CURRICULUM

for

DIPLOMA PROGRAMME

in

# ELECTRICAL AND ELECTRONICS ENGINEERING

3rd Year (5rd & 6th Semester)

FOR THE STATE OF HIMACHAL PRADESH

June, 2019

# Study & Evaluation Scheme

## 5th Semester Electrical & Electronics 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 Machines – III** | 5 | 2 | 30 | 20 | **50** | 100 | 3 | 50 | 3 | **150** | **200** |
| 5.3 | Power Electronics & Control of Drives** | 4 | 2 | 30 | 20 | **50** | 100 | 3 | 50 | 3 | **150** | **200** |
| 5.4 | Electrical Power System - II** | 4 | - | 50 | - | **50** | 100 | 3 | - | - | **100** | **150** |
| 5.5 | Elective – I | | | | | | | | | | | |
| | 5.5.1 Industrial Instrumentation*** | 5 | 2 | 30 | 20 | **50** | 100 | 3 | - | - | **100** | **150** |
| | 5.5.2 Non-Conventional Energy Resources** | 4 | 2 | 30 | 20 | **50** | 100 | 3 | - | - | **100** | **150** |
| | 5.5.3 Medical Electronics **** | 4 | - | 50 | - | **50** | 100 | 3 | - | - | **100** | **150** |
| 5.6 | Minor Project | - | 6 | | 50 | **50** | - | - | 50 | - | **50** | **100** |
| Industrial Training | | - | - | - | 50 | **50** | - | - | 50 | - | **50** | **100** |
| Student Centered Activities | | - | 4 | | 25 | **25** | - | - | - | - | | **25** |
| Total | | 22 | 16 | | | **375** | | | | | **700** | **1075** |

* Common with all diploma programmes

** Common with diploma in Electrical Engineering

*** Common with diploma in Instrumentation Engineering

****Common with diploma in Electronics and Communications 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 & Electronics 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 | Principles of Communication Engineering | 4 | 2 | 30 | 20 | **50** | 100 | 3 | 50 | 3 | **150** | **200** |
| 6.2 | Electrical Power System-III** | 4 | 2 | 30 | 20 | **50** | 100 | 3 | 50 | 3 | **150** | **200** |
| 6.3 | Programmable Logic Controllers & Microcontrollers** | 4 | 2 | 30 | 20 | **50** | 100 | 3 | 50 | 3 | **150** | **200** |
| 6.4 | Elective – II | | | | | | | | | | | |
| | 6.4.1 Utilization of Electrical Energy** | 4 | - | 50 | - | **50** | 100 | 3 | | | **100** | **150** |
| | 6.4.2 Energy Management** | 4 | - | 50 | - | **50** | 100 | 3 | - | - | **100** | **150** |
| | 6.4.3 Optical Fibre Communication *** | 4 | 2 | 30 | 20 | **50** | 100 | 3 | | | **100** | **150** |
| 6.5 | Practices in Communication Skills* | - | 2 | - | 50 | **50** | - | - | 50 | 3 | **50** | **100** |
| 6.6 | Major Project | - | 10 | | 100 | **100** | - | - | 100 | 3 | **100** | **200** |
| Student Centered Activities | | - | 2 | | | **25** | | | | | | **25** |
| **Total** | | **16** | **22** | | | **375** | | | | | **700** | **1075** |

* Common with all diploma programmes

** Common with diploma in Electrical Engineering

***Common with diploma in Electronics and Communications 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.*

## 5.1 BASICS OF MANAGEMENT & ENTREPRENEURSHIP DEVELOPEMENT

L T P
4 - -

**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.orf)
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

L T P
5 - 2

**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 toque
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 POWER ELECTRONICS AND CONTROL OF DRIVES

L T P
4 - 2

**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-PhaseConverters

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 &B ranko 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** |

# 5.4 ELECTRICAL POWER SYSTEM-II

L T P
4 - -

**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** |

# 5.5.1 INDUSTRIAL INSTRUMENTATION

L T P
5 - 2

**RATIONALE**

*Measurement of different parameters in the field of Instrument Engineering is very important, hence the syllabus has been designed in two parts to give through in sight in the measurements of parameters. Different methods of measurement and their appropriate selection with limitation have also been considered to bring the students to a level where they will be able to solve practical problems faced in the field.*

## DETAILED CONTENTS

1. **Temperature Measurement** **(20 hrs)**

- 1.1 Introduction to Temperature, Temperature scales and Conversions.
- 1.2 Methods of Temperature Measurements:
  - 1.2.1 Expansion Type: Bi-Metallic Thermometer, Liquid in Glass and Metal Thermometer.
  - 1.2.2 Electrical Type:
    - 1.2.2.1 RTD: Principle, Working, Construction and Types with Ranges, Different Configurations of RTD: Two Wire, Three Wire and Four Wire, Lead Wire Compensation in RTD, Applications.
    - 1.2.2.2 Thermistor: Principle, Working, Construction, Types, Applications.
    - 1.2.2.3 Thermocouple: Different Thermal Effects (Seebeck, Peltier and Thomson), Working Principle (Seebeck Effect), Thermocouple Construction, Types of Thermocouple (only Material of Constructions and their Ranges): J, K, T, E, N, S, R and B Type, Cold Junction Compensation of Thermocouples.
    - 1.2.2.4 Pyrometers: Radiation Pyrometers and Optical pyrometer.

2. **Level Measurement** **(15 hrs)**

- 2.1 Introduction to Level Measurement.
- 2.2 Methods of Level Measurement: Direct Methods and Indirect Methods.
- 2.3 Direct Methods: Visual level indicator, Hook Type Level Indicators, Float Type Level Indicators.
- 2.4 Indirect Methods (Hydrostatic Pressure Type): Pressure Gauge Methods, Air Bellows and Air Purge System.
- 2.5 Indirect Methods (Electrical Type): Resistance Type, Capacitance Type, Gamma ray Type (Radiation Type) and Ultrasonic Type.

3. **Flow Measurement** **(25 hrs)**

3.1 Introduction to Flow Measurement, Concept of Volumetric and Mass Flow Rate.

3.2 Concept of Reynolds Number in Flow Measurement, Different Types of Flow: Laminar and Turbulent, Bernoulli Equation.

3.3 Methods of Flow Measurement:

3.3.1 Variable Head/Differential Pressure/Obstruction Type Flow Meters:

3.3.1.1 Basic Operating Principle, Concept of Pressure Head.

3.3.1.2 Primary Elements of Differential Flow Meters: Orifice Plate, Venturi Tube, Flow Nozzle and Pitot Tube.

3.3.2 Variable Area Flow Meter: Rotameter.

3.3.3 Electromagnetic Flow Meter.

3.3.4 Ultrasonic Flow Meter.

3.3.5 Turbine Flow Meter.

3.3.6 Mass Flow Meter.

4. **Pressure Measurement** **(20 hrs)**

4.1 Introduction to Pressure and different types of Pressure.

4.2 Methods of Pressure Measurement:

4.2.1 Manometer: U Tube Manometer, Barometer, Inclined Manometer and Well Type Manometer.

4.2.2 Elastic Pressure Transducers: Bourdon Tube, Diaphragm and Bellow Type.

4.2.3 Force Balance Type: Dead Weight Tester.

4.2.4 Electrical Type: Strain Gauge Pressure Transducer, Potentiometric Pressure Transducer, Capacitive Pressure Transducer and LVDT Type Pressure Transducer.

4.3 Measurement of Vacuum: Pirani Gauge, Capsule Gauge, Mcleod Gauge, Thermal Conductivity Gauge.

## LIST OF PRACTICALS

1. To Study a Resistance Thermometer.
2. To Study Variable Area Flow Meter.
3. To Observe Flow Rate using a Turbine Type Flow Meter.
4. To Dismantle and Assemble a Bourdon's Pressure Gauge and identify its parts.
5. To Observe Pressure using Pressure Gauge of a Pressure Tank.
6. To Calibrate a Pressure Gauge using a Dead Weight Tester.

**REFERENCE BOOKS**


1. Industrial Instrumentation and Control, by S. K. Singh, TMH.
2. Introduction to Instrumentation and Measurement, by A. K. Ghosh, PHI.
3. Instrumentation Measurement and Analysis, by B. C. Nakra and K. K. Chaudhary, TMH.

4. Industrial Instrumentation, by Umesh Rathore, S. K. Kataria.
5. Industrial Instrumentation, by K. Krishnaswamy, New Age Publication.
6. Measurement, Instrumentation & Sensors, by John G. Webster, Springer.

## SUGGESTED DISTRIBUTION OF MARKS

| Topic No. | Time Allotted (Hrs) | Marks Allotted (%) |
|---|---|---|
| 1 | 20 | 25 |
| 2 | 15 | 20 |
| 3 | 25 | 30 |
| 4 | 20 | 25 |
| **Total** | **80** | **100** |

# 5.5.2 NON-CONVENTIONAL ENERGY RESOURCES

L T P

4 - 2

**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** |

# 5.5.3 MEDICAL ELECTRONICS

L T P
4 - -

**RATIONALE**

*A large number of electronic equipment's are being used in hospitals for patient care and diagnosis or carry out advanced surgeries. This subject will enable the students to learn the basic principles of different instruments used in medical science.*

**DETAILED CONTENTS**

1. Overview of Medical Electronics Equipment, classification, application and specifications of diagnostic, therapeutic and clinical laboratory equipment, method of operation of these instruments **(08 hrs)**

2. **Electrodes** **(10 hrs)**

   Bioelectric signals, Bio electrodes, Electrode, Electrode tissue interface, contact impedance, Types of Electrodes, Electrodes used for ECG, EEG

3. **Transducers** **(10 hrs)**

   Typical signals from physiological parameters, pressure transducer, flow transducer, temperature transducer, pulse sensor, respiration sensor,

4. **Bio Medical Recorders** **(12 hrs)**

   Block diagram description and application of following instruments
   - ECG Machine
   - EEG Machine
   - EMG Machine

5. **Patient Monitoring Systems** **(12 hrs)**

   - Heart rate measurement
   - Pulse rate measurement
   - Respiration rate measurement
   - Blood pressure measurement
   - Principle of defibrillator and pace mark

6. **Safety Aspects of Medical Instruments** **(12 hrs)**

   - Gross current shock
   - Micro current shock
   - Special design from safety considerations.
   - Safety standards.

**Note:** Students must be taken for a visit to hospital for exposure of various medical electronics related equipments like ventilator, boyles apparatus, pulse ox meters, defibrillators, bedside monitor and x-ray equipment etc.

**RECOMMENDED BOOKS**


1. Handbook of Biomedical Instrumentation by RS Khandpur,Tata McGraw Hill Education Pvt Ltd, New Delhi
2. Biomedical Instrumentation by Cromwell
3. Modern Electronics Equipment by RS Khandpur, TMH, New Delhi
4. Introduction to Biomedical Electronics by Edward J. Perkstein; Howard Bj, USA


**SUGGESTED DISTRIBUTION OF MARKS**

| Topic No. | Time Allotted (hrs) | Marks Allotted (%) |
|---|---|---|
| 1 | 08 | 12 |
| 2 | 10 | 14 |
| 3 | 10 | 14 |
| 4 | 12 | 20 |
| 5 | 12 | 20 |
| 6 | 12 | 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 communication devices such as mobiles etc.: their specifications, features, make (minimum three), and comparison of cost between different makes.
4. Various types of electronic gadgets 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 evolution 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 PRINCIPLES OF COMMUNICATION ENGINEERING

L T P
4 - 2

**RATIONALE**

*The study of principles of communication systems leads to further specialized study of audio and video systems, line communications and microwave communication systems. Thus the diploma-holder in Electronics and Communication Engineering shall find employment in areas of R and D, production, servicing and maintenance of various communication systems. The students should understand the advantage and limitations of various analog and digital modulation systems on a comparative as calendar late to them while studying practical communication systems.*

**DETAILED CONTENTS**

1. **Introduction** **(02 hrs)**
   - 1.1 Need for modulation and demodulation in communication systems.
   - 1.2 Basic scheme of a modern communication system.

2. **Amplitude modulation** **(05 hrs)**
   - 2.1 Derivation of expression for an amplitude modulated wave. Carrier and side band components. Modulation index. Spectrum and band width of AM Wave. Relative power distribution in carrier and side bands.
   - 2.2 Elementary idea of DSB-SC, SSB-SC, ISB and VSB modulations, their comparison, and areas of application.

3. **Frequency modulation** **(05 hrs)**
   - 3.1 Expression for frequency modulated wave and its frequency spectrum (without Proof and analysis of Bessel function) Modulation index, maximum frequency deviation and deviation ratio, BW and FM signals, Carson's rule.
   - 3.2 Effect of noise on FM carrier. Noise triangle, Role of limiter, Need for pre-emphasis and de-emphasis, capture effect.
   - 3.3 Comparison of FM and AM in communication systems.

4. **Phase modulation** **(03 hrs)**

   Derivation of expression for phase modulated wave, modulation index, comparison with frequency modulation.

5. **Principles of Modulators** **(09 hrs)**

   Working principles and typical application of:
   - Square Law Modulation.
   - Collector modulator
   - Balanced Modulator

6. **Principles of FM Modulators** **(07 hrs)**

   Working principles and applications of reactance modulator, varactor diode modulator, VCO and Armstrong phase modulator .

7. **Demodulation of AM Waves** **(09hrs)**

7.1 Principles of demodulation of AM wave using diode detect or circuit; concept of clipping and formula for RC time constant for minimum distortion (no derivation)

7.2 Principle of demodulation of AM Wave using synchronous detection.

8. **Demodulation of FM Waves** **(09hrs)**

8.1 Basic principles of FM detection using slope detector

8.2 Principle of working of the following FM demodulators:-

- Foster-Seeley discriminator
- Ratio detector
- Phase locked Loop (PLL) FM demodulators

9. **Pulse Modulation** **(15hrs)**

9.1 Statement of sampling theorem and elementary idea of sampling frequency for pulse modulation.

9.2 Basic concepts of time division multiplexing (TDM) and frequency division multiplexing (FDM).

9.3 Basic ideas about PAM, PPM, PWM.

9.4 Pulse code Modulation (PCM) Basic scheme of PCM system. Quantization, quantization error, companding error, block diagram of TDMPCM communication system and function of each block. Advantages of PCM systems. Concepts of differential PCM (DPCM).

9.5 Delta Modulation (DM), Basic principle of delta modulation system, advantages of delta modulation system over PCM system. Limitations of delta modulation, concept of adaptive delta modulation (ADM).

**LIST OF PRACTICALS**

1. To observe an AM wave on CRO and measure its modulation index.
2. To obtain an AM wave from a square law modulator circuit and observe wave forms.
3. To obtain an FM wave from voltage controlled oscillator circuit and measure the frequency deviation for different modulating signals.
4. To obtain modulating signal from an AM detector circuit and observe the pattern for different RC time constants.
5. To obtain modulating signal from a FM Ratio detector circuit.
6. To observe the sampled signal and compare it with the analog input signal.
7. To observe and note the pulse modulated signals (PAM, PPM, PWM) and compare them with the corresponding analog input signal.
8. To feed an analog signal to a PCM modulator and compare the demodulated signal with the analog input.
9. To study the process of delta modulation/demodulation.

**RECOMMENDED BOOKS**


1. Electronics Communication by Kennedy, Tata McGraw Hill, New Delhi
2. Electronics Communication by K S Jamwal, Dhanpat Rai and Co, New Delhi
3. Radio Engineering by G K Mittal, Khanna Publishers, New Delhi
4. Principles of Communication Engineering by D R Arora, Ishan Publications, Ambala
5. Communication Engineering by A Kumar
6. Principles of Communication Engineering by Manoj Kumar, Satya Prakashan, New

Delhi.
7. Principles of Communication Engineering by Anokh Singh ,S. Chand and Co., New Delhi.
8. Principles of Communication Engineering by Roody, Coolin

## SUGGESTIVE DISTRIBUTION OF MARKS

| Topic No. | Time Allotted (hrs) | Marks Allotted (%) |
|---|---|---|
| 1 | 2 | 5 |
| 2 | 5 | 10 |
| 3 | 5 | 10 |
| 4 | 3 | 5 |
| 5 | 9 | 10 |
| 6 | 7 | 10 |
| 7 | 9 | 10 |
| 8 | 9 | 10 |
| 9 | 15 | 30 |
| 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 $SF_6$ 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 Lightening, lightening 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 $SF_6$ 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 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 – Overview** **(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** |

# 6.4.1 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** |

# 6.4.2 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** |

# 6.4.3 OPTICAL FIBRE COMMUNICATION

| L | T | P |
|---|---|---|
| 4 | - | 2 |

**RATIONALE**

*Progressing from communication over copper wire to today's fibre optic communication, we have increased our ability to transmit more information, more quickly and over longer distances. This has expanded our boundaries and is finding a good slot in communication system. Optical fibers has replaced existing transmission media due to its advantages. As a result the technicians are supposed to have knowledge of optical communication. This subject will provide basic concepts and requisite knowledge and skill required.*

**DETAILED CONTENTS**

1. **Introduction** **(12 hrs)**
   1. Historical perspective, basic optical fibre communication systems, optical frequency range, advantages of optical fiber communication, application of fiber optic communication
   2. Electromagnetic spectrum used, Advantages and disadvantages of optical communication.
   3. Principle of light penetration, reflection, critical angle.

2. **Optical Fibres and Cables** **(08 hrs)**
   1. Constructional details of various optical fibers, multimode and mono-mode fibres, step index and graded index fibres, acceptance angle and types of optical fibre cables.
   2. Optical Fibers cable connectors and splicing techniques (Mechanical, fusion)

3. **Losses in Optical Fibre Cable** **(08 hrs)**
   1. Absorption Losses: Scattering Losses, Radiation losses, Connector losses, Bending loses.
   2. Dispersion: Types and its effect on data rate.
   3. Testing of losses using OTDR (Optical Time Domain Reflectometer).

4. **Optical Sources** **(10 hrs)**

   Characteristics of light used in optical communication, principle of operation of LED, different types of LED structures used and their brief description, Injection laser diode, principle of operation, different injection laser diodes, comparison of LED and ILD.

5. **Optical Detectors** **(08 hrs)**

   Characteristics of photo detectors used in optical communication; PIN diode and avalanche photo diode (APD), Noise in detectors

6. **Optical Amplifiers** **(10 hrs)**

   Types of optical amplifiers, semiconductor & fiber optical amplifiers Functional types, principal of operation of SOA, types of SOA. FPA, TWA, SOA applications, advantages, Drawbacks, EDFAS, Raman amplifiers

7. **Optical Fibre System Application** **(08 hrs)**

Role of OFC in Fibre to the x (FTTx), NGN (Next Generation Network), NFS ( Need for Spectrum), IOT (Internet of Things),

**LIST OF PRACTICALS**

1. Setting up of fibre analog link
2. Setting up of optic digital link
3. Measurement of bending losses in optical fibers
4. To measure and calculate numerical aperture of optical fiber
5. To observe characteristics of LED source and detector
6. To demonstrate the splicing of optical fiber
7. Demonstration of various components and tools used in optical fiber communication

**RECOMMENDED BOOKS**


1. Optical fibre Communication by John M Senior, Prentice Hall of India, New Delhi
2. Optical fibre Communication by J. Gower, Prentice Hall of India, New Delhi
3. Optical fibre Communication by Gerd Keiser, McGraw Hill International Editions
4. Optical Communications – Components and Systems by JH Franz and VK Jain, Narosa Publishing House, New Delhi
5. Optical Fibre Communication by Sangar and Sahdev, Uneek Publications, Jalandhar


**SUGGESTED DISTRIBUTION OF MARKS**

| Topic No. | Time Allotted (hrs) | Marks Allotted (%) |
|---|---|---|
| 1 | 12 | 20 |
| 2 | 8 | 15 |
| 3 | 8 | 15 |
| 4 | 10 | 15 |
| 5 | 8 | 10 |
| 6 | 10 | 15 |
| 7 | 8 | 10 |
| **Total** | **64** | **100** |

# 6.5 PRACTICES IN COMMUNICATION SKILLS

L T P
- - 2

**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)**

# 6.6 MAJOR PROJECT WORK

| L | T | P |
|---|---|---|
| - | - | 10 |

## RATIONALE

*Major Project Work aims at developing innovative skills in the students whereby they apply in totality the knowledge and skills gained through the course work in the solution of particular problem or by undertaking a project. In addition, the project work is intended to place students for project oriented practical training in actual work situation for the stipulated period.*

## LEARNING OUTCOMES

After undergoing the project work, students will be able to:

Apply in totality the knowledge and skills gained through the course work in the solution of particular problem or by undertaking a project. In addition, the project work is intended to place the learner for project oriented practical training in actual work situation for the stipulated period with a view to:

- Develop understanding regarding the size and scale of operations and nature of field-work in which students are going to play their role after completing the courses of study
- Develop understanding of subject based knowledge given in the classroom in the context of its application at work places
- Develop first hand experience and confidence amongst the students to enable them to use and apply polytechnic/institute based knowledge and skills to solve practical problems related to the world of work.
- Develop abilities like interpersonal skills, communication skills, positive attitudes and values etc.

## General Guidelines

The individual 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. The activity of problem identification should begin well in advance (say at the end of second year). Students should be allotted a problem of interest to him/her as a major project work. It is also essential that the faculty of the respective department may have a brainstorming session to identify suitable project assignments for their students. 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 project work identified in collaboration with industry should be preferred.

This practical training cum project work **should not be considered** as merely conventional industrial training in which students are sent at work places with either minimal or no supervision. This experience is required to be planned in advance and supervised on regular basis by the polytechnic faculty. For the fulfillment of above objectives, polytechnics may establish close linkage with 8-10 relevant organization for providing such an experience to

students. It is necessary that each organization is visited well in advance and activities to be performed by students are well defined. The chosen activities should be such that it matches with the curricular interest to students and of professional value to industrial/ field organizations. Each teacher is expected to supervise and guide 5-6 students.

Some of the project activities are given below:

- Projects related to designing small electrical equipment / instruments.
- Projects related to increasing productivity in electrical manufacturing areas.
- Projects related to quality assurance.
- Projects connected with repair and maintenance of plant and equipment.
- Projects related to design of PCBs.
- Projects related to design of small oscillators and amplifier circuits.
- Projects related to design, fabrication, testing and application of simple digital circuits and components.
- Projects related to microprocessor/microcontroller based circuits/ instruments.

**Some of the projects based on above areas are listed below for the benefit of students:**

1. Design and fabrication of control panel for various applications in the field of electrical engineering.
2. Rewinding of a single phase/three phase induction motor
3. Fabrication of working model of a solar thermal power plant.
4. Design and fabrication of automated car parking system.
5. Design and fabrication of automated gate control of railway crossing.
6. Design and fabrication of electrical resistive/inductive/capacitive loads.
7. Design and fabrication of remote control of various domestic electrical appliances.
8. Design and fabrication of microcontroller based DC drive system.
9. Design and fabrication of automatic water level control system.
10. Design and fabrication of automatic solar battery charger.
11. Fabrication of automatic star-delta starter.
12. Use of sensor in robotic action.
13. Fabrication of working model of hydro electric power plant.
14. Fabrication of sine wave inverter up to 500VA.
15. Fabrication of water level indicator.
16. Fabrication of rain/fire/ smoke/burglar detector.
17. Fabrication of automatic solar panel based street lights.
18. Fabrication of automatic solar panel based traffic lights
19. Fabrication of automatic voltage stabilizer up to 1 KVA.
20. Fabrication of working model of wind power plant.
21. Fabrication of heat convector blower with humidifier.
22. Fabrication of oil based radiation type room heater.
23. Fabrication of small 1- phase transformer up to 1KVA.
24. Fabrication of UPS up to 500VA.
25. Fabrication of a distribution board as per requirement.
26. Fabrication of Direct-On-Line (DOL) starter.
27. Fabrication of solar tracking system.
28. Fabrication of automatic power factor corrector.
29. Fabrication of electronic choke for fluorescent tubes.

30. Fabrication of electronic fan regulator.
31. Fabrication of desert cooler/ room cooler.
32. Fabrication of electric/solar water heater.
33. Erection, installation & commissioning of electrical equipments.
34. Fault detection & repair of electrical/ electronic instruments.
35. Drawing, estimating and costing of electrical installation of the institution from supplier's pole to the institution distribution board.
36. Drawing, estimating and costing of electrical installation of a workshop having a given number of electrically operated appliances/machines.
37. To study the laying out of underground distribution cable for a small colony starting from main distribution pole.
38. To study the erection of a 5 pole span over head line for a small distance for distribution of electrical energy and to prepare list of material required.
39. Energy audit for the workshop of your institution & to suggest remedies to reduce electricity bills.
40. Estimate the material required to provide a service connection to a consumer's premises for domestic purposes.
41. To survey the load of a given area in a village, small colony, calculate the effective load and find out the sizes of cables/conductors for the proposed distribution system.
42. Designing of light and fan scheme for an institutional or commercial building.
43. To study and estimate the material required during augmentation of a nearby pole mounted sub-station.
44. To study and estimate the material required during augmentation of a nearby in door sub-station.
45. To study and estimate the material required for a solar power station up to 100KW after visiting the actual site (Such power plants have already been installed at LPU at Jalandhar and PEDA/CREST in Punjab and Chandigarh).
46. To prepare a proposal for substation of your institution , calculating the total load (estimating and costing)
47. Installation of home security system
48. Detection of electricity theft control system with wireless indication system
49. Fabrication of cyclo-converter ( frequency changer)
50. Design and fabrication of panel for automatic switching of DG set with supply system
51. Design and fabrication of wireless AC Power transmission.

**NOTE**: Each student has to take one project individually and one to be shared with a group of four-five students depending upon cost and time involved.

There is no binding to take up the above projects as it is only a suggestive list of projects.