terminal voltage, regulation of a transformer-mathematical relation
3.11 Losses in a transformer
3.12 Open circuit and short circuit test. Calculation of efficiency, condition for maximum efficiency-maintenance of Transformer, scheduled Maintenance
3.13 Auto transformer construction, working and applications
3.14 Different types of transformers including dry type transformer.

4. Transformers three phase (10 hrs)

4.1 Construction of three phase transformers and accessories of transformers such as Conservator, breather, Buchholtg Relay, Tap Changer (off load and on load) (Brief idea)
4.2 Types of three phase transformer i.e. delta-delta, delta-star, star-delta and star-star
4.3 Conditions for parallel operation (only conditions are to be studied)
4.4 On load tap changer
4.5 Difference between power and distribution transformer
4.6 Cooling of transformer

LIST OF PRACTICALS

1. To measure the angular displacement of rotor of the three phase synchronous machine with respect to the stator on application of DC to the field winding and simultaneously to each phase-winding in sequence

OR

Measurement of the angular displacement of the rotor of a slip-ring induction motor on application of DC to stator of motor winding in sequence and simultaneously to each phase of rotor winding

2. Speed control of dc shunt motor (i) Armature control method (ii) Field control method
3. Study of dc series motor with starter (to operate the motor on no load for a moment)
4. Determination of efficiency of DC motor by Swinburne's Test at (i) rated capacity (ii) half full load
5. To perform open circuit and short circuit test for determining: (i) equivalent circuit (ii) the regulation and (iii) efficiency of a transformer from the data obtained from open circuit and short circuit test at full load

6. To find the efficiency and regulation of single phase transformer by actually loading it.
7. Checking the polarity of the windings of a three phase transformer and connecting the windings in various configurations
8. Finding the voltage and current relationships of primary and secondary of a three phase transformer under balanced load in various configurations conditions such as
   (a) Star-star
   (b) Star delta
   (c) Delta star
   (d) Delta - Delta configuring conditions.

INSTRUCTIONAL STRATEGY

Electrical machines being a core subject of electrical diploma curriculum, where a student will deal with various types of electrical machines which are employed in industry, power stations, domestic and commercial appliances etc. After studying this subject, an electrical diploma holder must be competent to repair and maintain these machines and give suggestions to improve their performance. Special care has to be taken on conceptual understanding of concepts and principles in the subject. For this purpose exposure to industry, work places, and utilization of various types of electrical machine for different applications may be emphasized. Explanation of practical aspects of the subject will make the students capable of performing various tests on the machines as per latest BIS specifications.

RECOMMENDED BOOKS

Electrical Machines by SK Bhattacharya, Tata Mc Graw Hill, Education Pvt Ltd. New Delhi

Electrical Machines by SK Sahdev, Uneek Publications, Jalandhar

Electrical Machines by Nagrath and Kothari, Tata Mc Graw Hill, New Delhi

Electrical Machines by JB Gupta, SK Kataria and Sons, New Delhi

Electrical Machines by Fitzgerald

Electrical Machines by Smarajit Ghosh-Pearson Publishers, Delhi.

SUGGESTED DISTRIBUTION OF MARKS FOR FACILITATING THE PAPER SETTER

Sr. No	Topic	Time Allotted (Hrs)	Marks Allocation (%)
1	Introduction to Electrical Machine	6	10
2	DC Machines	24	40
3	Transformers (single phase)	24	35
4	Transformers three phase	10	15
	Total	**64**	**100**

4.2 ELECTRICAL MEASURING INSTRUMENTS AND INSTRUMENTATION

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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: (10 hrs)

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

2. Ammeters and Voltmeters (Moving coil and moving iron type): (8 hrs)

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

3. Wattmeters (Dynamometer Type) (4 hrs)

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

4. Energymeter (Induction type): (6 hrs)

    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: (12 hrs)

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)

5.2 Instrument Transformers: Construction, working and applications

a) CT

b) PT and their ratio and phase angle error

6. Electronic Instruments: (6 hrs)

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

6.2 Digital multi-meter (only block diagram) and Applications

7. LCR meters. (4 hrs)

Study of LCR meters and their applications

8. Power Measurements in 3-phase circuits by (6 hrs)

(i) 2 wattmeter method in balanced and imbalanced circuits and simple problems

(ii) Three wattmeter method

Measurement of Non-electrical Quantities (Introduction only) (4 hrs)

Basic concept of pressure measurement, flow measurement, level measurement, displacement measurement using transducers

Measurement of Temperature (4 hrs)

Different types of thermometers, thermocouple, resistance temperature detector and their construction, principle and working.

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 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 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 FOR FACILITATING THE PAPER SETTER

Sr. No	Topic	Time Allotted (hrs)	Marks Allocation (%)
1	Introduction to Electrical Measuring Instruments	10	15
2	Ammeters and Voltmeters	8	15
3	Watt Meter	4	5
4	Energy Meter	6	10
5	Miscellaneous Measuring Instruments:	12	20
6	Electronic Instruments:	6	10
7	LCR Meters	4	5
8	Power Measurements in 3-phase circuits	6	10
9	Measurement of Non-electrical quantities	4	5
10	Measurement of Temperature	4	5
	Total	**64**	**100**

4.3 ELECTRONICS - II

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RATIONALE

The purpose of the introduction of electronics in the electrical engineering diploma course has been already explained in the rationale of the subject Basic Electronics in this course topic like Amplifiers, Oscillators and Wave Shape Circuits have been dealt with.

DETAILED CONTENTS

1. Transistor Audio Power Amplifier (12 hrs)

   1.1 Difference between voltage and power amplifier
   1.2 Important terms in Power Amplifier, collector efficiency, distortion and dissipation capability
   1.3 Classification of power amplifier class A, B and C
   1.4 Class A single-ended power amplifier, its working and collector efficiency
   1.5 Impedance matching in a power amplifier using transformer
   1.6 Heat sinks in power amplifiers
   1.7 Push-pull amplifier: circuit details, working and advantages (no mathematical derivations)
   1.8 Principles of the working of complementary symmetry push-pull amplifier

2. Tuned Voltage Amplifier (8 hrs)

   2.1 Introduction
   2.2 Series and parallel resonance (No mathematical derivation)
   2.3 Single and double tuned voltage amplifiers
   2.4 Frequency response of tuned voltage amplifiers
   2.5 Applications of tuned voltage amplifiers

3. Feedback in Amplifiers (8 hrs)

   3.1 Feedback and its importance, positive and negative feedback and their need
   3.2 Voltage gain of an amplifier with negative feedback $A = \frac{A}{1+\beta A}$
   3.3 Effect of negative feedback on voltage gain, stability, distortion, band width, output and input impedance of an amplifier (No mathematical derivation)
   3.4 Typical feedback circuits
   3.5 Effect of removing the emitter by-pass capacitor on a CE transistor amplifier
   3.6 Emitter follower and its applications

4. Sinusoidal Oscillators (8 hrs)

4.1. Sinusoidal Oscillators – positive feedback in amplifiers
4.2. Difference between an oscillator and an alternator
4.3. Essentials of an oscillator
4.4. Circuit details and working of LC oscillators viz. Tuned Collector, Hartley and Colpitt's oscillators
4.5. R-C oscillator circuits, phase shift and Wein bridge oscillator circuits
4.6. Introduction to piezoelectric crystal and crystal oscillator circuit

5. Wave-Shaping and Switching Circuits (15 hrs)

5.1 Concept of Wave-shaping
5.2 Wave-shaping circuits
  a. R-C differentiating and integrating circuits
  b. Diode clipping circuits
  c. Diode clamping circuits
  d. Applications of wave-shaping circuits
5.3 Transistor as a switch (explanation using CE transistor characteristics)
5.4 Collector coupled astable, monostable, bistable multivibrator circuits (explanation using wave shapes). Brief mention of uses of multivibrators
5.5 Working and applications of transistor inverter circuit using power transistors

Power supplies: (5 hrs)

Working Principles of different types of power supplies viz. CVTs, UPS, Stabilizers, SMPS, IC voltage regulator (78 XX,79XX)

7. Operational Amplifier (8 hrs)

7.1. The basic operational amplifier. The differential amplifier. The emitter coupled differential amplifier. Offset even voltages and currents
7.2. Basic operational amplifier applications, analog integrator and differentiator
7.3. Familiarization with specifications and pin configuration of IC 741
7.4. Block diagram and operation of 555 IC timer

LIST OF PRACTICALS

1. To measure (a) optimum load (b) output power (c) signal handling capacity of a push-pull amplifier
2. To observe the effect of negative current feedback on the voltage gain of a single stage transistor amplifier by removing emitter bye-pass capacitor.
3. To measure (a) voltage gain (b) input and output impedance for an emitter follower circuit
4. To measure frequency generation in (a) Hartley (b) R-C Phase Shift oscillator
5. To observe the differentiated and integrated square wave on a CRO for different values of R-C time constant

6. Clipping of both portion of sine-wave using:
    a) diode and dc source
    b) zener diodes

   Clamping a sine-wave to:
    a) Negative dc voltage
    b) Positive dc voltage
7. To generate square-wave using an astable multivibrator and to observe the wave form on a CRO
8. To observe triggering and working of a bistable multivibrator circuit and observe its output wave form on a CRO
9. To use the op-Amp (IC 741) as inverting one and non-inverting amplifiers, adder, comparator, integrator and differentiator
10. To study the pin configuration and working of IC 555 and its use as monostable and astable multivibrator
11. To realize the regulated power supply by using three terminal voltage regulator ICs such as 7805, 7905, 7915 etc.

INSTRUCTIONAL STRATEGY

The teacher should bring 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 encouraged to do practical work independently and confidently.

RECOMMENDED BOOKS

1. A text book of Basic Electronics and Linear Circuits by NN Bhargava and others, Tata McGraw Hill, New Delhi
2. Electronics Principles by SK Sahdev, Dhanpat Rai and Co., New Delhi
3. Electronics Principles by Albert Paul Malina, Tata McGraw Hill, New Delhi
4. Operational Amplifiers and Linear Circuits by Rama Kant and A. Gaykwad, Prentice Hall of India, New Delhi
5. Electronic Devices Circuits by Rama Reddy, Narosa Publishing House Pvt. Ltd., New Delhi
6. Electronic Devices and Circuits by Millman and Halkias, McGraw Hill, New Delhi
7. Analog Electronics – II by DR Arora, Ishan Publication, Ambala
8. Electronic Devices and Circuits by JC Karhara, King India Publication, New Delhi
9. Electronic Devices and Circuits-I, Eagle Prakashan, Jalandhar
10. Electronic Devices Circuits by JB Gupta, SK Kataria and Sons, New Delhi

SUGGESTED DISTRIBUTION OF MARKS FOR FACILITATING THE PAPER SETTER

Sr. No	Topic	Time Allotted (hrs)	Marks Allocation (%)
1	Transistor Audio Power Amplifier	12	20
2	Tuned Voltage Amplifier	8	10
3	Feedback in Amplifiers	8	10
4	Sinusoidal Oscillators	8	10
5	Wave-Shaping and Switching Circuits	15	30
6	Power Supplies	5	10
7	Operational Amplifier	8	10
	Total	**64**	**100**

4.4 ESTIMATING AND COSTING IN ELECTRICAL ENGINEERING

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RATIONALE

A diploma holder in electrical engineering should be familiar to Indian Standards and relevant Electricity Rules. Preparation of good estimates is a professional's job, which requires knowledge of materials and methods to deal with economics. The contents of this subject have been designed keeping in view developing requisite knowledge and skills of estimation and costing in students of diploma in electrical engineering.

DETAILED CONTENTS

1. Introduction (8 hrs)

Purpose of estimating and costing, proforma for making estimates, preparation of materials schedule, costing, price list, preparation of tender document (with 2-3 exercises), net price list, market survey, overhead charges, labour charges, electrical point method and fixed percentage method, contingency, profit, purchase system, enquiries, comparative statements, orders for supply, payment of bills. Tenders – its constituents, finalization, specimen tender.

2. Types of wiring (8 hrs)

Cleat, batten, casing capping and conduit wiring, comparison of different wiring systems, selection and design of wiring schemes for particular situation (domestic and Industrial). Selection of wires and cables, wiring accessories and use of protective devices i.e. MCB, ELCB etc. Use of wire-gauge and tables (to be prepared/arranged)

3. Estimating and Costing:
(20 hrs)

3.1 Domestic installations; standard practice as per IS and IE rules. Planning of circuits, sub-circuits and position of different accessories, electrical layout, preparing estimates including cost as per schedule rate pattern and actual market rate (single storey and multi-storey buildings having similar electrical load)

3.2 Industrial installations; relevant IE rules and IS standard practices, planning, designing and estimation of installation for single phase motors of different ratings, electrical circuit diagram, starters, preparation of list of materials, estimating and costing exercises on workshop with singe-phase, 3-phase motor load and the light load (3-phase supply system)

3.3 Service line connections estimate for domestic and Industrial loads (over-head and under ground connections) from pole to energy meter.

4. Estimating the material required for (12 hrs)

a) Transmission and distribution lines (overhead and underground) planning and designing of lines with different fixtures, earthing etc. based on unit cost calculations

b) Substation: Types of substations, substation schemes and components, estimate of 11/0.4 KV pole mounted substation up to 200 KVA rating, earthing of substations, Key Diagram of 66 KV/11KV Substation.

Single line diagram, layout sketching of outdoor, indoor 11kV sub-station or 33kV sub-station

INSTRUCTIONAL STRATEGY

Teacher should identify/prepare more exercises on the pattern shown above. The teacher should make the students confident in making drawing and layouts of electrical wiring installations and doing estimation and costing leading to preparation of small tender document.. This capability will lead the students to become a successful entrepreneur. Take the students to field/laboratory and show the material and equipment.

RECOMMENDED BOOKS

1. Electrical Installation, Estimating and Costing by JB Gupta, SK Kataria and Sons, New Delhi

2. Estimating and Costing by SK Bhattacharya, Tata McGraw Hill, New Delhi
3. Estimating and Costing by Surjeet Singh, Dhanpat Rai & Co., New Delhi
4. Estimating and Costing by Qurashi
5. Estimating and Costing by SL Uppal, Khanna Publishers, New Delhi
6. Electrical Estimating and Costing by N Alagappan and B Ekambaram, TMH, New Delhi

SUGGESTED DISTRIBUTION OF MARKS FOR FACILITATING THE PAPER SETTER

Sr. No	Topic	Time Allotted (hrs)	Marks Allocation (%)
1	Introduction	8	15
2	Types of wiring	8	15
3	Estimating and Costing	20	40
4	Estimating the material required for	12	30
	Total	**48**	**100**

4.5 PC MAINTENANCE AND REPAIR

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RATIONALE

PC is a tool that defines today current age and culture. A right understanding about any tool is required to use it effectively. There has been a complete revolution in this area because of rapid advancement in the field of electronics. The PC is the most logical and modern machine and is no more difficult to understand its functions. It is very important to learn the various components of PC and how these parts work together. All technically trained individuals must understand the general nature of PC operation of memory, I/O techniques, interfacing applications etc. Looking at the importance and usefulness, this subject has been included in the curriculum.

DETAILED CONTENTS

Note:

Since this is a practical type subject, there will be no theory examination. List of practicals are listed below:

LIST OF PRACTICALS

1. Introduction to Computer hardware components
2. Familiarization with PC assembling and dissembling.
3. BIOS configuration and settings.
4. Installation of Hard-Disk drive including partitioning and formatting.
5. Familiarization with cables i.e. co-axial, UTP and fiber-optic cable and their installation
6. Installation and configuration of dial-up networking for Broad band internet
7. Installation of Windows Operating Systems
8. How to make an E-mail-ID on internet.
9. Installation of a printer on different operating systems
10. Virus – removal and use of anti-virus down loads etc.
11. Installation of
    - (a) CD or DVD Drive
    - (b) Sound card, Speaker and headphone
    - (c) Printer drivers
    - (d) Software
12. Downloading of various software
13. Recognition of USB port and other parts like thumb drive or Card Reader etc.
14. (a) Replacement of RAM
    - (b) Replacement of Power Supply

RECOMMENDED BOOKS

1. Hardware Bible ; Winn. L. Rosch, Techmedia
2. PC Maintenance and Repair by Mohit Sofat; Ishan Publications, Ambala
3. The complete PC Upgrade and Maintenance Guide, Mark Minasi, BPB Publications, New Delhi
4. Computer Networks, A. Tanenbaum, PHI Ltd., New Delhi
5. PC Maintenance and Troubleshooting by “Biglow”
6. PC Upgrading, Maintenance and Troubleshooting Guide by SK Chouhan ; SK Kataria and Sons, New Delhi

4.6 ELECTRICAL WORKSHOP PRACTICE – II

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RATIONALE

An electrical diploma holder will be required to inspect, test and modify the work done by skilled workers or artisans working under him. In addition to these persons, 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, faultfinding, wiring in electrical appliances and installations.

DETAILED CONTENTS

1. To carry out pipe/plate earthing for a small house and 3-phase induction motor. Testing the earthing using earth tester

2. Connections of single phase and 3-phase motors, through an appropriate starter and to change their direction of rotation

3. Wiring, testing and fault finding of the following contactor control circuits operating on 3-phase supply:

    a) Remote control circuits
    b) Time delay circuits
    c) Inter locking circuits
    d) Sequential operation control circuits

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

4. Winding/re-winding of a fan (ceiling and table) and choke

5. Power cable jointing using epoxy based jointing kits

6. Demonstration of laying of underground cables at worksite

7. Dismantling/assembly of star-delta and DOL starter

8. Dismantling and assembly of voltage stabilizers

9. Repair and maintenance of domestic electric appliances, i.e. electric iron, geyser, fan, heat convector, desert cooler, room heater, electric kettle, electric oven, electric furnace etc.

10. Dismantling/assembly/maintenance of motor operated appliances such as mixer, blender, drill machine etc.