

## 4.1 ELECTRICAL MACHINES-I

L. T. P  
4 - 3

### 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 equation  |          |
|    | 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 Performance and characteristics of different types of DC motors                   |          |
|    | 2.8 Speed control of dc shunt/series motors   |          |
|    | 2.9 Need of starter, three point dc shunt motor starter and 4 point starter           |          |
|    | 2.10 Applications of DC motors  |          |
|    | 2.11 Faults in dc machines and their retrospective                                    |          |
|    | 2.12 Losses in a DC machine   |          |
|    | 2.13 Determine of loses by Swimburn 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 on load (including voltage drops and its phasor diagram)
  - 3.7 Transformer – neglecting voltage drop in the windings – Ampere turn balance – its phasor diagram
  - 3.8 Mutual and leakage fluxes, leakage reactance
  - 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 for efficiency, condition for maximum efficiency
  - 3.13 Cooling of transformer, conservator
  - 3.14 Auto transformer construction, working and applications
  - 3.15 Different types of transformers
4. Three phase Transformers ( 10 hrs)
- 4.1 Construction of three phase transformer
  - 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, ON/OFF load tap changer
  - 4.5 Difference between power and distribution transformer
  - 4.6 Cooling of transformer

### LIST OF PRACTICALS

1. Introduction to electrical machines

Measurement of 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. DC machines

- 2.1 Speed control of dc shunt motor (i) Armature control method (ii) Field control method
- 2.2 Study of dc series motor with starter (to operate the motor on no load for a moment)
- 2.3 Determination of efficiency of DC motor by swimbuns test at (i) rated capacity (ii) half full load

3. Transformers (single phase)
  - 3.1 To perform open circuit and short circuit test for determining equivalent circuit parameter of a transformer
  - 3.2 To determine the regulation and efficiency from the data obtained from open circuit and short circuit test at full load
4. Three-phase transformers
  - 4.1 Checking the polarity of the windings of a three phase transformer and connecting the windings in various configurations
  - 4.2 Finding the voltage and current relationships of primary and secondary of a three phase transformer under balanced load in various configurations conditions

#### **RECOMMENDED BOOKS**

1. Electrical Machines by SK Bhattacharya, Tata Mc Graw Hill, New Delhi
2. Electrical Machines by SK Sahdev, Unique International Publications, Jalandhar
3. Electrical Machines by Nagrath and Kothari, Tata Mc Graw Hill, New Delhi
4. Electrical Machines by SB Gupta, SK Kataria and Sons, New Delhi

## 4.2 ELECTRICAL MEASUREMENTS AND MEASURING INSTRUMENTS

L T P  
3 - 2

### RATIONALE

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

### DETAILED CONTENTS

1. Introduction to Electrical Measuring Instruments: (6 hrs)
  - 1.1 Concept of measurement and instruments
  - 1.2 Electrical quantities and instruments for their measurements
  - 1.3 Types of electrical measuring instruments – indicating, integrating and recording instrument
  - 1.4 Essentials of indicating instruments – deflecting, controlling and damping torque
  
2. Ammeters and Voltmeters (Moving coil and moving iron type): (6 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 compensation
  - 4.2 Simple problems
  - 4.3 Construction and working principle of maximum demand indicators

- 5 Miscellaneous Measuring Instruments: (10 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. Electronics Instruments: (5 hrs)
- 6.1 Cathode Ray Oscilloscope: Block diagram, working of CRO and its various controls. Applications of CRO.
- 6.2 Digital multi-meter (only block diagram)
7. LRC meters. (3 hrs)
8. Power Measurements in 3-phase circuits: (2 hrs)
- 8.1 Three wattmeter method
- 8.2 Two watt meter method
9. Measurement of Non-electrical Quantities (Introduction only) (3 hrs)
- 9.1 Basic concept Pressure measurement, flow measurement, level measurement, displacement measurement
10. Measurement of Temperature (3 hrs)
- Different types of thermometers, thermocouple, resistance temperature detector

### LIST OF PRACTICALS

1. Use of multimeter for measuring voltage, current and resistance
2. To calibrate 1-phase energy meter by direct loading method.
3. To measure the value of earth resistance.
4. To measure power, power factor in a 1-phase circuit, using wattmeter and power factor meter and 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, frequency of a Sinusoidal signal with CRO.
7. Measurement of power in a 3 phase circuit using CT, PT and 3-phase energy meter.
8. Connecting appropriate instruments at the supply of an installation to measure supply voltage, frequency, power, maximum demand, Phase sequence, energy consumed (Instruments to be used are CRO, VTVM, Maximum demand Indicator, phase sequence indicator, Energy meter and power factor meter)
9. Use of LCR meter for measuring inductance, capacitance and resistance.

**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
7. Basic Electrical Measurements by Melville B. Staut.

## 4.3 ELECTRONIC DEVICES AND CIRCUITS

L T P  
4 - 2

### 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** (10 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** (7 hrs)
  - 2.1 Introduction
  - 2.2 Series and parallel resonance
  - 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** (7 hrs)
  - 3.1 Feedback and its importance, positive and negative feedback and their need
  - 3.2 Voltage gain of an amplifier with negative feedback  $A = \frac{A}{1+AB}$
  - 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 an ordinary CE transistor amplifier
  - 3.6 Emitter follower and its applications

#### 4. Sinusoidal Oscillators

- 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
  - 5.2.1 R-C differentiating and integrating circuits
  - 5.2.2 Diode clipping circuits
  - 5.2.3 Diode clamping circuits
  - 5.2.4 Application 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

#### 8. Working Principles of different types of power suppliers viz. CVTs, UPS, Stabilizers, SMPS, IC voltage regulator etc.

(5 hrs)

#### 9. Operational Amplifier

- 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. Familiarisation with specifications and pin onfiguration 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 in Class A single-ended transistor amplifier
2. To measure (a) optimum load (b) output power (c) signal handling capacity in a push-pull amplifier
3. To measure voltage gain and plot the frequency response curve of single-stage feedback
4. To measure (a) voltage gain (b) input and output impedance for an emitter follower circuit
5. To measure frequency generation in (a) Hartley (b) Colpitt and (c) Wein bridge oscillators (d) phasing oscillator
6. To observe the differentiated and integrated square wave on a CRO for different values of R-C time constant
7. (i) Clipping of one portion of sine-wave using diode



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

### 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 & 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

## 4.4 ELECTRICAL ENGINEERING DESIGN AND DRAWING - II

L T P  
2 - 6

### RATIONALE

A polytechnic pass-out in electrical engineering is supposed to have ability to :

- i) Read, understand and interpret engineering drawings
- ii) Communicate and correlate through sketches and drawings
- iii) Prepare working drawings of alternative panels, transmission and distribution

The contents of this subject has been designed to develop requisite knowledge and skills of electrical drawings in the students of diploma in electrical engineering.

### DETAILED CONTENTS

- |    |  |          |
|----|--|----------|
| 1  | Contractor Control Circuits  | (70 hrs) |
|    | Design of Circuit Drawing of schematic diagram and power wiring diagram of following circuits, specification of contactors |          |
|    | 1.1 DOL starting of 3-phase induction motor  |          |
|    | 1.2 Remote Control of 3-phase induction motor  |          |
|    | 1.3 3-phase induction motor getting supply from selected feeder  |          |
|    | 1.4 Forwarding/reversing of a 3-phase induction motor  |          |
|    | 1.5 Two speed control of 3-phase induction motor   |          |
|    | 1.6 Limit switch control of a 3-phase induction motor  |          |
|    | 1.7 Sequential operating of two motors using time delay relay  |          |
|    | 1.8 Automatic star delta starter for 3-phase Induction Motor   |          |
| 2. | Earthing   | (30 hrs) |
|    | 2.1 Purpose of earthing  |          |
|    | 2.2 Different types of earthing, drawings of plate and pipe earthing   |          |

- 2.3 Procedure of earthing, test of materials required and costing
- 2.4 Method of reducing earth resistance
- 2.5 Relevant IS specifications of earth electrode for earthing a transformer, a high building
- 2.6 Earthing layout of distribution transformer
- 2.7 Substation earthing layout and earthing materials
- 2.8 Key diagram of 11KV, 33Kv, 66KV, 132 KV sub-stations
- 3. Drawings of Machine Parts (28 hrs)
  - 3.1 End cover of induction motor
  - 3.2 Rotor of a squirrel cage induction motor
  - 3.3 Field coil of a DC motor
  - 3.4 Terminal plate of an induction motor
  - 3.5 Motor body (induction motor) as per IS specifications
  - 3.6 Sliprings of 3-phase induction motor

### **RECOMMENDED BOOKS**

- 1. Electrical Design and Drawings by Raina & Bhattacharya
- 2. Electrical Design & Drawings by Sarabjeet Singh
- 3. IEEE Guide 80 for Earthing, IEEE Publication, New York
- 5. Electrical Controls in Industry by Charles Siskind
- 6. BIS for Electrical Earthing

## 4.5 ELECTRICAL WORKSHOP PRACTICE - II

L T P  
- - 6

### 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, fault finding, 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 test
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:
  - c) Remote control circuits
  - d) Time delay circuits
  - e) Inter locking circuits
  - f) Sequential operation control circuits
7. Winding/re-winding of a fan (ceiling and table) and choke
8. Soldering and de-soldering practice (soldering and de-soldering of electronic components on PCB)
9. Power cable jointing using epoxy based jointing
10. Demonstration of laying of underground cables at worksite
11. Dismantling/assembly of star-delta/DOL starter and slipping induction motor starter
12. Dismantling and assembly of voltage stabilizers

## 4.6 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 job, which requires knowledge of materials and methods and the principles of economics. The contents of this subject has 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

Purpose of estimating and costing, proforma for making estimates, preparation of materials schedule costing, price list, tender document 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

Electrical, batten, casing-casing and conduit wiring, comparison of different wiring, 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.

#### 3. Estimating and Costing:

3.2 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)

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, sizing of diagram, starters, preparation of materials lists, estimating and costing exercises on workshop with single-phase, 3-phase motor load and the light load (3-phase supply system)

3.3 Service line connection estimate for domestic and Industrial loads (over-head and under ground connections) from pole to energy meter. Electrical forms: different types of fans and their sizes, air-conditioners, exhaust fans, determination of size and number of fans for a given situation.

4. 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.

#### **RECOMMENDED BOOKS**

1. Electrical Estimating and Costing by JB Gupta, Satya Prakashan, New Delhi
2. Estimating and Costing by SK Bhattacharya, Tata McGraw Hill, New Delhi
3. Estimating and Costing by 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

## ENTREPRENEURIAL AWARENESS CAMP

This is to be organized at a stretch for two to three days during second year. Lectures will be delivered on the following broad topics. There will be no examination for this subject

1. Who is an entrepreneur?
2. Need for entrepreneurship, entrepreneurial career and wage employment
3. Scenario of development of small scale industries in India
4. Entrepreneurial history in India, Indian values and entrepreneurship
5. Assistance from District Industries Centres, Commercial Banks, State Financial Corporations, Small industries Service Institutes, Research and Development Laboratories and other financial and development corporations
6. Considerations for product selection
7. Opportunities for business, service and industrial ventures
8. Learning from Indian experiences in entrepreneurship (Interaction with successful entrepreneurs)
9. Legal aspects of small business
10. Managerial aspects of small business