

## 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 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 Swinburn 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 Swinburn's 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

### SUGGESTED DISTRIBUTION OF MARKS FOR FACILITATING THE PAPER SETTER

Sr. No.	Topic	Time Allotted (hrs)	Marks Allocation%
1.	Introduction to Electrical Machines	6	10
2.	DC Machines	24	35
3.	Transformers (single phase)	24	35
4.	Three phase Transformers	10	20
<b>Total</b>		<b>64</b>	<b>100</b>

## 4.2 ELECTRICAL AND ELECTRONIC MEASURING INSTRUMENTS

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### RATIONALE

A diploma holder, in the real world of work, is required to handle wide variety of instruments while testing, trouble shooting, calibration etc. He has to perform various jobs in the field as well as in testing laboratories in addition to his duties of installation, operation, and maintenance. Persons working on control panels in power plants, substations and in industries, will come across use of various types of electrical and electronic instruments for taking measurements of various parameters. The study of this subject will help students to gain the knowledge of working principles and operation of different instruments and during practical sessions they will acquire the requisite skills.

### 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)

Construction, working principle and application of Meggar, Earth tester, Multimeter, Frequency meter (dynamometer type) single phase power factor meter (Electrodynamometer type).

6. Cathode Ray Oscilloscope (10 hrs)
- Construction and working of Cathode Ray Tube (CRT)
  - Time base operation and need for blanking during flyback, synchronization
  - Block diagram description of a basic CRO and triggered sweep oscilloscope, front panel controls
  - Specifications of CRO and their explanation
  - Measurement of current, voltage, frequency, time period and phase using CRO
  - CRO probes, special features of dual beam, dual trace, delay sweep
  - Digital storage oscilloscope (DSO) : block diagram and working principle
7. Signal Generators and Analytical Instruments (10 hrs)
- Explanation of block diagram specifications of low frequency and RF generators, pulse generator, function generator
  - Distortion factor meter; wave analyser and spectrum analyser
8. Digital Instruments (12 hrs)
- Comparison of analog and digital instruments
  - Working principle of ramp, dual slope and integration type digital voltmeter
  - Block diagram and working of a digital multimeter
  - Measurement of time interval, time period and frequency using universal counter/frequency counter
  - Working principle of logic probe, logic pulser, logic analyzer, logic comparator, signature analyzer and logic analyzer

### 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. To observe the loading effect of a multimeter while measuring voltage across a low resistance and high resistance
7. To observe the limitations of a multimeter for measuring high frequency voltage
8. Measurement of voltage, frequency, time period and phase using CRO
9. Measurement of rise time and fall time using CRO
10. Measurement of voltage, frequency, time and phase using DSO
11. Measurement of resistance and inductance of coil using RLC Bridge
12. Measurement of distortion of RF signal generator using distortion factor meter
13. Use of logic pulser and logic probe
14. Measurement of time period, frequency, average period using universal counter/ frequency counter

### **INSTRUCTIONAL STRATEGY**

The subject requires both theory and practical emphasis simultaneously, so that the student can understand the practical significance of the various areas. Visits to instrumentation and communications industries must be carried out, so as to make the students can understand where and how the various instruments are used in the industry.

### **RECOMMENDED BOOKS**

1. Electronics Measurement and Instrumentation by AK Sawhney, Dhanpat Rai and Sons, New Delhi
2. Electronics Measurement and Instrumentation by Oliver, Tata McGraw Hill Education Pvt Ltd, New Delhi
3. Electronics Instrumentation by Cooper, Prentice Hall of India, New Delhi
4. Electronics Test and Instrumentation by Rajiv Sapra, Ishan Publications, Ambala
5. Electronics Instrumentation by JB Gupta, Satya Prakashan, New Delhi
6. Electronics Measurement and Measuring Instrumentation by SK Sahdev, Uneek Publications, Jalandhar
7. A Course in Electrical Measurement and Measuring Instruments by AK Sawhney and PL Bhatia; Dhanpat Rai and Sons, New Delhi
8. Experiments in Basic Electrical Engineering by SK Bhattacharya and KM Rastogi, New Age International (P) Ltd., Publishers, New Delhi

**SUGGESTED DISTRIBUTION OF MARKS FOR FACILITATING THE PAPER SETTER**

<b>Sr. No.</b>	<b>Topic</b>	<b>Time Allotted (hrs)</b>	<b>Marks Allocation%</b>
1.	Introduction to electrical measuring instruments:	6	10
2.	Ammeters and voltmeters (moving coil and moving iron type):	6	10
3.	Watt meters (Dynamometer Type)	4	5
4.	Energy meter (Induction type):	6	10
5.	Miscellaneous Measuring Instruments:	10	15
6.	Cathode Ray Oscilloscope	10	15
7.	Signal Generators and Analytical Instruments	10	15
8.	Digital Instruments	12	20
<b>Total</b>		<b>64</b>	<b>100</b>

## 4.3 ELECTRONIC DEVICES AND CIRCUITS

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### RATIONALE

The purpose of the introduction of electronics in the Electrical Engineering/ Power Station Engineering/ Electrical and Electronics Engineering diploma course has been already explained in the rationale of the subject Basic Electronics. In this course topics 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 (8 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 (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  $A = \frac{A}{1+AB}$
  - 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 (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) 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
6. Working Principles of different types of power suppliers viz. CVTs, UPS, Stabilizers, SMPS, IC voltage regulator etc. (5 hrs)
7. Operational Amplifier (10 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. Familiarisation 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 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  
(ii) Clipping of both portion of sine-wave using:
  - a) diode and dc source
  - b) zener diodes

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

### RECOMMENDED BOOKS

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

### SUGGESTED DISTRIBUTION OF MARKS FOR FACILITATING THE PAPER SETTER

Sr. No.	Topic	Time Allotted (hrs)	Marks Allocation%
1.	Transistor Audio Power Amplifier	10	15
2.	Tuned Voltage Amplifier	08	14
3.	Feedback in Amplifiers	08	14
4.	Sinusodal Oscillators	08	14
5.	Wave-Shaping and Switching Circuits	15	20
6.	Working Principles of different types of power suppliers viz. CVTs, UPS, Stabilizers, SMPS, IC voltage regulator etc.	05	08
7.	Operational Amplifier	10	15
<b>Total</b>		<b>64</b>	<b>100</b>

## 4.4 FIRE EQUIPMENT AND MACHINERY

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### RATIONALE

The subject of fire equipment and machinery is most important in the fire service. It is the back bone of fire service. So knowledge and understanding of fire equipment and machinery is very essential. This subject includes fire extinguishers, foam and foam making equipment, hose and hose fittings, ladders, hydrant and water relay, breathing apparatus and other related special appliances. Hence the subject

### DETAILED CONTENTS

1. Fire Extinguisher (12 hrs)  
Principle, installation, maintenance, construction and practical use of :
  - a) Co<sub>2</sub> Water type extinguisher
  - b) Foam/Mechanical Foam extinguisher
  - c) Vapour forming- Liquid or gas extinguisher- use of Hallon clean agent extinguisher
  - d) DCP/ABC extinguisher- Maintenance procedure of all type extinguisher. I.S. specification of extinguishers
  
2. Foam and Foam Making Equipment (12 hrs)  
Introduction, different type of foam concentrates, functional requirements, compatibility of foam, concentrates and dry chemical powder, foam making equipments, care and maintenance of foam making equipments- reference ISI specifications
  
3. Hose and Hose Fittings (08hrs)  
Introduction, General characteristics of standard delivery and section hose material construction maintenance, repairs and testing and latest development as per ISI.
  
4. Small Gears (08 hrs)  
Function and construction of various sophisticated small gears used in Fire Service including power operated gears, description and use of oxy-acetylene cutting set oxy-propane cutting set, jacks, jumping cushion, blower exhauster, protective clothing , powered spreader, lifting bags, cut of saw, chain saw, cutting tools.
  
5. Special Appliances such as Pump and Pump Priming, Water-Tender (14 hrs)  
Emergency Tender, Crash Fire Tender, TTL, Hydraulic Platform, Hose laying lorry, Breakdown Van, control unit, canteen van, DCP Tender, Foam Tender, pumps and their standard standard specifications.

6. Ladders (12 hrs)
- Introduction of sophisticated aerial ladder construction, use testing and maintenance of title and hydraulic platform, method of practical operation and technique of ladders and safety requirement, extension ladders, escape ladder and hook ladder.
7. Hydrant and Water Relay (04 hrs)
- Water requirements to IS specifications. Principle and practical consideration of various methods of water relay and operational hints
8. Breathing Apparatus (10 hrs)
- Introduction, need and importance of BA set in fire service, air breathing apparatus - description of the set, face mask, demand valve whistle manifold and reducer. Airline equipments, testing and maintenance, working duration of BA set. BA set equipments, distress signals unit, communication equipment, guide and personal lines calculation of condition and duration with reference to ISI specifications

### **LIST OF PRACTICALS**

1. Demonstration and operation of extinguishers, method of recharging general maintenance and procedure and standard test.
2. Standard Drills with foam and foam making equipment, practical considerations and operation data and techniques of various equipments.
3. Hose Drill Practice of cleaning, drying repair and testing, storage condition under varying pressure, details of hose tower and its requirements.
4. Demonstration and practice of operation of various gears
5. Demonstration, operational procedure, practice of Special appliances
6. Standard drills, demonstrations, practices of rescue using aerial ladder care maintenance and test
7. Demonstration and practice of relay operation
8. Charging of cylinders, care and maintenance of cylinders, working and operational procedure for the use of BA set and line signal.

### **INSTRUCTIONAL STRATEGY**

This subject on fire equipments and machinery is being introduced for the use and guidance of students with a view to minimize their work of notes taking on theory enabling them to follow closely the instructions given on the subject by the teachers. Teacher should take help of charts CD as well as actual equipments where possible must be show to the students explaining all features of the equipments and uses.

**RECOMMENDED BOOKS**

1. Elements of Fire Fighting and Fire Department Operations – IFSTA
2. Fire Prevention – Inspection and Code Enforcement by David Diamantes.
3. Fire Technology; NFPA Journal.

**SUGGESTED DISTRIBUTION OF MARKS**

<b>Topic No.</b>	<b>Time Allotted (Hrs)</b>	<b>Marks Allotted (%)</b>
1.	12	14
2.	12	14
3.	08	10
4.	08	10
5.	14	20
6.	12	15
7.	04	05
8.	10	12
<b>Total</b>	<b>80</b>	<b>100</b>

## 4.5 PHYSICAL TRAINING AND DRILL - II

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Physical fitness is an essential part of “Fire Technology and Safety” curriculum. We may have all facilities, gadgets, equipment but without active involvement of humans, all these things are of no use. Emphasis has been laid on physical training and drill which will be essential for every student from 3<sup>rd</sup> semester onward. There will be one hour drill daily in the morning that too in the field and in proper dress. This, in turn, will develop physical strength, confidence, stamina, and courage to face the challenges of fire hazards.

In addition, fire fighting and field training will be given which will include:

- Marching and marking time
- Saluting with message
- Squad formation, changing direction
- Open and closed march, side stepping
- Get on parade
- Wheeling in file marching
- Pump drill, combined hose
- Hydrant and pump drills

A special instructor will be engaged by the polytechnic who will impart the required drill and physical training.

## 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