

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, concept of torque
 - 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

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 Types of dc generation on the basis of excitation, voltage built up in a dc shunt generator
 - 2.6 Significance of back e.m.f., the relation between back emf and Terminal voltage
 - 2.7 Armature Reaction
 - 2.8 Commutation 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 Losses in a DC machine
 - 2.14 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, saving of copper, 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, Buchholz 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. 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. Study of 3 point starter for starting D.C. shunt motor.
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

1. Electrical Machines by SK Bhattacharya, Tata Mc Graw Hill, Education Pvt Ltd. New Delhi
2. Electrical Machines by SK Sahdev, Uneek Publications, Jalandhar
3. Electrical Machines by Nagrath and Kothari, Tata Mc Graw Hill, New Delhi
4. Electrical Machines by JB Gupta, SK Kataria and Sons, New Delhi
5. Electrical Machines by Fitzgerald
6. 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 ENERGY SOURCES AND MANAGEMENT OF ELECTRICAL ENERGY

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RATIONALE

Since the conventional energy resources are under fast depletion, it is high time to tap the non-conventional energy sources also. So, the solution primarily lies in tapping all possible energy generation sources but efficient use of available energy is also important. The electrical diploma holder must be made aware about saving and conserving Electrical Energy and tackle the problems of environmental pollution as they will have to face this challenge in future life. Hence the subject.

DETAILED CONTENTS

1. Introduction: (6 hrs)
Various energy sources, importance of non conventional sources of energy, present scenario, future prospects and economic criteria
2. Solar Energy: (12 hrs)
Principle of conversion of solar radiation into heat, photo-voltaic cell, electricity generation, application of solar energy like solar water heaters, solar furnaces, solar cookers, solar lighting, solar pumping.
3. Bio-energy: (8 hrs)
Bio-mass conversion technologies- wet and dry processes. Methods for obtaining energy from biomass. Power generation by using gasifiers
4. Wind Energy: (8 hrs)
Wind energy conversion, windmills, electricity generation from wind- types of wind mills, local control, energy storage
5. Geo-thermal and Tidal Energy: (12 hrs)
Geo-thermal sources, Ocean thermal electric conversion, open and closed cycles, hybrid cycles. Prime movers for geo-thermal energy conversion. Steam Generation and electricity generation.
6. Magneto Hydro Dynamic (MHD) Power Generation (04 hrs)
7. Chemical Energy Sources: (10 hrs)
Design and operating principles of a fuel cell, conversion efficiency, work output and e.m.f of fuel cells, applications.

8. Energy Conservation and Management (20 hrs)
- a) Need for energy conservation with brief description of oil and coal crisis.
 - b) Environmental aspects
 - c) Energy efficiency- its significance
 - d) Energy efficient technology an overview
 - e) Energy conservation in Domestic sector- Lighting, home appliances
 - f) Need for energy efficient devices
 - g) Energy conservation in Industrial sector- Motors, Industrial lighting, Distribution system, Pumps, Fans, Blowers etc.,
 - h) Energy conservation in Agriculture sector, Tube-well pumps, diesel-generating sets, Standby energy sources.
 - i) Macro Level approach for energy conservation at design stage.

RECOMMENDED BOOKS :

1. Solar Energy – Principles of thermal collection and Storage SP Sukhatme, Tata McGraw Hill Publication, New Delhi.
2. Non-Conventional Energy Resources by RK Singal, SK Kataria and Sons, New Delhi
3. Solar Energy Utilization; GD Rai ; Khanna Publishers, New Delhi.
4. Reviews of Renewable Energy Sources, Vol. 3, Edited by MS Sodha, S.S. Mathur, MAS Malik, TC Kandpal ; Wley Eastern Limited, New Delhi.
5. Renewable Energy Sources and Conversion Technology by NK Bansal, Manfred Kleemann, Michael Meliss, Tata McGraw Hill Publishing Co. Ltd New Delhi.
6. Energy Today and Tomorrow, Maheshwar Dayal; Publications Division, Ministry of Information and Broadcasting, Govt. of India, New Delhi.
7. Energy Technology (non-conventional, renewable and conventional) by S Rao and BB Parulekar, Khanna Publishers, New Delhi
8. Manual on Energy Efficiency at Design Stage, CII Energy Management Cell.
9. Energy Conservation-case studies in ceramic industry, sugar industry, fertiliser industry, cement industry. CII, Energy Management Cell etc

INSTRUCTIONAL STRATEGY

The teacher should make the student s aware about the depletion of energy sources and the availability of alternate sources of energy their feasibility and limitations. The need for adopting non-conventional energy sources should be made clear to students. While explaining the need and energy management,

the teacher should give students home assignments based on energy conservation. The students should be made familiar with the energy efficient devices, various approaches to conserve energy, energy auditing procedure etc. Teacher must give practical application of these energy sources in nearby surrounding areas.

SUGGESTED DISTRIBUTION OF MARKS FOR FACILITATING THE PAPER SETTER

Sr. No	Topic	Time Allotted (hrs)	Marks Allocation (%)
1.	Introduction	06	05
2.	Solar Energy	12	15
3.	Bio-energy	08	10
4.	Wind Energy	08	10
5.	Geo-thermal and Tidal Energy	12	15
6.	Magneto Hydro Dynamic Power Generation	04	05
7.	Chemical Energy Sources	10	10
8.	Energy Conservation and Management	20	30
	Total	80	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
6. Power supplies: (5 hrs)
- Working Principles of different types of power supplies viz. CVTs, 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, integrator and differentiator, summer, subtractor
- 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 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
2. To measure (a) optimum load (b) output power (c) signal handling capacity of a push-pull amplifier
3. To observe the effect of negative current feedback on the voltage gain of a single stage transistor amplifier by removing emitter by-pass capacitor.
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) R-C Phase Shift oscillator
6. To observe the differentiated and integrated square wave on a CRO for different values of R-C time constant
7. 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
8. To generate square-wave using an astable multivibrator and to observe the wave form on a CRO and verify the result using p-spice software
9. To observe triggering and working of a bistable multivibrator circuit and observe its output wave form on a CRO

10. To use the op-Amp (IC 741) as inverting one and non-inverting amplifiers, adder, comparator, integrator and differentiator and verify the result using p-spice software
11. To study the pin configuration and working of IC 555 and its use as monostable and astable multivibrator
12. To realize the regulated power supply by using three terminal voltage regulator ICs such as 7805, 7905, 7915 etc. and verify the result using p-spice software.

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 ELECTRICAL ENGINEERING DESIGN AND DRAWING - II

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RATIONALE

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

- i) Read, understand and interpret electrical engineering drawings
- ii) Communicate and correlate through sketches and drawings
- iii) Prepare working drawings of electrical circuits, motor control, earthing and motor parts

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

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|----|--|---|
| 1 | Contractor Control Circuits | (48 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 | 3-phase induction motor getting supply from selected feeder |
| | 1.3 | Forwarding/reversing of a 3-phase induction motor |
| | 1.4 | Two speed control of 3-phase induction motor |
| | 1.5 | Limit switch control of a 3-phase induction motor |
| | 1.6 | Sequential operating of two motors using time delay relay |
| | 1.7 | Manually generated star delta starter for 3-phase induction motor |
| | 1.8 | Automatic star delta starter for 3-phase Induction Motor |
| 2. | Earthing | (30 hrs) |
| | 2.1 | Concept and 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 (18 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
4. Electrical Controls in Industry by Charles Siskind
5. BIS for Electrical Earthing

4.5 INSTRUMENTATION

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RATIONALE

This subject deals with the various instruments, their construction and working which control the various parameters and operations in any industry. Electrical supervisor employed for maintenance of electrical equipment/ machinery is required to diagnose faults, rectify them and test the total system for good performance. Thus there is a need of introducing diploma holders to the basics of Instrumentation. Basics of instrumentation has been dealt with in this subject

DETAILED CONTENTS

1. Measurements: (3 hrs)

Importance of measurement, basic measuring systems, advantages and limitations of each measuring systems and display devices
2. Transducers: (6 hrs)

Theory, construction and use of various transducers (resistance, inductance, capacitance, electromagnetic, piezo electric type)
3. Measurement of Displacement and Strain: (10 hrs)

Displacement Measuring Devices: wire wound potentiometer, LVDT, strain gauges and their different types such as inductance type, resistive type, wire and foil type etc. Gauge factor, gauge materials and their selections. Use of electrical strain gauges, strain gauge bridges and amplifiers.
4. Force and Torque Measurement: (10 hrs)

Different types of force measuring devices and their principles, load measurements by using elastic transducers and electrical strain gauges. Load cells, measurements of torque by brake, dynamometer, electrical strain gauges, speed measurements; different methods, devices.
5. Pressure Measurement: (5 hrs)

Bourdon pressure gauges, electrical pressure pick ups and their principle, construction and applications. Use of pressure cells.
6. Flow Measurement: (4 hrs)

Basic principles of magnetic and ultrasonic flow meters

7. Measurement of Temperature: (5 hrs)
Bimetallic thermometer, thermoelectric thermometers, resistance thermometers, thermocouple, thermistors and pyrometer. Temperature recorders
8. Measurement of other non electrical quantities such as humidity, pH, level and vibrations (5 hrs)

PRACTICAL EXERCISES

1. To measure the level of a liquid using a transducer
2. To measure temperature using a thermo-couple
3. Study and use of digital temperature controller
4. Use of thermistor in ON/OFF transducer
5. Study of variable capacitive transducer
6. Draw the characteristics of a potentiometer
7. To measure linear displacement using LVDT
8. To study the use of electrical strain gauge
9. To study weighing machine using load cell
10. To study pH meter.

INSTRUCTIONAL STRATEGY

The teacher should explain the scope of various measuring devices and their practical applications in the field. The transducers and measuring devices must be shown to the students and they should be trained in the reaction, operation, maintenance and calibrations. Frequent visits to nearby process industries will be of immense help to the students.

RECOMMENDED BOOKS

1. Electronic Measurement and Instrumentation by Dr Rajendra Prasad
2. Electronic Measurement and Instrumentation by JB Gupta, SK Kataria and Sons, New Delhi
3. Electrical and Electronics Measurement and Instrumentation by AK Sawhney, Dhanpat Rai and Co., New Delhi
4. Electronic Instrumentation and Measurement Techniques by WD Cooper, AD Helfrick Prentice Hall of India Pvt. Ltd. New Delhi
5. Industrial Instrumentation by Umesh Rathore, SK Kataria and Sons, New Delhi

6. SUGGESTED DISTRIBUTION OF MARKS FOR FACILITATING THE PAPER SETTER

Sr. No	Topic	Time Allotted (hrs)	Marks Allocation (%)
1	Measurements	3	6
2	Transducers	6	12
3	Measurement of Displacement and Strain	10	20
4	Force and Torque Measurement	10	20
5	Pressure Measurement	5	12
6	Flow Measurement	4	8
7	Measurement of Temperature	5	12
8	Measurement of other non electrical quantities	5	10
	Total	48	100

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'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 (10 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: (30 hrs)
 - 3.1 Domestic installations; description of various tests to test the wiring installation before commissioning, 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 (for house of two room set along with layout sketch).
 - 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 single-phase, 3-phase motor load and the light load (3-phase supply system)

- 3.3 Service line connections estimate for domestic upto 10 KW and Industrial loads upto 20 KW (over-head and under ground connections) from pole to energy meter.
4. Estimating the material required for (16 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, methods of earthing of substations, Key Diagram of 66 KV/11KV and 11 KV/0.4 KV 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	10	20
3	Estimating and Costing	30	40
4	Estimating the material required for	16	25
	Total	64	100

INDUSTRIAL TRAINING

(during summer vacation after IV Semester)

It is needless to emphasize further the importance of Industrial Training of students during their 3 years of studies at Polytechnics. It is industrial training, which provides an opportunity to students to experience the environment and culture of industrial production units and commercial activities undertaken in field organizations. It prepares student for their future role as diploma engineers in the world of work and enables them to integrate theory with practice. Polytechnics have been arranging industrial training of students of various durations to meet the above objectives.

This document includes guided and supervised industrial training of a minimum of 4 weeks duration to be organised during the semester break starting after second year i.e. after IV Semester examinations. The concerned HODs along with other teachers will guide and help students in arranging appropriate training places relevant to their specific branch. It is suggested that a training schedule may be drawn for each student before starting of the training in consultation with the training providers. Students should also be briefed in advance about the organizational setup, product range, manufacturing process, important machines and materials used in the training organization.

Equally important with the guidance is supervision of students training in the industry/organization by the teachers. A minimum of one visit per week by the teacher is recommended. Students should be encouraged to write daily report in their diary to enable them to write final report and its presentation later on.

An internal assessment of 50 and external assessment of 50 marks have been provided in the study and evaluation scheme of V Semester. Evaluation of professional industrial training report through viva-voce/presentation aims at assessing students understanding of materials, industrial process, practices in industry/field organization and their ability to engage in activities related to problem solving in industrial setup as well as understanding of application of knowledge and skills learnt in real life situations. The formative and summative evaluation may comprise of weightage to performance in testing, general behaviour, quality of report and presentation during viva-voce examination. It is recommended that such evaluations may be carried out by a team comprising of concerned HOD, teachers and representative from industry.

Teachers and students are requested to see the footnote below the study and evaluation scheme of IV Semester for further details.