

CURRICULUM

For

DIPLOMA PROGRAMME

In

ELECTRICAL ENGINEERING

3rd Year (5th & 6th Semester)

FOR THE STATE OF HIMACHAL PRADESH



June, 2019

Study & Evaluation Scheme

5th Semester Electrical Engineering

SN	Subjects	Hrs/Week		Evaluation Scheme								Total Marks
				Internal Assessment			External Assessment					
		Th	Pr	Th	Pr	Total	Th	Hrs	Pr	Hrs	Total	
5.1	Basics of Management & Entrepreneurship Development*	4	-	50	-	50	100	3	-	-	100	150
5.2	Electrical Machine-III**	5	2	30	20	50	100	3	50	3	150	200
5.3	Electrical Power System-II**	4	-	50	-	50	100	3			100	150
5.4	Power Electronics & Control of Drives**	4	2	30	20	50	100	3	50	3	150	200
5.5	Elective-I 5.5.1 Non-Conventional Energy Resources** 5.5.2 Illumination Engineering 5.5.3 Hybrid Electrical Vehicles	4	2	30	20	50	100	3	50	3	150	200
5.6	Minor Project	-	6	-	50	50	-	-	50	3	50	100
	Industrial Training	-	-	-	50	50	-	-	50	-	50	100
	Student Centered Activities	-	4	-	-	25	-	-	-	-		25
	Total	21	16	190	160	375	500		250		750	1125

*Common with all diploma programmes

** Common with diploma in Electrical and Electronics Engineering

Note: Apart from the above mentioned number of hours for each subject (Theory & Practical), at least **TWO** hours/week for each class should be allocated for Library to motivate the students to attend library compulsory. The attendance of library period should be added in master attendance.

Study & Evaluation Scheme

6th Semester Electrical Engineering

SN	Subjects	Hrs/Week		Evaluation Scheme								Total Marks
				Internal Assessment			External Assessment					
		Th	Pr	Th	Pr	Total	Th	Hrs	Pr	Hrs	Total	
6.1	Energy Management**	4	-	50	-	50	100	3	-	-	100	150
6.2	Electrical Power System-III**	4	2	30	20	50	100	3	50	3	150	200
6.3	Utilization of Electrical Energy**	4	-	50	-	50	100	3	-	-	100	150
6.4	Elective-II											
	6.4.1 Programmable Logic Controllers & Microcontrollers**	4	2	30	20	50	100	3	50	3	150	200
	6.4.2 Industrial Automation											
	6.4.3 Testing & maintenance of Electrical Machines											
6.5	Estimating & Costing in Electrical Engineering	4	-	50	-	50	100	3	-	-	100	150
6.6	Major Project	-	10	-	100	100	-	-	100	3	100	200
6.7	Practices in Communication Skills*	-	2	-	50	50	-	-	50	3	50	100
	Student Centered Activities	-	2	-	-	25	-	-	-	-	25	25
	Total	20	18	210	190	425	500		250		750	1175

** Common with diploma in Electrical and Electronics Engineering

*Common with all diploma programmes

Note: Apart from the above mentioned number of hours for each subject (Theory & Practical), at least **TWO** hours/week for each class should be allocated for Library to motivate the students to attend library compulsory. The attendance of library period should be added in master attendance.

DETAILED CONTENTS

OF

5th & 6th SEM.

ELECTRICAL

ENGINEERING

CURRICULUM

5.1 BASICS OF MANAGEMENT & ENTREPRENEURSHIP DEVELOPMENT

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RATIONALE

In present scenario, there is an urgent need to develop right kind of attitude, knowledge and skills amongst the Diploma engineers leading them to achieve gainful wage/ self-employment. There is a huge gap in perceptions of employers and employees regarding meeting the job requirements. Also the dual challenges of competing in global working environment and keeping pace with the rapid technological advancements call for re-design of curricula and thus enabling the importance of generic and managerial skills. Entrepreneurship development aim at developing conceptual understanding for setting up owns' business/enterprise to cope up with the problem of unemployment and also to promote the socio- economic development of our country. Both the subject areas, "Basics of Management and entrepreneurship development" are supplementary to each other. Knowledge and skills of these must be imparted to diploma engineering students for enhancing their employability and confidence in their personal and professional life.

DETAILED CONTENTS

- 1. Introduction to Management** (7 hrs)
 - 1.1 Definitions and concept of Management
 - 1.2 Functions of management- planning, organizing, staffing, coordinating and controlling.
 - 1.3 Various areas of management
 - 1.4 Structure of an Organization

- 2. Self-Management and Development** (10 hrs)
 - 2.1 Life Long Learning Skills, Concept of Personality Development, Ethics and Moral values
 - 2.2 Concept of Physical Development; Significance of health, hygiene, body gestures
 - 2.3 Time Management Concept and its importance
 - 2.4 Intellectual Development: Reading skills, speaking, listening skills, writing skills (Note taking, rough draft, revision, editing and final drafting), Concept of Critical Thinking and Problem Solving (approaches, steps and cases).
 - 2.5 Psychological Management: stress, emotions, anxiety and techniques to manage these.
 - 2.6 ICT & Presentation skills; use of IT tools for good and impressive presentations.

- 3. Team Management** (10 hrs)
 - 3.1 Concept of Team Dynamics. Team related skills, managing cultural, social and ethnic diversity in a team.
 - 3.2 Effective group communication and conversations.
 - 3.3 Team building and its various stages like forming, storming, norming, performing and adjourning

- 3.4 Leadership, Qualities of a good leader
- 3.5 Motivation, Need of Motivation, Maslow's theory of Motivation
- 4. Project Management (5 hrs)**
 - 4.1 Stages of Project Management; initiation, planning, execution, closing and review (through case studies), SWOT analysis concept.
- 5. Introduction to Entrepreneurship (10 hrs)**
 - 5.1 Entrepreneurship, Need of entrepreneurship, and its concept, Qualities of a good entrepreneur
 - 5.2 Business ownerships and its features; sole proprietorship, partnership, joint stock companies, cooperative, private limited, public limited, PPP mode.
 - 5.3 Types of industries: micro, small, medium and large
- 6. Entrepreneurial Support System (Features and Roles in Brief) (7 hrs)**
 - 6.1 District Industry Centers (DICs), State Financial Corporations (SFCs), NABARD,
 - 6.2 MSME (Micro, Small, Medium Enterprises) – its objectives & list of schemes
- 7. Market Study and Opportunity Identification (7 hrs)**
 - Types of market study: primary and secondary, product or service identification, assessment of demand and supply, types of survey and their important features
- 8. Project Report Preparation (8 hrs)**
 - 8.1 Preliminary Report, Techno-Economic Feasibility Report, Detailed Project Report (DPR).

LIST OF TUTORIAL EXERCISES

1. Understanding Self-Management and Development (Related to Chapter 02); through examples, cases, exercises, panel discussions, seminars, meditation and yoga techniques.
2. SWOT Analysis
3. Team Management (Related to chapter 03); through examples, cases, role plays, group discussions and panel discussions.
4. Market Study and Opportunity Identification (Related to Chapter 07); through literature reviewing, making questionnaires, conducting mock interviews and analyzing data for product/service identification and demand assessment.
5. Project Management and Project Report Preparation through exercises on making project reports on micro and small enterprises. Case studies and SWOT analysis of projects can be taken.

RECOMMENDED BOOKS

1. Generic Skill Development Manual, MSBTE, Mumbai
2. Lifelong Learning, Policy Brief(www.oecd.org)
3. Towards Knowledge Society, UNESCO Publication, Paris
4. Entrepreneurship Development by CB Gupta and P Srinivasan: Sultan Chand and sons: New Delhi
5. Essentials of Management by H Koontz, C O' Daniel , McGraw Hill
6. Principles and Practice of Management by Shyamal Bannerjee: Oxford and IBM Publishing Co, New Delhi
7. Management by James AF Stoner, R Edward Freeman and Daniel R Gilbert Jr., Prentice Hall of India Pvt. Ltd, New Delhi
8. Entrepreneurship Development by S. L. Gupta and Arun Mittal: IBH Publication
9. A Handbook of Entrepreneurship, Edited by B S Rathore and Dr. J S Saini
10. Entrepreneurship Development and Small Business Enterprises by Poornima M: Pearson Education India
11. Handbook of Small Scale Industry by P M Bhandari

SUGGESTED DISTRIBUTION OF MARKS

Topic No.	Time Allotted (hrs)	Marks Allotted (%)
1	07	10
2	10	15
3	10	15
4	05	10
5	10	15
6	07	10
7	07	10
8	08	15
Total	64	100

5.2 ELECTRICAL MACHINE-III

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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 engineering diploma holder must be competent to repair and maintain these machines and give suggestions to improve their performance. Explanation of practical aspects of the subject will make the students capable of performing various tests on the machines as per latest BIS specifications. This part of the electrical machines covers three phase induction and synchronous machines. Apart from this fractional single phase fractional horse power motors and special motors have also been incorporated.

DETAILED CONTENTS

1. Three Phase Induction Motors

(22 hrs)

- 1.1 Constructional features of squirrel cage and wound rotor induction motors, comparison of cage and wound rotor Induction motors
- 1.2 Production of rotating magnetic field in a three phase winding
- 1.3 Principle of operation of induction motor, slip, significance of slip
- 1.4 Effect of slip on various parameters of rotor circuit: rotor resistance, rotor inductance, rotor current, rotor frequency
- 1.5 Torque developed in 3-phase induction: starting torque, condition for maximum torque, running torque and maximum torque
- 1.6 Torque-slip and torque-speed curve
- 1.7 Effect of rotor resistance upon torque slip relationship of slip ring induction motor
- 1.8 Starting of 3-phase induction motors using DOL, Star-delta, and Autotransformer
- 1.9 Speed control methods of 3-phase induction motor
- 1.10 Testing of 3-phase motor on no load and blocked rotor test to find Efficiency
- 1.11 Effect of induction motors on system power factor
- 1.12 Double cage rotor induction motor and its applications
- 1.13 Applications of induction motors

2. Synchronous Generator (Alternator)

(22 hrs)

- 2.1 Construction Feature of synchronous machine, salient and cylindrical type rotor synchronous machine, comparison between salient and cylindrical rotor machine
- 2.2 Advantages of rotating field system
- 2.3 Different types of excitation system for synchronous machine: dc excitation system, static excitation system and brushless excitation system
- 2.4 EMF equation of alternator
- 2.5 Concentrated and distributed windings, Concept of distribution factor and coil span factor and pitch factor

- 2.6 Effect of armature reaction on terminal voltage
- 2.7 Concept of synchronous reactance and synchronous impedance
- 2.8 Phasor diagram of alternator on load: resistive, inductive and capacitive load
- 2.9 Effect of power factor on the terminal voltage of alternator
- 2.10 Voltage regulation of alternator, determination of voltage regulation using synchronous impedance method
- 2.11 Need and necessary conditions for parallel operation of alternators.
- 2.12 Synchronization of alternators with bus bars using Synchroscope method and lamps method.

3. Synchronous Motor (18 hrs)

- 3.1 Introduction: Construction, operating principle
- 3.2 Starting methods of synchronous motor
- 3.3 Equivalent circuit diagram of synchronous motor
- 3.4 Effect of change in excitation of a synchronous motor, V-curve of synchronous motor
- 3.5 Concept of hunting, causes and prevention of hunting in Synchronous Motor
- 3.6 Application of synchronous motor as synchronous condenser, other applications of synchronous motor

4. Single Phase Motors (12 hrs)

- 4.1 Production of rotating field in 1-phase induction motor: double field revolving theory and cross field theory
- 4.2 Operating Principle, Constructional features and Applications of Split-phase, capacitor start, capacitor-start capacitor-run, and Shaded Pole motors
- 4.3 Reluctance Motor: Construction, working principle & Applications
- 4.4 Hysteresis Motor: Construction, working principle & Applications
- 4.5 Universal Motor: Construction, working principle & Applications

5. Special Purpose Motors (6 hrs)

Linear Induction Motor & Permanent Magnet Brushless DC Motor (Only working principle and applications), Servo Motor (AC and DC) & Stepper Motor (Only working principle)

LIST OF PRACTICALS

1. To Start a 3-phase Induction Motor with DOL and Auto Transformer Starter
2. To determine the performance parameters of a 3-phase Induction Motor using no load test and blocked rotor test
3. Determination of effect of rotor resistance on torque speed curve of wound rotor 3-phase induction motor
4. To plot a curve between no load terminal voltage and excitation current in a synchronous generator at constant speed

5. Determination of relationship between the field current and load current of an alternator at constant speed
6. Determination of relationship between the voltage and load current of an alternator, keeping excitation and speed constant
7. To perform the open circuit test and short circuit test on a synchronous generator (Alternator) and to find the voltage regulation of alternator using synchronous impedance method.
8. To perform the synchronization of two 3-phase alternator (or one alternator with grid) using a) Synchroscope, b) Lamps dark method, c) Two bright one dark method
9. To determine the effect of variation of excitation current on performance of a synchronous motor at different loading condition.

RECOMMENDED BOOKS

1. Electrical Machines by S K Bhattacharya, McGraw Hill, New Delhi
2. Electrical Machines by S K Sahdev, Unique International Publications, Jalandhar
3. Electrical Machines by Nagrath and Kothari, Tata McGraw Hill, New Delhi
4. Electrical Engineering by JB Gupta, S K Kataria and Sons, New Delhi
5. Electrical Machines by Samarjit Ghosh, Pearson Education (Singapore)

SUGGESTED DISTRIBUTION OF MARKS

Topic No.	Time Allotted (hrs)	Marks Allotted (%)
1	22	30
2	22	30
3	18	20
4	12	15
5	06	05
Total	80	100

5.3 ELECTRICAL POWER SYSTEM-II

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RATIONALE

The majority of the polytechnic pass outs who get employment in State Electricity Boards have to perform various activities in the field of Generation, Transmission and Distribution of Electrical power. The range of these activities vary from simple operation and maintenance of equipment, lines, fault location, planning and designing of simple distribution schemes, executive and supervisory control in power stations, transmission and distribution networks in addition to administrative jobs including public relations. They should also be made aware of recent developments, current practices in the electricity departments, corporations and boards to keep them abreast with modern techniques in Transmission and Distribution of Electrical Power. This part of the electrical power system covers transmission and distribution systems.

DETAILED CONTENTS

- 1. Electrical Power Supply System (10 hrs)**
 - 1.1 Single line diagram of Electrical Power Supply System
 - 1.2 Advantages of high voltage transmission
 - 1.3 Various systems of electrical power transmission: DC system, 1-phase AC system, 2-phase ac system, 3-phase AC system
 - 1.4 Comparison between AC and DC system for transmission of electrical power

- 2. Mechanical Design of Overhead Transmission Line (12 hrs)**
 - 2.1 Types of line supports, types of conductors, earth wire and their accessories
 - 2.2 Insulator, selection of insulator, string efficiency of suspension type insulator
 - 2.3 ACSR Conductor, Bundled conductors, Transposition of 3-phase line
 - 2.4 Span length, Sag and stress calculation, Stringing chart, Sag template, effects of wind and ice on Sag (numerical)

- 3. Electrical Aspects of Transmission Line (10 hrs)**
 - 3.1 Choice of working voltage for transmission
 - 3.2 Economic size of line conductor- Kelvin's law
 - 3.3 Inductance of a conductor due to internal flux and external flux
 - 3.4 Inductance of a single phase two-wire line and of three phase line
 - 3.5 Capacitance of three phase line, charging current due to capacitance
 - 3.6 Skin effect, Ferranti effect, proximity effect in conductors of transmission line
 - 3.7 Corona: factor affecting, advantages and disadvantages, corona power losses and methods to reduce the corona

- 4. Substation and Distribution System (10 hrs)**
 - 4.1 Substation: Indoor and outdoor substations, equipment for substation, auxiliary supply

- 4.2 Distribution Systems: Radial, ring mains and inter-connected distribution system
- 4.3 Comparison of AC and DC distribution system

5. Underground Distribution System (7 hrs)

- 5.1 Advantages and disadvantages of underground system with respect to overhead system
- 5.2 Underground Cables: Types of cables, construction of cables, grading of cables, capacitance, ratings, thermal characteristics and applications

6. Extra High Voltage AC and DC Transmission System (9 hrs)

- 6.1 Necessity of EHV Transmission
- 6.2 Limitation of EHV-AC Transmission System
- 6.3 Basic Concepts of HVDC System
- 6.4 Limitation of HVDC Transmission
- 6.5 Comparison between EHV-AC and HV-DC Transmission

7. Role of Power Factor in Power System (6 hrs)

- 7.1 Concept of power factor
- 7.2 Causes and effects of low power factor in power system
- 7.3 Methods to improve power factor: Synchronous condenser, Static capacitor bank and VAr Static Compensators

RECOMMENDED BOOKS

1. Electrical Power System and Analysis by CL Wadhwa, 3rd edition, New Age International Publishers, New Delhi
2. Substation Design and Equipment by Satnam and PV Gupta, Dhanpat Rai & Sons, New Delhi
3. Electrical Power System by VK Mehta, S Chand and Co., New Delhi
4. Electrical Power System by JB Gupta, S K Kataria and Sons, New Delhi
5. Sub-Station Design by Satnam, Dhanpat Rai and Co., New Delhi
6. Electrical Power Distribution System by AS Pabla, Tata McGraw Hill, New Delhi
7. Electrical Power System by S Channi Singh, Tata McGraw Publishing Co. New Delhi
8. A Course in Electrical Power by A. Chakarborty, M. L.Soni, P. V. Gupta and U. S. Bhatnagar, Dhanpat Rai & Sons, New Delhi
9. Electrical Power Systems by B. M. Weedy, Wiley Publishing

SUGGESTED DISTRIBUTION OF MARKS

Topic No.	Time Allotted (hrs)	Marks Allotted (%)
1	10	15
2	12	20
3	10	15
4	10	15
5	07	10
6	09	15
7	06	10
Total	64	100

5.4 POWER ELECTRONICS AND CONTROL OF DRIVES

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RATIONALE

In broad terms, the function of power electronics is to control the electrical energy by supplying voltage and current in a form that is optimally suited to the load. Now a day's electrical machine are controlled by Power Electronics based control methods using various power electronics devices of high power ratings. The various conventional control & relays are replaced by electronic control & relays, employing solid state power semi-conductor devices. Therefore, the subject of power electronics is essential for electrical engineering students so that they can be well averse with modern control techniques using power electronics devices.

DETAILED CONTENTS

1. Power Semiconductor Devices

(16 hrs)

- 1.1 Advantages of Power Electronics devices based control over conventional control
- 1.2 Construction, Operation, Symbol & V-I Characteristics of Silicon Controlled Rectifier (SCR)
- 1.3 Thyristor Specifications and Ratings: Voltage Ratings, Current Ratings, Power Ratings and Temperature Ratings. Turn ON & Turn- OFF time
- 1.4 Thyristor Turn On (Triggering) Methods: Voltage Triggering, Gate Triggering, dv/dt Triggering and Radiation Triggering.
- 1.5 Thyristor Turn off Process (Commutation techniques)
- 1.6 Series and Parallel Connections of SCRs: it's need and criteria
- 1.7 Heat Sinks- Function/need of Heat Sink, Types of Mountings
- 1.8 Thyristor Family: Symbols, Construction, Operation & V-I Characteristics of TRIAC, DIAC, and UJT
- 1.9 UJT Relaxation Oscillator: Circuit description and Working

2. Converters (Controlled Rectifiers)

(14 hrs)

- 2.1 Difference between Uncontrolled rectifier & Controlled rectifier
- 2.2 Single Phase Half Wave Controlled Converter
 - With Resistive Load
 - With RL Load and Freewheeling Diode
- 2.3 Single Phase Fully Controlled Full Wave Converter
 - With Resistive Load
 - With RL Load (with & without freewheeling diode)
- 2.4 Three Phase Fully Controlled Bridge Converter

- 2.5 Comparison of 3 phase and 1-Phase Converters
- 2.6 Cycloconverters (50 Hz to 25 Hz, 16.33Hz, 12.5Hz): Introduction, classification, working principle and applications
- 2.7 Dual Converters (1-phase & 3-phase): Classification, working principle and applications

3. Inverters (8 hrs)

- 3.1 Working Principle of Inverter
- 3.2 Series Inverter
 - Operation of Series Inverter Circuit
- 3.3 Parallel Inverter
 - Operation of Parallel Inverter Circuit
- 3.4 Single Phase Bridge Inverter
 - Half Bridge Inverter
 - Full Bridge Inverter

4. Choppers (DC to DC Converters) (10 hrs)

- 4.1 Working Principle of Chopper, Duty Cycle of Chopper
- 4.2 Types of Duty Cycle Control
 - Constant Frequency System
 - Variable Frequency System
- 4.3 Classification of Choppers
 - Class A, Class B, Class C, Class D and Class E: Their Circuit description and Working
- 4.4 Applications of Choppers

5. Power Electronic Applications in Control of Drives (6 hrs)

- 5.1 DC Drives: Speed control of DC motors with Single phase and Three-phase controlled converters, Speed Control of DC motors using Chopper circuit.
- 5.2 AC Drives: Speed control of three-phase Induction Motor with Variable voltage, and variable frequency (VVVF Drives) using power electronics devices.

6. Other Applications of Power Electronics based Devices (10 hrs)

- Automatic Street Light Control using Thyristors
- Battery Charging Control
- Static Excitation System for Alternators
- Static Circuit Breakers (AC & DC)

LIST OF PRACTICALS

1. To identify the terminals SCR and plot the V-I Characteristics of SCR.
2. To observe input and output waveforms in Half Wave Controlled Rectifier Circuit.
3. To observe input and output waveforms in Full Wave Fully Controlled Rectifier Circuit at different firing angle using resistive and resistive-inductive (R-L) loads with and without free-wheeling diode.
4. To observe output waveforms of UJT relaxation oscillator circuit by varying the relaxation time.
5. To plot the VI characteristics of Triac.
6. To observe input and output waveforms using Series Inverter Circuit.
7. To observe input and output waveforms using Parallel Inverter Circuit.
8. To observe input and output waveforms in various chopper configurations under different duty cycles.
9. To Perform Speed control of DC motor using single phase half/fully controlled converter circuit.

RECOMMENDED BOOKS

1. Power Electronics by Dr. P. S. Bhimbhra, Khanna Publisher, New-Delhi
2. Power Electronics by B. R. Gupta & V. Singhal, KATSON Publication, New Delhi
3. Power Electronics: Circuits, Devices & Applications, by M. H. Rashid, Pearson Education India Publication
4. Fundamentals of Electrical Drives, by G. K. Dubey, Narosa Publication House
5. Power Electronics: Converters & Regulators by Branco Blanusa & Branco L. Dokic, Published by Springer

SUGGESTED DISTRIBUTION OF MARKS

Topic No.	Time Allotted (hrs)	Marks Allotted (%)
1	16	25
2	14	20
3	08	15
4	10	15
5	06	10
6	10	15
Total	64	100

5.5.1 NON-CONVENTIONAL ENERGY RESOURCES

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RATIONALE

Energy is a crucial input in the process of economic, social and industrial development. High-energy consumption has traditionally been associated with higher quality of life, which in turn is related to Gross National Product (GNP). Since the conventional energy resources are under strain of depletion, it is high time to tap the non-conventional energy sources. The electrical diploma holder will have to face this challenge in future life. Therefore this subject is introduced as an elective subject in diploma programme to familiarize the diploma students with non-conventional engineering sources, so that they may be able to know the renewable energy conversion systems and its importance.

DETAILED CONTENTS

- 1. Introduction (5 hrs)**
Importance of Non-conventional sources of energy, Present energy scenario, Role of non-conventional or renewable energy sources in present energy scenario
- 2. Solar Energy (9 hrs)**
Principle of conversion of solar radiation into heat, Photo-Voltaic Cell, Electricity generation using Solar Energy, Applications of Solar Energy: Solar water heaters, Solar Furnaces, Solar cookers, Solar lighting, Solar pumping.
- 3. Hydro Energy (7 hrs)**
Main elements of small (Mini and Micro) hydro-electric power generation system, control requirements in small hydro power plants, advantages of small hydro power plants over large hydro power generation systems
- 4. Bio-Energy (9 hrs)**
Bio-mass Conversion Technologies: Wet and Dry processes. Methods for obtaining energy from biomass. Power generation using biomass gasifier.
- 5. Wind Energy (9 hrs)**
Wind Energy Conversion system, Types of wind mills, electricity generation using wind mills, control mechanism in wind energy conversion system, and energy storage systems
- 6. Geo-Thermal and Tidal Energy (9 hrs)**
Geo-thermal sources, Ocean thermal electric conversion, open and closed cycles, hybrid cycles, Tidal power basics and schemes of electricity generation using tidal power
- 7. Magneto Hydro Dynamic (MHD) Power Generation (3 hrs)**
Introduction, working principle and MHD system

8. Chemical Energy (7 hrs)

Principle of working of fuel cell, conversion efficiency, work output and emf of fuel cells, applications of fuel cells.

9. Thermo Electric Power (6 hrs)

Basic working principle of thermo-electric power, Thermo-electric power generation, thermoelectric materials and their application.

LIST OF PRACTICALS

1. Demonstration/Study of Photo Voltaic cell.
2. Demonstration/Study of Solar Cooker.
3. Study of Solar based lighting system installed in the premises and prepare report on the features and functions of components used in the system.
4. Study of Micro/Pico Hydro Power plants installed in the vicinity and prepare a report.
5. Study of a Wind turbine generator.
6. Visit to biogas plants, domestic community/institution for study and demonstration of biogas plant.
7. Study of a solar based water heating system in the institution premises and prepare a report.

RECOMMENDED BOOKS

1. Energy Management by Dr. Sanjeev Singh & Dr. Umesh Rathore, KATSON Publications New Delhi
2. Energy Management by Dr. Umesh Rathore, KATSON Publications 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 ; Wiley 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 Technology (non-conventional, renewable and conventional) by S Rao and BB Parulekar, Khanna Publishers, New Delhi
7. Non-Conventional Energy Resources by RK Singal, SK Kataria and Sons, New Delhi
8. Solar Energy – Principles of thermal collection and Storage S P Sukhatme, Tata McGraw Hill Publication, New Delhi

SUGGESTED DISTRIBUTION OF MARKS

Topic No.	Time Allotted (hrs)	Marks Allotted (%)
1	05	05
2	09	15
3	07	10
4	09	15
5	09	15
6	09	15
7	03	05
8	07	10
9	06	10
Total	64	100

5.5.2 ILLUMINATION ENGINEERING

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RATIONALE

One of the main applications of electricity is in the form of lighting. The knowledge of various types of luminaries and their output is very important in designing the lighting schemes for a particular application. This subject will help the diploma students in acquiring the knowledge on various types of lamps and other accessories and their areas of application in domestic, industrial and other commercial sectors.

DETAILED CONTENTS

- 1 Fundamentals of Illumination (10 hrs)**
 - 1.1 Illumination Terminology
 - 1.2 Laws of Illumination
 - 1.3 Features of good Illumination scheme
 - 1.4 Advantages of good Illumination scheme
 - 1.5 Measurement of level of Illumination

- 2 Lamps & Lighting Accessories (12 hrs)**
 - 2.1 Types of lamps: ARC lamps, HPMV lamps, Sodium Lamps, CFL Lamps, Metal halides, LED lamps, Neon Lamps & Sign Tubes, Halogen Lamps.
 - 2.2 Lighting accessories.
 - 2.3 Comparison of different luminaries

- 3 Illumination Control & Control Circuits (10 hrs)**
 - 3.1 Purpose of lighting control
 - 3.2 Dimmer Transformer & their types
 - 3.3 Electronic Dimmer
 - 3.4 Enhancing Lighting control.
 - 3.5 Control circuits for lamps(specify)

- 4 Illumination for Interior Applications (12 hrs)**
 - 4.1 Standard for various situations of Interior Illumination
 - 4.2 Design Techniques
 - 4.3 Design considerations for Interior location of Residential, Commercial, Industrial premises
 - 4.4 Design Illumination scheme for different Interior locations of Residential, Commercial, Industrial unit.

- 5 Illumination for Outdoor Applications (12 hrs)**
 - 5.1 Factory Lighting
 - 5.2 Street Lighting
 - 5.3 Flood Lighting
 - 5.4 Railway Lighting

- 5.5 Lighting for Advertisement/Hoardings
- 5.6 Lighting for indoor and outdoor sports stadiums

6 Lighting for Special Applications (08 hrs)

- 6.1 Agriculture & Horticulture
- 6.2 Health Care Centers /Hospitals
- 6.3 Decorating Purposes
- 6.4 Stage Lighting
- 6.5 Aquariums & Shipyards

LIST OF PRACTICALS

1. To Measure Illumination for different luminaries by lux meter.
2. Study the various lamps available in the market & collect the technical information.
3. Visit to nearby lamp manufacturing industry.
4. Prepare a report of different luminaries available in the market & collect the technical data (Visit local market / Use internet for data collection).
5. Study the different lighting accessories required for various types of lamps.
6. Design an Illumination scheme for a garden of medium size.
7. Design an Illumination scheme for a conference room of medium size.
8. Design an Illumination scheme for a workshop for fine work of medium size.
9. Design an Illumination scheme for a medium size Hotel / Hospital / Shopping complex.

RECOMMENDED BOOKS

1. Applied Illumination Engineering by J. L. Lindsay, The Fairmount Press
2. Lighting Engineering: Applied Calculations by R. H. Simons & Robert Bean
3. Illumination Engineering: Design & Non-Imaging Optics by R. J. Koschel, IEEE

SUGGESTED DISTRIBUTION OF MARKS

Topic No.	Time Allotted (hrs)	Marks Allotted (%)
1	10	15
2	12	20
3	10	15
4	12	20
5	12	20
6	08	10
Total	64	100

5.5.3 HYBRID ELECTRIC VEHICLES

L T P

4 - 2

RATIONALE

Present energy scenario prevalent across the world demands for the shifting from conventional fuel based vehicles to electric operated vehicles due to the escalation of fuel prices and environmental concern due to the burning of fuel. Lot of research is continuously going on in designing and developing the vehicles operated on hybrid power generation system especially solar and storage battery. This course highlights the basic concepts of hybrid electric vehicles. After this course students will be able to know the basic concepts of electrical vehicles architectural design, energy storage and charging systems.

DETAILED CONTENTS

1. Introduction: Electrical Vehicles (14 hrs)

- 1.1 History
- 1.2 Indian & Global Scenario of Electric Vehicles
- 1.3 Components of Electric Vehicle
- 1.4 Comparison with Internal Combustion Engine
- 1.5 EV classification and their electrification levels.
- 1.6 Calculation of Motor Torque

2. Electric Vehicle Architecture Design (20 hrs)

- 2.1 Types of Electric Vehicles and Components
- 2.2 Electrical Protection and System requirements
- 2.3 Photoelectric Solar based EV design
- 2.4 Battery Electric Vehicle (BEV)
- 2.5 Hybrid Electric Vehicle
- 2.6 Comparison of various electric vehicles

3. Electric Drives and Controller (16 hrs)

- 3.1 Types of Motors
- 3.2 Selection and sizing of Motor
- 3.3 RPM and Torque calculation of motor
- 3.4 Motor Controllers
- 3.5 Component sizing
- 3.6 Physical locations
- 3.7 Mechanical connection of motor
- 3.8 Electrical connection of motor

4. Electric Vehicle Charging Station (14 hrs)

- 4.1 Type of charging station
- 4.2 Selection and Sizing of charging station
- 4.3 Components of charging station
- 4.4 Single line diagram of charging station

LIST OF PRACTICALS

1. Design the layout of electric vehicle showing various components used in an EV.
2. Study a Solar based electric vehicle and mention the rating and function of each components used in Solar based EV.
3. Study a Battery based electric vehicle and mention the rating and function of each components used in BEV.
4. Study a Hybrid electric vehicle and mention the rating and function of each components used in HEV.
5. To observe and carry out the charging of a battery operated EV using charging station.

RECOMMENDED BOOKS

1. Hybrid Electric Vehicles: Principles and Applications with Practical Perspectives by Chris Mi & M. A. Masrur, Wiley Publisher
2. Modern Electric, Hybrid Electric, and Fuel Cell Vehicles: Fundamentals by Ali Emadi, M. Ehsani & Y. Gao, CRC Press
3. Standards: IEC IEC 60068-2 (1,2,14,30),IEC 61683,IEC 60227,IEC 60502 IEC 60947 part I,II

SUGGESTED DISTRIBUTION OF MARKS

Topic No.	Time Allotted (hrs)	Marks Allotted (%)
1	14	20
2	20	35
3	16	25
4	14	20
Total	64	100

5.6 MINOR PROJECT

L T P
- - 6

Minor project work aims at exposing the students to industrial/field practices so as to have an appreciation of size, scale and type of operations; and work culture in the industries. Also the student will be able to comprehend concepts, principles and practices taught in the classroom and their application in solving field/industrial problems. The work done in minor project work will also prepare them in taking up problem solving at latter stage under major project work.

Depending upon the interests of the students and location of the organization the student may be asked for:

Market Study in the following cases:

1. Various types of Cables available in the market, their current rating/ specifications, different makes/ manufacturing companies (minimum three), comparison of cost between different makes.
2. Various types of domestic/ wiring components such as switches, sockets, holders, conduits, battens, fixtures etc. : their specifications, different makes or manufacturing companies(minimum three), comparison of cost between different makes.
3. Various types of protective devices used in domestic and industrial wiring such as MCBs, ELCB/RCCB, fuses etc. their specifications, make (minimum three), and comparison of cost between different makes.
4. Various types of electric lamps (luminaries)available in the market, their specifications, different makes or manufacturing companies (minimum three), comparison of cost between different makes.
5. Various types of Electrical Appliances (domestic and commercial) available in the market, their specifications, different makes or manufacturing companies (minimum three), comparison of cost between different makes.

NOTE:-The students of the class may be divided into groups (3 to 5 students per group) and work may be assigned to each group as per their interest.

The components of evaluation will include the following:

Component	Weightage
a) Punctuality/Attendance	20 %
b) Initiative in learning new thing	10 %
c) Performance as Individual in the Team	10%
d) Project Report	40%
e) Viva	20%

6.1 ENERGY MANAGEMENT

L T P

4 - -

RATIONALE

Energy plays an important role in economic growth of any country. Economic growth is a measure of country's progress. Due to the difference in demand and supply of the energy, there is an urgent need of efficient and economic use of energy by incorporating energy conservation techniques and by efficiently managing the use of energy. The subject of Energy Management has become an integral part of every curriculum in degree and diploma levels in every professional institution. This subject will make the students to learn about the basic concepts of energy management so that they can apply these concepts while managing the energy intensive utilities.

DETAILED CONTENTS

1. **Review of Various Energy Sources** (10 hrs)
Brief overview of present energy scenario in India and worldwide, brief overview of share (in %age) of various energy sources in present energy scenario in India & worldwide, Basic concept and importance of Energy Management.
2. **Energy Conservation** (22 hrs)
Energy Conservation and its Need
Energy Conservation opportunities & energy efficient technologies in domestic and industrial sectors:
 - Energy Efficient lighting: Methods/Technologies of energy efficient lighting systems.
 - Heating: Energy efficient Methods/Technologies for energy savings in Furnaces, Ovens, Boilers, Heat Exchangers, Cooling Towers, and Pumps.
 - Cooling Systems : Methods/Technologies for Energy Savings in Ventilating systems and Air Conditioners (HVAC Systems)
 - Energy Efficient Motors, Soft Starters, and Variable Frequency Drives.
 - Power Factor improvement devices and their significance in energy conservation.
 - Amorphous Core Transformers
3. **Energy Conservation in Transmission and Distribution Systems** (10 hrs)
Reactive power compensation, Demand Side Management, Losses in transmission and distribution system and its minimization
4. **Energy Audit** (16 hrs)
Need of Energy Audit, Types of Energy Audit: Preliminary Audit, General or Mini audit, and Comprehensive Audit, Energy Audit methodologies/Procedure, Energy Flow Diagram and its importance.
Measurements in energy audit, List of measuring instruments and equipment used in

energy audit, Questionnaires for the energy audit, Energy audit checklist, Calculation of payback period, Case studies (any *Two*) of Energy Audit of any Commercial building and Small Industrial installation.

5 Energy and Environment

(6 hrs)

Environment and social concerns related to energy utilization, Environment impact assessment and its need, Environmental impact assessment in India.

RECOMMENDED BOOKS

1. Energy Management by Dr. Umesh Rathore, KATON Publication New Delhi
2. Energy Management by Dr. Sanjeev Singh & Dr. Umesh Rathore, KATON Publication New Delhi
3. Economic Loading of Power Plant and Electric System by M. J. Steinberg and T. H. Smith, John Willey
4. Generation Distribution and Utilization of Electrical Energy by C L Vadhawa, New Age Publication.
5. Study the World Energy Report
6. Study the Energy Audit Reports
7. Manuals of B. E. E (Bureau of Energy Efficiency)

SUGGESTED DISTRIBUTION OF MARKS

Topic No.	Time Allotted (hrs.)	Marks Allotted (%)
1	10	15
2	22	35
3	10	15
4	16	25
5	6	10
Total	64	100

6.2 ELECTRICAL POWER SYSTEM –III

L T P

4 - 2

RATIONALE

This part of the electrical power system covers switchgears and protection systems. The majority of the polytechnic pass outs who get employment in State Electricity Boards have to perform various activities in the field of Switchgear and Protection Systems of Electrical power. The range of these activities vary from operation and maintenance of various switchgears used in the electrical substation and implementing various protection schemes used for various electrical machines such as generators, transformers and transmission lines. After this course students will be able to operate and maintain various equipment of substations and implement various protection schemes used in the power system.

DETAILED CONTENTS

- 1. Introduction to Switchgear (8 hrs)**
 - 1.1 Switchgear, Essential features of Switchgear
 - 1.2 Switchgear elements and its operation
 - 1.3 Bus-bar arrangements
 - 1.4 Concept of short-circuit, short circuit current

- 2. Power System Faults (9 hrs)**
 - 2.1 Types of faults: symmetrical faults, unsymmetrical faults
 - 2.2 Unsymmetrical faults: Analysis of L-to-L, L-to-G and L-L-to-G faults

- 3. Fuses (5 hrs)**
 - 3.1 Advantages and disadvantages of fuse
 - 3.2 Desirable characteristics of fuse element, fuse element materials
 - 3.3 Important terms related to fuse: current rating of fuse element, fusing current, fusing factor, cut-off current, arcing time and breaking capacity
 - 3.4 Types of fuse: LV fuse and HV fuse
 - 3.5 LV fuse: semi-enclosed rewritable fuse and HRC fuse-their construction and working
 - 3.6 HV fuse: cartridge type, liquid type and metal clad type-their construction & working

- 4. Circuit Breakers (13 hrs)**
 - 4.1 Difference between Switch, Isolator and Circuit Breakers
 - 4.2 Function of Isolator and Circuit breaker
 - 4.3 Difference between Fuse and Circuit Breaker
 - 4.4 Arc phenomenon in circuit breaker: principles and methods of arc extinction.
 - 4.5 Terms related to circuit breaker: arc voltage, re-striking voltage and recovery voltage

- 4.6 Construction, working principles, types and applications of Air-Blast Circuit Breaker, Oil Circuit Breaker, Vacuum Circuit Breaker and SF₆ Circuit Breaker, Comparison between various types of Circuit Breakers in terms of their features and application areas.
- 4.7 Circuit breaker rating: breaking capacity, making capacity and short-time rating

5. Protective Relays (13 hrs)

- 5.1 Introduction: fundamental requirement of relay, function of relay
- 5.2 Electromagnetic attraction type relay
- 5.3 Electromagnetic induction type relays
- 5.4 Instantaneous relay, Inverse Time Relay, Definite Time lag relay
- 5.5 Relays Terminology: Pick-up Current, Current Setting, Plug Setting Multiplier (PSM), Time Setting Multiplier (TSM), Time/PSM Curve
- 5.6 Distance or Impedance Relay: definite-distance and time distance impedance relay
- 5.7 Differential Relays: current differential and voltage balance differential relay
- 5.8 Brief idea of Static and Microprocessor based relays & their applications

6. Protection Schemes in Power System (9 hrs)

- 6.1 Differential Protection Scheme for Alternators
- 6.2 Protection Schemes for Transformer, Buchholz relay
- 6.3 Merz-price voltage balance protection scheme for bus-bar and transmission line
- 6.4 Earth fault or Leakage Protection

7. Over-voltage Protection (7 hrs)

- 7.1 Introduction: voltage surge, causes of overvoltage
- 7.2 Lightning, lightning arresters such as rod gap, horn gap, multi-gap, expulsion type and valve type arrester
- 7.3 Brief idea about surge absorber
- 7.4 Transmission Line and substation protection against over-voltages

LIST OF PRACTICALS

- 1. Study of various types of fuses used in domestic and industrial installations
- 2. To study the construction of IDMT over-current relay
- 3. To study and plot Time-Current characteristics at various multiples of plug setting current in IDMT over current relay
- 4. Study of Air Blast Circuit breaker
- 5. Study of MOCB & BOCB
- 6. Study of SF₆ Circuit breaker
- 7. Study of Vacuum Circuit Breaker
- 8. Routine Testing of Circuit breaker as per IS specifications

Note: A visit to nearby substation may be carried out to study the various types of circuit breakers and other switchgear.

RECOMMENDED BOOKS

1. Principles of Power Systems by V.K. Mehta, S Chand and Co., New Delhi
2. A Course in Electrical Power by A. Chakarborty, M. L. Soni, P. V. Gupta and Bhatnagar, Dhanpat Rai & Sons, New Delhi
3. Testing, Commissioning, Operation and Maintenance of Electrical Equipment by S Rao, Khanna Technical Publication, New Delhi
4. Electrical Power – II by SK Sahdev, Unique International Publications, Jalandhar (Pb)
5. Electrical Power Systems by CL Wadhwa, Wiley Eastern Ltd., New Delhi
6. Electrical Power by Dr. SL Uppal, Khanna Publications, Delhi
7. Preventive Maintenance of Electrical Apparatus by SK Sharotri, Katson Publishing House, Ludhiana
8. Electrical Power Systems by B. M. Weedy, Wiley Publishing

SUGGESTED DISTRIBUTION OF MARKS

Topic No.	Time Allotted (hrs)	Marks Allotted (%)
1	08	12
2	09	15
3	05	8
4	13	20
5	13	20
6	09	15
7	07	10
Total	64	100

6.3 UTILIZATION OF ELECTRICAL ENERGY

L T P

4 - -

RATIONALE

This subject assumes importance in view of the fact that a technician has to work in a wide spectrum of activities wherein he has to make selection from alternative schemes making technical and economic considerations; e.g. to plan and design an electrical layout using basic principles and handbooks, to select equipment, processes and components in different situations. The curriculum has been designed keeping the above objectives in view. Besides giving him basic knowledge in the topics concerned, attempts have been made to ensure that the knowledge acquired is applied in various fields as per his job requirements. To orient the subject matter in the proper direction, visits to industrial establishments are recommended in order to familiarize the students with the new developments in different areas.

DETAILED CONTENTS

1. Electric Drives

(10 hrs)

- 1.1 Advantages of Electric Drives
- 1.2 Characteristics of different mechanical loads
- 1.3 Types of Motors used as electric drive
- 1.4 Electric braking
 - 1.4.1 Plugging
 - 1.4.2 Rheostatic braking
 - 1.4.3 Regenerative braking
- 1.5 Methods of power transfer by direct coupling by using devices like belt drive, gears, chain drives.
- 1.6 Selection of motors for different types of domestic loads
- 1.7 Selection of drive for applications such as general workshop, textile mill, paper mill, steel mill, printing press, cranes and lift. Applications of flywheel.

2. Illumination

(10 hrs)

- 2.1 Nature of light, visibility spectrum curve of relative sensitivity of human eye and wave length of light
- 2.2 Definition: Luminous flux, solid angle, luminous intensity, illumination, luminous efficiency, depreciation factor, coefficient of utilization, space to height ratio, reflection factor, glare, shadow, lux level.
- 2.3 Laws of Illumination
- 2.4 Different type of lamps, construction and working of incandescent and discharge lamps– their characteristics, fittings required for filament lamp, mercury vapor, sodium lamp, fluorescent lamp, halogen lamp, neon lamp, Compact fluorescent lamp, LED lamps.

- 2.5 Main requirements of proper lighting; absence of glare, contrast and shadow
- 2.6 Illumination requirement for street lighting, flood lighting, monument lighting and decorative lighting.
- 2.7 LED based lighting systems, advantages of LED based lighting

3. Electric Heating (10 hrs)

- 3.1 Advantages of Electrical Heating
- 3.2 Electrical Heating Methods:
 - 3.2.1 Resistance heating – direct and indirect resistance heating, electric ovens, their temperature range, properties of resistance heating elements, thermostat control circuit
 - 3.2.2 Induction Heating: Principle of core type and coreless induction furnace, their construction and applications
 - 3.2.3 Electric Arc Heating: direct and indirect arc heating, construction, working and applications of arc furnace.
 - 3.2.4 Dielectric heating: working principle and applications in industrial fields
 - 3.2.5 Infra-red heating and its applications
 - 3.2.6 Microwave heating and its applications

4. Electric Welding (6 hrs)

- 4.1 Advantages of Electric Welding
- 4.2 Welding methods
 - 4.2.1 Principles of resistance welding, types – spot, projection, seam and butt welding, welding equipment
 - 4.2.2 Principle of arc production, electric arc welding, characteristics of arc; carbon arc, metal arc, hydrogen arc welding method and their applications. Power supply requirement. Advantages of using coated electrodes, comparison between AC and DC arc welding, welding control circuits, welding of aluminum and copper materials

5. Electrolytic Processes (6 hrs)

- 5.1 Need of Electro-deposition
- 5.2 Laws of Electrolysis, process of electro-deposition - clearing, operation, deposition of metals, polishing and buffing
- 5.3 Equipment and accessories for electroplating
- 5.4 Factors affecting electro-deposition
- 5.5 Electroplating of non-conducting materials

6. Electrical Circuits used in Refrigeration, Air Conditioning and Water Coolers

(6 hrs)

- 6.1 Principle of air conditioning, vapor pressure, refrigeration cycle, eco-friendly refrigerants

- 6.2 Description and Working of Electrical circuits used in
 - 6.2.1 Refrigerator,
 - 6.2.2 Air-conditioner
 - 6.2.3 Water cooler

7. Electric Traction

(16 hrs)

- 7.1 Requirements of ideal Traction System, Different systems of electric traction, DC and AC systems, diesel electric system, types of services – urban, sub-urban, and main line and their speed-time curves, Advantages of Electric Traction
- 7.2 Different accessories for track electrification; such as overhead catenary wire, conductor rail system, current collector-pantograph
- 7.3 Electrical block diagram of an Electric Locomotive with description of various equipment and accessories used.
- 7.4 Types of motors used for electric traction
- 7.5 Starting and braking of electric locomotives
- 7.6 Introduction to EMU (Electrical Multiple Unit) and Metro Railway
- 7.7 Modern Electrical Traction systems, their features and advantages

Note: *Students should be taken for visits to nearest electrified railway track to study the electric traction system and industrial installation for studying electroplating process and various types of welding being used.*

RECOMMENDED BOOKS

1. Art and Science of Utilization of Electrical Energy by H.Partap, Dhanpat Rai & Sons, Delhi
2. Utilization of Electrical Energy by J.B. Gupta, Kataria Publications, Ludhiana
3. Utilization of Electrical Energy by Sahdev, Unique International Publication, Jalandhar
4. A Text Book. of Electrical Power by Dr. S. L.Uppal, Khanna Publications, Delhi
5. Modern Electric Traction by H Partap, Dhanpat Rai & Sons, Delhi
6. Utilization of Electrical Energy by O.S. Taylor, Pitman Publications
7. Generation, Distribution and Utilization if Electrical Power by C.L.Wadhwa, Wiley Eastern Ltd., New Delhi

SUGGESTED DISTRIBUTION OF MARKS

Topic No.	Time Allotted (hrs)	Marks Allotted (%)
1	10	15
2	10	15
3	10	15
4	06	10
5	06	10
6	06	10
7	16	25
Total	64	100

6.4.1 PROGRAMMABLE LOGIC CONTROLLERS & MICROCONTROLLERS

L T P

4 - 2

RATIONALE

A diploma holder when employed in automated industrial process controls or in automated power station will be required to know the basics of Programmable Logic Controllers, their working and their programming. In industry, many manufacturing processes demand a sequence of operation, which are to be performed repetitively. Early automation systems were mechanical in design, timing and sequencing being effected by gears and cams. Slowly these design concepts were replaced by electrical drives which were controlled by relays and now by programmable logic controllers (PLCs). A PLC is a solid state device, designed to operate in noisy industrial environments and can perform all logic functions. PLCs are widely used in all industries for efficient control operations. A diploma holder in industry is called upon to design, modify and troubleshoot such control circuits. Looking at the industrial applications of PLCs in the modern industry, this subject finds its usefulness in the present curriculum. Microcontrollers have also assumed great significance in the field of electronics and comma goods industry, and thus considered to be an important field of engineering. This subject aims to expose the students to both of these and give them adequate knowledge of these topics.

DETAILED CONTENTS

1. Introduction to PLC

(5 hrs)

Relays based logic circuits, limitations of relays based logic circuit, Concept of PLC, Advantages of PLCs over electromagnetic relays based logic circuits, Different programming languages used in PLC

2. Architectural Detail and Working of PLC

(9 hrs)

- 2.1 Basic operation and principle of working of PLC
- 2.2 Architectural details of PLC
- 2.3 Input & Output Modules in PLC
- 2.4 Opto-isolation Circuit in PLC and its need
- 2.5 Memory structures in PLC
- 2.6 HMI (Human Machine Interface) used in PLC system
- 2.7 Power supply requirements in PLC

3. Instructions Set

(7 hrs)

- 3.1 Addressing in PLC: I/O Address
- 3.2 Basic instructions: Examine ON, Examine OFF, Latch/Unlatch, Output Energize, Hold ON.
- 3.3 Timer instructions: On delay timer, Off delay timer, retentive/non-retentive timers, resetting of timers
- 3.4 Counter instructions: Up Counter, Down Counter, resetting of Counters

- 3.5 Comparison instructions like equal, not equal, greater, greater than equal, less than, less than equal
- 4. Ladder Logic Programming (9 hrs)**
Introduction to Ladder Logic programming, Ladder logic programming examples based on basic instructions, timer and counter instructions.
- 5. Applications of PLCs (7 hrs)**
Description, I/O assignment and ladder logic program for the following applications/processes
- 5.1 Forward/reverse control of motor using PLC
 - 5.2 Process Control (Stirred tank Heating Control)
 - 5.3 Car parking control
 - 5.4 Doorbell operation
 - 5.5 Traffic light control
- 6. 8051 Micro Controller – Over View (11 hrs)**
- 6.1 Difference between Microprocessor & Microcontroller
 - 6.2 Architectural Detail of 8051 microcontroller
 - 6.3 Pin details of 8051 microcontroller
 - 6.4 I/O Port Structure
 - 6.5 Memory Organization in 8051
 - 6.6 Special Function Registers
 - 6.7 Instructions in 8051 Microcontroller
 - 6.8 Addressing Modes in 8051 Microcontroller
 - 6.9 Timer operation
 - 6.10 Interrupts in 8051
- 7. Assembly language programming in 8051 Microcontroller (5 hrs)**
- 7.1 Structure of Assembly Language
 - 7.2 Assemblers and Compilers
 - 7.3 Assembler Directives
- 8. Design and Interface using 8051 Microcontroller (7 hrs)**
Keypad interface, 7- Segment interface, Stepper Motor interface
- 9. Introduction to PIC Microcontroller and Arduino board (4 hrs)**

LIST OF PRACTICALS

1. Observe various components /parts/symbols/connections of a PLC demonstration kit in your laboratory.
2. Observe the performance of following applications/processes operated using PLC kit and process panels in your lab. Write down the process/operation sequence, assign the inputs/outputs used in the process, write the ladder diagram program and run the required PLC program stored in the PLC and observe the sequence of operation process with:
 - 2.1 Doorbell operation.
 - 2.2 Traffic light control.
 - 2.3 Car parking
 - 2.4 Automatic Star/Delta Starter
 - 2.5 Process control
3. Observe various components/parts/symbols/connections of 8051 microcontroller Training kit in your laboratory.
4. Interface Seven segment display with Arduino board.

RECOMMENDED BOOKS

1. Programmable Logic Controller by Job Dan Otter; P.H. International, Inc,USA
2. PLC & Microcontrollers by Dr. Umesh Rathore, KATSON Publications New Delhi
3. PLC & Microcontrollers by Dr. Umesh Rathore & Ved Prakash Verma, KATSON Publications New Delhi
4. Introduction to PLCs by Gary Dunning, Thomson Press
5. Module on PLCs and their Applications by Rajesh Kumar, NITTTR Chandigarh
6. The 8051 Micro controller by 1 Scot Mackenzie, Prentice Hall International, London
7. The 8051 Micro controllers Architecture, programming and Applications by Ayala; Penram International
8. Process Control Instrumentation Technology by Johnson, Curtis; EE Edition, Prentice Hall of India, New Delhi
9. Microcontrollers by Ayala
10. The 8051 Microcontroller and Embedded Systems Using Assembly and C 2nd Edition, by M. A. Mazidi

SUGGESTED DISTRIBUTION OF MARKS

Topic No.	Time Allotted (Hrs)	Marks Allotted (%)
1	05	10
2	09	15
3	07	10
4	09	10
5	07	10
6	11	20
7	05	10
8	07	10
9	04	5
Total	64	100

6.4.2 INDUSTRIAL AUTOMATION

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4 - 2

RATIONALE

1. To explain applications of control systems / Automation
2. Design & program PLC using Ladder logic.
3. To study working of control components in automation system

DETAILED CONTENTS

- | | |
|--|-----------------|
| 1 Introduction to Automation | (5 hrs) |
| 1.1 Need of automation | |
| 1.2 Advantages of automation | |
| 1.3 Requirements of automation | |
| 2 Control System | (9 hrs) |
| 2.1 Concept of Control system | |
| 2.2 Types of Control: Open loop & Close loop | |
| 2.3 Examples of Open loop and Close loop Control System | |
| 2.4 Basic block diagram of Control System | |
| 2.5 Transfer Function | |
| 3 Control System Components | (11 hrs) |
| 3.1 Contacts-types, Current capacity | |
| 3.2 Solenoids, Relays: Electromechanical type ,reed type | |
| 3.3 I/P devices- switches-push buttons, foot switch, selector switch, pilot Switch, proximity, photoelectric, temperature actuated, level control, pressure sensing, overload sensing | |
| 3.4 O/P devices- Contactors, Valves, | |
| 4 Electrical Actuators | (7 hrs) |
| 4.1 Potentiometers as error detector | |
| 4.2 Servomotors-AC & DC | |
| 4.3 Synchros - transmitter, control transformer, use of Synchro as error detector | |
| 4.4 Stepper motor as actuator | |
| 5 Types of Controllers | (9 hrs) |
| 5.1 Hydraulic Controllers: Pumps and Valves, advantages & disadvantages of hydraulic controllers , | |
| 5.2 Pneumatic Controllers: Resistance & Capacitance effects of pressure system, pneumatic flapper-nozzle system, pneumatic relays, actuating valves, cylinders, comparison between pneumatic & hydraulic systems | |
| 5.3 Digital Controllers-brief overview of microprocessor & micro- controller based control systems | |

6 Control Actions (7 hrs)

- 6.1 On-Off, P, I, P+I, P+D, P+I+D, actions
- 6.2 P+I+D action using hydraulic, pneumatic electronic controller

7 Programmable Logic Controller (11 hrs)

- 7.1 Advantages of PLC over conventional relays based control
- 7.2 Architectural detail of PLC and function of each block
- 7.3 PLC Operation, Scan Cycle & Scan Time
- 7.4 Basic Instructions used in PLC (Examine ON, Examine OFF, Output Energize, Latch/Unlatch)
- 7.5 Timers & Counter Instructions
- 7.6 Ladder Logic Programs based on basic instructions and timer/counter instructions

8 Introduction to DCS & SCADA (5 hrs)

- 8.1 Distributed Control System(DCS)-brief introduction to DCS components and its applications
- 8.2 SCADA- brief introduction to SCADA system components and its applications
- 8.3 Smart Sensors

LIST OF PRACTICALS

1. To plot the Characteristics of potentiometer.
2. Use of potentiometer as error detector.
3. To plot V-I characteristics of DC & AC Servomotors. Compare them with DC & AC motor characteristics.
4. To use Synchro transmitter- control transformer pair as error detector.
5. Measure step angle for a stepper motor in forward & reverse direction.
6. Observe various components/parts/symbols/connections of a PLC demonstration kit in your laboratory.
7. Draw a ladder logic diagram using PLC for two different examples of industrial process.
8. Identify the parts of hydraulic/ pneumatic Servo system.

RECOMMENDED BOOKS

1. Control System Engineering by Nagrath & Gopal, Wiley Eastern Publisher
2. Modern Control Systems by K. Ogata, PHI
3. Industrial Control Engg. By Jacob, PHI
4. Hydraulic & Pneumatics by Andrew Parr
5. Basic Instrumentation Systems & PLC by Dr. Umesh Rathore, KATSON Publication
6. Computer based Industrial Control by Krishan Kant, PHI
7. Process Control Instrumentation Technology by Curtis Johnson, PHI

SUGGESTED DISTRIBUTION OF MARKS

Topic No.	Time Allotted (hrs)	Marks Allotted (%)
1	05	05
2	09	10
3	11	20
4	07	10
5	09	15
6	07	10
7	11	20
8	05	10
Total	64	100

6.4.3 TESTING & MAINTENANCE OF ELECTRICAL MACHINES

L T P

4 - 2

RATIONALE

This is technology level subject with application in Industry, commercial, public utility departments such as PWD, Irrigation, SEBs, Power Corporations, Water supply & Sewage board etc. After studying this subject student will be able to inspect, test, install & commission Electrical Machines as per IS and International standards. He/She shall carry out routine & preventive maintenance of electrical machines & possesses knowledge of Indian Electricity Act, safety rules, safety of machines & persons, prevention of accident. This will help him to initiate total productive maintenance.

DETAILED CONTENTS

1. Safety & Prevention of Accidents (5 hrs)

Definition of Safety, Hazard, accident, major accident hazard, responsibility, authority, accountability, Monitoring. Need of Safety, I.E. Rules & Statutory regulations for safety of persons & equipment in electrical installation, Dos & don'ts for Substation operators, Causes of electrical accidents, severity of shock, Procedure for rescuing the person who has received an electric shock, methods of providing artificial respiration, Precautions to be taken to avoid fire due to electrical faults, various measures to prevent electrical accidents, types and operation of fire extinguishers.

2. Introduction to Testing & Maintenance of Machines (10 hrs)

Objectives of Testing, Concept of tolerance, Routine tests, Special tests, Methods of testing: Direct, Indirect and Regenerative, Concepts of preventive, predictive, and breakdown maintenance, Advantages of maintenance, Preventive maintenance schedule, Introduction to Total Productive Maintenance.

3. Testing & Maintenance of Rotating Electrical Machines (12 hrs)

Type tests, routine tests & special tests of single and three-phase Induction motors, Routine, Preventive, & breakdown maintenance of Single & 3-phase Induction motors as per IS 9001:1992. Maintenance schedule of alternators & synchronous machines as per IS 4884- 1968. Brake test on DC Series motor.

4. Testing & Maintenance of Transformers (10 hrs)

Procedure for conducting following tests on Transformers: Measurement of winding resistance, no load losses, & no load current, impedance, voltage, load losses,

Insulation resistance, Induced over voltage withstand test, separate source voltage withstand test, Impulse voltage withstand test, Temperature rise test of oil & winding.

Different methods of determining temp rise in transformer: back to back test, short circuit test, open delta (delta –delta) test.

Preventive maintenance & routine maintenance of distribution transformer as per I.S. Periodic checks for replacement of oil, silica gel, parallel operation of single & 3-phase transformer, load sharing calculations

5. Testing & Maintenance of Insulation (5 hrs)

Classification of insulating materials as per I.S, factors affecting life of insulating materials, measurement of insulation resistance & interpretation of condition of insulating. Methods of measuring temperature of internal parts of windings/machines & applying the correction factor when the machine is hot.

Properties of good transformer oil, Causes of contamination of insulating oil, Procedure of acidity test, sludge test, crackle test and flash point test, Need and method of Filtration of Transformer oil, Methods of cleaning the insulation covered with loose, dry dust, sticky dirt, & oily viscous films, procedure for cleaning, washing & drying of insulation, re-varnishing, Methods of internal heating & vacuum impregnation.

6. Trouble Shooting of Electrical Machines & Switchgear (12 hrs)

Significance of Trouble Shooting of electrical machines, procedure of trouble shooting, Internal and External causes of Equipment failure.

Various types of faults (mechanical, electrical & magnetic) in electrical machines and reason for their occurrence,

Use and application of following tools in Troubleshooting: Bearing puller, Filler gauge, Dial indicator, Spirit level, Megger, Earth tester, Growler, Multimeter, Trouble shooting charts for Single & 3-phase Induction Motor, Transformers.

Common troubles in electrical installation, maintenance & trouble shooting of LV switchgear like MCCB, ELCB, contactors & batteries.

7. Installation of Electrical Machines & Equipment (10 hrs)

Factors involved in designing the machine foundation, Requirement of different dimension of foundation for static & rotating machines, procedure for levelling & alignment of two shafts of directly & indirectly coupled drives, effects of misalignment, Installation of rotating machines as per I.S.

Use of various devices & tools in loading, unloading, lifting, and carrying heavy equipment.

LIST OF PRACTICALS

1. Draw circuit diagram, select appropriate meters and connect it to perform routine test on single phase Induction motor.
2. As per the given circuit diagram perform routine test on three phase Induction motor, & calculate the different parameters.
3. Select two single phase transformers, perform polarity test, mark its terminals, select appropriate meters & perform back to back test, compare its regulation with direct loading method.
4. Carry out OC & SC test on Induction motor and calculate motor parameters.
5. Perform brake test on DC series motor & plot characteristic of output against torque, speed, and load current.
6. Observe & carry out weekly, monthly & yearly maintenance of motor in your workshop & prepare its report.
7. Prepare trouble-shooting chart for single and three phase transformers.
8. Prepare trouble-shooting chart for single and three phase motors.

RECOMMENDED BOOKS

1. Operation and Maintenance of Electrical Machines- Vol-I & II
2. Handbook & Journals on Preventive Maintenance by C. J. Hubert
3. Installation, Maintenance and Repair of Electrical Machines and Equipment by Madhvi Gupta, KATSON Publication
4. Electrical Workshop Practices by Dr. Umesh Rathore & Naresh K. Sharma, KATSON Publication New-Delhi
5. A Course in Electrical Installation, Estimating & Costing by J. B. Gupta, KATSON Publication

SUGGESTED DISTRIBUTION OF MARKS

Topic No.	Time Allotted (hrs)	Marks Allotted (%)
1	05	10
2	10	15
3	12	20
4	10	15
5	05	10
6	12	15
7	10	15
Total	64	100

6.5 ESTIMATING & 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 (14 hrs)**
Estimating, Purpose of estimating and costing, proforma for making estimates, catalogue, costing, price list, tender document, net price list, market survey, overhead charges, labor charges, electrical point method and fixed percentage method, contingency, profit, purchase system, enquiries, comparative statements, orders for supply, payment of bills. Tenders – it's constituents, types and procedure.
- 2. Wiring Systems and Protection Devices (14 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 such as fuse, MCB, ELCB and their selection. Use of wire-gauge and tables.
- 3. Estimating and Costing of Domestic & Industrial Electrical Installations (22 hrs)**
 - 3.1 Domestic installations: Standard practices 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.
 - 3.2 Industrial installations: relevant IE rules and 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 lighting load (3-phase supply system).
 - 3.3 Service line connections estimate for domestic and Industrial loads (overhead and Under-ground connections) from pole to energy meter.
 - 3.4 Earthing Systems Estimation: IS specifications regarding earthing, types of earthing, List of materials required for earthing, Design of earth wire/strip and electrode for domestic and industrial installation.

4. **Estimating of Transmission/Distribution Lines & Substations** (14 hrs)
- 4.1 Transmission and distribution lines (overhead and underground) planning and designing of lines with different fixtures, based on unit cost calculations.
- 4.2 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/33kV/11kV Substation.

RECOMMENDED BOOKS

1. A Course in Electrical Installation, Estimating and Costing by J.B. Gupta, SK Kataria and Son (KATSON), New Delhi
2. A Textbook on Electrical Workshop Practices by Dr. Umesh Rathore and Naresh Kumar Sharma, KATSON Publication, New Delhi
3. Electrical Design, Estimating and Costing by K. B. Raina & S. K. Bhattacharya, McGraw Hill Book Company, New Delhi
4. Estimating and Costing by Surjeet Singh, Dhanpat Rai & Co., New Delhi
5. Electrical Estimating and Costing by N Alagappan and B Ekambaram, TMH, New Delhi

SUGGESTED DISTRIBUTION OF MARKS

Topic No.	Time Allotted (hrs)	Marks Allotted (%)
1	14	22
2	14	22
3	22	34
4	14	22
Total	64	100

6.6 MAJOR PROJECT

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RATIONALE

Project work aims at developing skills in the students whereby they apply in totality the knowledge and skills gained through the course in solving a practical problem undertaken as a project work. The students have different aptitudes and strengths. Project work therefore, should match the strengths of students. For this purpose, students should be asked to identify the type of project work, they would like to execute. It is also essential that the faculty of the respective departments may have a brainstorming session to identify suitable project assignments. The project assignment can be individual assignment or a group assignment. There should not be more than 3 students if the project work is given to a group. The students should identify themselves or be given project assignment at least two to three months in advance. The project work identified in collaboration with industry/field organization should be preferred.

DETAILED CONTENTS

Each teacher is required to guide the project work of 5-6 students at a time. The project assignments may consist of:

- a) Projects related with repair and maintenance of electrical machine parts
- b) Estimating and costing projects in electrical engineering
- c) Design of components/ parts/ machinery related to Electrical Engineering
- d) Projects related to quality control
- e) Project work related to increase productivity and Energy Efficiency
- f) Project related to fabrication of automated control circuits using electronic devices
- g) Projects relating to erection, installation, calibration and testing of electrical installation
- g) Projects related to Energy Conservation and Energy Audit
- h) Projects related to Renewable Energy Conversion Technologies
- i) Projects related to industry/utilities related design problems and their solutions

For Students of Electrical Engineering Diploma Programme the project work can be grouped under the following three groups. A number of projects have been mentioned under each section. A student should take at least **TWO** projects; both of which should not be from the same group. Report for all projects should be prepared and will give a seminar. The same will be assessed for internal and external assessment

SECTION A

1.1 Electrical Machines and Equipment

- 1.1 Automatic Star Delta Starter using Relays and Adjustable Electronic Timer for Induction Motor
- 1.2 Design and Construction of a Small Transformer (100 VA to 1kVA rating)
- 1.3 Construction of phase sequence indicator (Phase Sequence Checker for Three-Phase Supply)
- 1.4 Construction of Hot air drier
- 1.5 Construction of a Simple loop Generator
- 1.6 Design and fabrication of Automatic Curtain Operating System
- 1.7 Construction of Automatic Water Level Controller
- 1.8 Design and Construction of Desert Cooler
- 1.9 Rewinding of motors up to 5HP ratings
- 1.10 Erection/Installation and Commissioning of Electrical Machines in a Workshop
- 1.11 Fault detection and repair of electrical/electronic instruments
- 1.12 Design and assembly of relay and contactor based control circuit
- 1.13 Study and details descriptions of Electrical system in an Electric locomotive unit

SECTION B

1.2 Electrical Power and Energy

- 1.2.1 Drawing, estimating and costing of electrical installation of the institution from supplier's pole to the institution distribution board.
- 1.2.2 Drawing, estimating and costing of electrical installation of a workshop having a given number of electrically operated appliances/machines.
- 1.2.3 To study and prepare the estimate for laying of underground distribution cable for a small colony/industrial installation starting from main distribution pole
- 1.2.4 To study the erection of overhead line for a small distance for distribution of electrical energy. Prepare the list of materials and estimate the cost.
- 1.2.5 To survey the load of given area in a village, small colony, calculate the effective load and find out the sizes of the cables/conductors for the proposed distribution system
- 1.2.6 Designing of light and fan scheme for an institutional or commercial building
- 1.2.7 To study the augmentation of a nearby pole mounted sub-station or any high voltage tower of transmission line passing nearby
- 1.2.8 To design the illumination scheme suggesting types of luminaries to be used for various sections of any domestic or commercial installation or sports complex.
- 1.2.9 To design the illumination scheme suggesting types of luminaries to be used for various sections of any industrial installation

- 1.2.10 Preparing a Model of Wind Energy Conversion System
- 1.2.11 Preparing a Model of Hybrid Power Generation System using hydro/solar/wind energy and Storage battery system
- 1.2.12 Detailed Energy Audit of an Industrial/commercial or Domestic electrical installation
- 1.2.13 Design and Fabrication of a Solar Tree
- 1.2.14 Wireless Power Transfer project
- 1.2.15 Over Voltage or Under Voltage Tripping Mechanism
- 1.2.16 Solar Powered Auto-Irrigation System
- 1.2.17 XBEE Based Remote Monitoring of 3 Parameters on Transformer / Generator Health

SECTION C

1.3 Electronic Based Projects

Fabrication of:

- 1.3.1 Voltage Stabilizer for Refrigerator, Air-Conditioner
- 1.3.2 Emergency light using SCR
- 1.3.3 Regulated Power supply (+/-12V and +6/-V) using 7812, 7912 and 7806, 7906
- 1.3.4 Automatic Battery Charger Circuit using SCR
- 1.3.5 Burglar Alarm Circuit
- 1.3.6 Fire Sensing Alarm Circuit
- 1.3.7 Automatic Street light Control Circuit
- 1.3.8 Thyristors based Converter/Inverter Circuit.
- 1.3.9 Traffic Lights Control Circuit
- 1.3.10 Automatic Car Parking Control Circuit
- 1.3.11 Thyristors based Speed controller for DC or AC Motors
- 1.3.12 Solar based lighting/heating system using Solar Tracker
- 1.3.13 Small PLC based Automatic Control Circuits
- 1.3.14 Microcontroller based Automatic Control Circuits
- 1.3.15 Mobile based Control System for Household gadgets
- 1.3.16 Electronic Soft Starter for 3-Phase Induction Motor
- 1.3.17 Programmable Switching Control for Industrial Automation in Repetitive Nature of Work
- 1.3.18 Energy Meter Billing with Load Control over GSM with User Programmable Number Features by PIC Microcontroller
- 1.3.19 GSM Based Monthly Electricity Energy Billing and SMS upon GSM with User Programmable Features.
- 1.3.20 Solar Powered LED Street Light with Auto-Intensity Control
- 1.3.21 Solar Power Charge Controller

6.7 PRACTICES IN COMMUNICATION SKILLS

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RATIONALE

For successful completion of diploma programme, the students should possess adequate command on language and communication skills so that they are able to express themselves with ease and felicity. The language used by the students should be appropriate to objectives and occasion. The contents of this subject shall provide them practical training through language laboratory.

LIST OF PRACTICALS

1. **Exercises on phonetics** (8 hrs)
 - 1.1 Identifications of English phonemes
 - 1.2 Stress and Intonation
 - 1.3 Speaking exercises with emphasis on voice modulation (reading and extempore)
2. **Group Discussion** (4 hrs)
3. **Exercises on** (4 hrs)
 - Self-assessment using tools like SWOT analysis
 - Listening skills
4. **Internet communication and Correspondence** (4 hrs)
 - 4.1 Resume writing
 - 4.2 Covering letter
 - 4.3 Agenda and Minutes of meeting
 - 4.4 Business Correspondence
5. **Exercises on** (4 hrs)
 - 5.1 Body language and Dress sense
 - 5.2 Etiquettes and mannerism in difficult situations like business meetings, table manners, Telephone etiquette
 - 5.3 Manners related to opposite gender
 - 5.4 Cross-cultural Communication
6. **Mock interviews** (telephonic/personal) (4 hrs)
7. **Role plays for effective Communication** (4 hrs)