COMPETENCY BASED CURRICULUM

DIPLOMA
IN
ELECTRICAL ENGINEERING

(Duration 3 Years)
NSQF Level – 5

Under
Haryana State Board of Technical Education

Developed By

Curriculum Development Center

National Institute of Technical Teachers Training & Research

(Ministry of Education, Government of India)

Sector - 26, Chandigarh, UT, India.

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PREFACE

Learning and learning experience are the foundation of any education system. Appropriateness of education and its useful implications stand on the platform of knowledge and skill. But the knowledge and skill cannot be quantified qualitatively without ensuring learning experience. Curriculum is the pathway to select and organise learning experience. It helps the teachers to provide tangible resources, goals and objectives to learners. Curriculum acts as a catalyst to stimulate creativity, innovation, ethics, values, responsibility and many human factors. Curriculum embodies rigour and high standards and creates coherence to empower learner to meet the industrial and societal needs. Curriculum is a central guide for a teacher to plan a standard based sequence for the instructional delivery.

The industrial revolution 4.0 has forced the technical education system to reinvent the curriculum to meet the human resource requirement of the industry. The data driven systems relying on the subjects like machine-learning, Artificial Intelligence, Data Science etc are literally forcing the technical education system to offer different subjects differently to address the emerging challenges. The non-linear way of learning now facilitates students to choose path of knowledge to skill or vice-versa. The bi-directional process requires innovative curriculum design and revision. Diploma programme is now more challenging than ever. The level of skill and knowledge demanded by industry from diploma holders are highly interdisciplinary at the same time address special need. Hence, there is a need to align the curriculum to National Skill Qualification Framework (NSQF).

National Education Policy, NEP-2020 has now opened up diversities for the education system to explore and exploit to make the education relevant. The policy emphasises to inculcate value, ethics, respect to culture and society etc along with industry ready knowledge and skill among the students. The interdisciplinary nature of curriculum, academic bank of credits and integration of technology in teaching-learning envisaged in NEP-2020 make it more challenging for curriculum development. NITTTR, Chandigarh has developed the art of curriculum development over 54 years of its existence. The expertise and experience available in the institute follow time-tested and acclaimed scientific methods to design/revise curriculum. The experienced faculty members entrusted with the curriculum development or revision activities are well-versed with NSQF, NEP and Outcome based education. I am happy to note that **Haryana State Board of Technical Education, Punchkula, Haryana** reposed their confidence on this expertise to develop **AICTE/NSQF/NEP 2020** aligned curriculum for the state. This documented curriculum is an outcome of meticulous planning and discussions among renowned experts of the subject through series of workshops. The effective implementation of this curriculum supported with quality instructional resources will go a long way in infusing the learning experience among learners to make them industry ready.

Director

National Institute of Technical Teachers Training & Research, Chandigarh

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Professor & Head
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1. SALIENT FEATURES

1.	Name	:	**Diploma in Electrical Engineering**
2.	Duration	:	**03 Years**
3.	Hours per week	:	**35**
4.	Entry Qualification	:	**10th Pass**
5.	Student Intake	:	**As per sanctioned strength**
6.	Pattern	:	**Semester**
7.	Scheme	**:**	**Multipoint Entry and Exit**
8.	NSQF Level	:	**5**
9.	Theory Practical Ratio	:	**38 : 62**
10.	Project Work	:	**Minor and Major Project**
11.	In-house/Industrial Internship	:	**Mandatory after First and Second Year**

2. NSQF GUIDELINES

National Skill Qualification Framework has defined total Ten Levels. Each level of the NSQF is associated with a set of descriptors made up of five outcome statements, which describe in general terms, the minimum knowledge, skills and attributes that a learner needs to acquire in order to be certified for that level.

Fig.1: NSQF Domains

NSQF LEVEL - 3 COMPLIANCE

The NSQF level - 3 descriptor is as follows:

Process	• Person may carry out a job which may require limited range of activities routine and predictable.
Professional Knowledge	• Basic facts, process and principle applied in trade of employment.
Professional Skill	• Recall and demonstrate practical skill, routine and repetitive in narrow range of application.
Core Skill	• Communication written and oral, with minimum required clarity, skill of basic arithmetic and algebraic principles, personal banking, basic understanding of social and natural environment.
Responsibility	• Under close supervision. Some responsibility for own work within defined limit.

Fig 2: NSQF Level – 3 Descriptor

Work requiring knowledge, skills and aptitudes at level 3 will be routine and predictable. Job holders will be responsible for carrying out a limited range of jobs under close supervision. Their work may require the completion of a number of related tasks. People carrying out these job roles may be described as "Semi skilled workers". Individuals in jobs which require level 3 qualifications will normally be expected to be able to communicate clearly in speech and writing and may be required to use arithmetic and algebraic processes. They will be expected to have previous knowledge and skills in the occupation and should know the basic facts, processes and principles applied in the trade for which they are qualified and be able to apply the basic skills of the trade to a limited range of straightforward jobs in the occupation.

They will be expected to understand what constitutes quality in their job role and more widely in the sector or sub-sector and to distinguish between good and bad quality in the context of the jobs they are given. Job holders at this level will be expected to carry out the jobs they are given safely and securely. They will work hygienically and in ways which show an understanding of environmental issues. This means that they will be expected to take responsibility for their own health and safety and that of fellow workers and, where appropriate, customers and/or clients. In working with others, they will be expected to conduct themselves in ways which show a basic understanding of the social environment. They should be able to make a good contribution to team work.

NSQF LEVEL - 4 COMPLIANCE

The NSQF level-4 descriptor is given below:

Process	• Work in familiar, predictable, routine, situation of clear choice
Professional Knowledge	• Factual knowledge of field of knowledge or study.
Professional Skill	• Recall and demonstrate practical skill, routine and repetitive in narrow range of application, using appropriate rule and tool, using quality concepts.
Core Skill	• Communication written and oral, with required clarity, skill of basic arithmetic and algebraic principles, personal banking, basic understanding of social and natural environment.
Responsibility	• Responsibility for own work and learning.

Fig 3: NSQF Level – 4 Descriptor

Work requiring knowledge, skills and aptitudes at level 4 will be carried out in familiar, predictable and routine situations. Job holders will be responsible for carrying out a range of jobs, some of which will require them to make choices about the approaches they adopt. They will be expected to learn and improve their practice on the job. People carrying out these jobs may be described as "skilled workers". Individuals in jobs which require level 4 qualifications should be able to communicate clearly in speech and writing and may be required to use arithmetic and algebraic processes. They will be expected to have previous knowledge and skills in the occupation in which they are employed, to appreciate the nature of the occupation and to understand and apply the rules which govern good practice. They will be able to make choices about the best way to carry out routine jobs where the choices are clear.

They will be expected to understand what constitutes quality in the occupation and will distinguish between good and bad quality in the context of their job roles. Job holders at this level will be expected to carry out their work safely and securely and take full account of the health and safety on colleagues and customers. They will work hygienically and in ways which show an understanding of environmental issues. In working with others, they will be expected to conduct themselves in ways which show a basic understanding of the social and political environment. They should be able to guide or lead teams on work within their capability.

NSQF LEVEL - 5 COMPLIANCE

The NSQF level-5 description is given below:

Process	• Job that requires well developed skill, with clear choice of procedures in familiar context.
Professional Knowledge	• Knowledge of facts, principles, processes and general concepts, in a field of work or study.
Professional Skill	• A range of cognitive and practical skills required to accomplish tasks and solve problems by selecting and applying basic methods, tools, materials and information.
Core Skill	• Desired mathematical skill; understanding of social, political; and some skill of collecting and organising information, communication.
Responsibility	• Responsibility for own work and learning and some responsibility for others' works and learning

Fig 4: NSQF Level – 5 Descriptor

Work requiring knowledge, skills and aptitudes at level 5 will also be carried out in familiar situations, but also ones where problems may arise. Job holders will be able to make choices about the best procedures to adopt to address problems where the choices are clear. Individuals in jobs which require level 5 qualifications will normally be responsible for the completion of their own work and expected to learn and improve their performance on the job. They will require well developed practical and cognitive skills to complete their work. They may also have some responsibility for others' work and learning. People carrying out these jobs may be described as "fully skilled workers" or "supervisors".

Individuals employed to carry out these jobs will be expected to be able to communicate clearly in speech and writing and may be required to apply mathematical processes. They should also be able to collect and organise information to communicate about the work. They will solve problems by selecting and applying methods, tools, materials and information. They will be expected to have previous knowledge and skills in the occupation, and to know and apply facts, principles, processes and general concepts in the occupation. They will be expected to understand what constitutes quality in the occupation and will distinguish between good and bad quality in the context of their work. They will be expected to operate hygienically and in ways which show an understanding of environmental issues. They will take account of health and safety issues as they affect the work they carry out or supervise.

In working with others, they will be expected to conduct themselves in ways which show an understanding of the social and political environment.

3. NATIONAL EDUCATION POLICY (NEP) - 2020

NEP 2020 aims at a comprehensive holistic education to develop all capacities of human beings - intellectual, aesthetic, social, physical, emotional, and moral - in an integrated manner. A holistic arts education will help develop well-rounded individuals that possess: critical 21st century capacities in fields across the arts, humanities, languages, sciences, social sciences, and professional, technical, and vocational fields; an ethic of social engagement; soft skills, such as communication, discussion and debate; and rigorous specialization in a chosen field or fields. Such a holistic education shall be, in the long term, the approach of all undergraduate programmes, including those in professional, technical, and vocational disciplines.

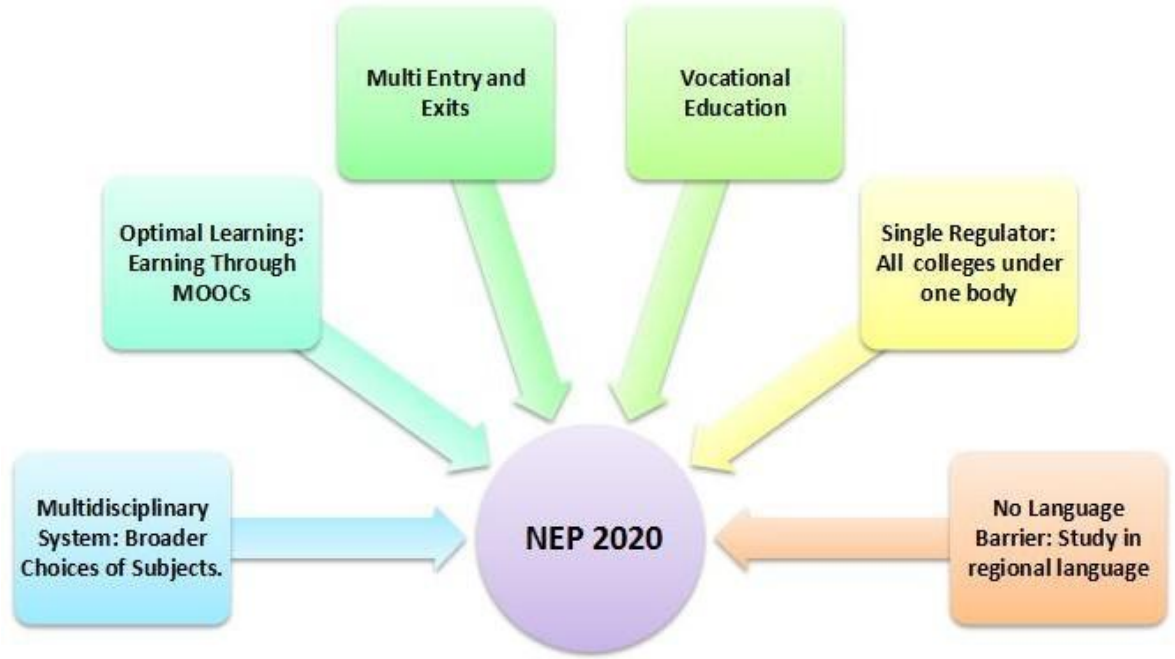

Fig 5: NEP 2020

Flexibility in curriculum and novel and engaging course options will be on offer to students, in addition to rigorous specialisation in a subject or subjects. Pedagogy for courses will strive for significantly less rote learning and an increased emphasis on communication, discussion, debate, research, and opportunities for cross-disciplinary and interdisciplinary thinking. The flexible and innovative curriculum shall emphasize on offering credit-based courses and projects in the areas of community engagement and service, environmental education and value-based education. as part of a holistic education, students will be provided with opportunities for internships with local industry, businesses, artists, crafts persons, villages and local communities, etc., as well as

research internships with faculty and researchers at their own or other HEIs or research institutions, so that students may actively engage with the practical side of their learning and, as a by-product, further improve their employability.

Effective learning requires relevant curriculum, engaging pedagogy, continuous formative assessment and adequate student support. The curriculum must be updated regularly aligning with the latest knowledge requirements and shall meet specified learning outcomes. High-quality pedagogy is then necessary to successfully impart the curricular material to students; pedagogical practices determine the learning experiences that are provided to students - thus directly influencing learning outcomes. The assessment methods have to be scientific and test the application of knowledge. Higher Education Institutes should move to a criterion-based grading system that assesses student achievement based on the learning goals for each programme, making the system fairer and outcomes more comparable. HEIs should also move away from high-stakes examinations towards more continuous and comprehensive evaluation.

4. DIPLOMA PROGRAMME OUTCOMES

The program outcomes are derived from five domains of NSQF Level namely Process, Professional Knowledge, Professional Skill, Core Skill, Responsibility. After completing this programme, the student will be able to:

PO1: Acquire knowledge of basic mathematics, sciences and basic engineering to understand Electrical Engineering.

PO2: Identify principles, processes and professional knowledge to solve broad-based Electrical Engineering problems

PO3: To develop special skills required for repairing small electrical domestic appliances, making joints and carrying out work and detecting faults etc. in electrical equipment and circuit.

PO4: Demonstrate skill of communication, basic mathematics, collecting and organizing information along with knowledge of social, political and natural environment.

PO5: Take the responsibility to work as dedicated electrical technician who is capable of identifying solutions to various problems faced by the society.

PO6: Engage in Multi-disciplinary skills, team spirit and leadership qualities with professional ethics, to excel in professional career and/or higher studies in Electrical Engineering

5. DERIVING CURRICULUM SUBJECT AREAS FROM DIPLOMA PROGRAMME OUTCOMES

The following curriculum subject areas have been derived from Programme outcomes:

Sr. No.	Programme Outcomes	Curriculum Subject Areas
1.	**PO1:** Acquire knowledge of basic mathematics, sciences and basic engineering to understand Electrical Engineering.	● Applied Physics – I ● Applied Mathematics - I ● Applied Mathematics-II ● Applied Physics - II ● Principles of Electrical Engineering ● Engineering Graphics ● Environmental Studies & Disaster Management ● Electrical Machines –I ● Electrical Engineering Materials ● Electrical Engineering Drawing ● Estimating and Costing in Electrical ● Engineering ● Electrical Measurement & ● Instrumentation
2.	**PO2:** Identify principles, processes and professional knowledge to solve broad-based Electrical Engineering problems	● Applied Physics - I ● Principles of Electrical Engineering ● Electrical Networks ● Applied Physics – II ● Non-Conventional Sources of Energy ● Analog & Digital Electronics ● Electrical Engineering Materials ● Utilization of Electrical Energy ● Electrical Machines –II ● Power system ● Power System Protection

3.	**PO3:** To develop special skills required for repairing small electrical domestic appliances, making joints and carrying out work and detecting faults etc. in electrical equipment and circuit.	● Applied Physics - II ● Electrical Networks ● Industrial / In - House Training. ● Engineering Graphics ● Basic Electrical Workshop ● Utilization of Electrical Energy ● PLC & Microcontrollers ● Industrial Electronics and Control of Drives ● Power system ● Electrical Traction system ● Solar Panel Installation and Maintenance ● Installation and Maintenance of Electrical Equipment ● HVDC & Flexible AC Transmission Systems
4.	**PO4:** Demonstrate skill of communication, basic mathematics, collecting and organizing information along with knowledge of social, political and natural environment.	● English and Communication Skills - I ● Applied Mathematics - I ● Fundamentals of IT ● Applied Mathematics – II ● Environmental Studies & Disaster Management ● Open Elective ● English and Communication Skills – II ● Estimating and Costing in Electrical ● Engineering ● Programming Skills ● Multi-disciplinary Elective ● Minor Project ● Entrepreneurship Development and Management ● Energy Conservation and Audit ● Industrial Training / Major Project

5.	**PO5:** Take the responsibility to work as dedicated electrical technician who is capable of identifying solutions to various problems faced by the society.	● Principles of Electrical Engineering ● Basic Electrical Workshop ● Non-Conventional Sources of Energy ● Electrical Networks ● Electrical Engineering Drawing ● Estimating and Costing in Electrical ● Engineering ● Electrical Traction system ● Installation and Maintenance of Electrical Equipment ● Industrial Training / Major Project ● Smart Grid and Distributed Generation System
6.	**PO6:** Engage in Multi-disciplinary skills, team spirit and leadership qualities with professional ethics, to excel in professional career and/or higher studies in Electrical Engineering	● Multidisciplinary Elective ● Open Elective ● Energy Conservation and Audit ● Entrepreneurship Development and Management

FIRST YEAR
NSQF LEVEL - 3

6. STUDY AND EVALUATION SCHEME (FIRST YEAR)

FIRST SEMESTER:

Sr. No.	SUBJECTS	STUDY SCHEME Periods/Week		Credits (C) L+P = C	MARKS IN EVALUATION SCHEME						Total Marks of Internal & External
					INTERNAL ASSESSMENT			EXTERNAL ASSESSMENT			
		L	P		Th	Pr	Tot	Th	Pr	Tot	
1.1	*English & Communication Skills-I	2	2	2+1=3	40	40	80	60	60	120	200
1.2	*Applied Mathematics - I	4	-	4+0=4	40	-	40	60	-	60	100
1.3	*Applied Physics -I	2	2	2+1=3	40	40	80	60	60	120	200
1.4	Principles of Electrical Engineering	3	4	3+2=5	40	40	80	60	60	120	200
1.5	*Fundamentals of IT	2	4	2+2=4	40	40	80	60	60	120	200
1.6	* Engineering Graphics	-	6	3	-	40	40	60	-	60	100
#Student Centred Activities (SCA)		-	4	-	-	-	-	-	-	-	-
Total		**13**	**22**	**22**	**200**	**200**	**400**	**360**	**240**	**600**	**1000**

* Common with other diploma programmes

Student Centred Activities will comprise of co-curricular activities like extension lectures on Constitution of India, Games, Yoga, Human Values & Ethics, Knowledge of Indian System, Hobby Clubs e.g. Photography etc., Seminars, Declamation Contests, Educational Field Visits, NCC, NSS, Cultural Activities and Self-study etc.

SECOND SEMESTER:

Sr. No.	SUBJECTS	STUDY SCHEME Periods/Week		Credits (C) L+P = C	MARKS IN EVALUATION SCHEME						Total Marks of Internal & External
					INTERNAL ASSESSMENT			EXTERNAL ASSESSMENT			
		L	P		Th	Pr	Tot	Th	Pr	Tot	
2.1	* Applied Mathematics -II	4	-	4+0=4	40	-	40	60	-	60	100
2.2	*Applied Physics -II	2	2	2+1=3	40	40	80	60	60	120	200
2.3	Electrical Networks	3	4	3+2=5	40	40	80	60	60	120	200
2.4	Non-conventional Sources of Energy	2	2	2+1 = 3	40	40	80	60	60	120	200
2.5	*Environmental Studies and Disaster Management	2	-	2+0=2	40	-	40	60	-	60	100
2.6	Basic Electrical Workshop	-	8	0+4=4	-	40	40	-	60	60	100
#Student Centred Activities (SCA)		-	6	-	-	-	-	-	-	-	-
Total		**13**	**22**	**21**	**200**	**160**	**360**	**300**	**240**	**540**	**900**

* Common with other diploma programmes

Student Centred Activities will comprise of co-curricular activities like extension lectures on Constitution of India, Games, Yoga, Human Values & Ethics, Knowledge of Indian System, Hobby Clubs e.g. Photography etc., Seminars, Declamation Contests, Educational Field Visits, NCC, NSS, Cultural Activities and Self-study etc.

Summer Industrial/In-house Training: After 2nd semester, students shall undergo Summer Training **of 4 Weeks.**

7. DIPLOMA PROGRAMME HORIZONTAL AND VERTICAL ORGANISATION OF SUBJECTS

Sr. No.	Subjects	Hours Per Week	
		First Semester	Second Semester
1.	English and Communication Skills - I	4	-
2.	Applied Mathematics - I	4	-
3.	Applied Physics - I	4	-
4.	Principles of Electrical Engineering	7	
5.	Fundamentals of IT	6	-
6.	Engineering Graphics	6	-
7.	Student Centered Activities	4	-
8.	Applied Mathematics-II	-	4
9.	Applied Physics - II	-	4
10.	Electrical Networks	-	7
11.	Non-conventional Sources of Energy	-	4
12.	Environmental Studies and Disaster Management	-	2
13.	Basic Electrical Workshop	-	8
14.	Student Centered Activities	-	6
	Total	**35**	**35**

8. COMPETENCY PROFILE & EMPLOYMENT OPPORTUNITIES

Electrical engineers design, develop, test, and supervise the manufacturing of electrical equipment, such as electric motors, radar and navigation systems, communications systems, or power generation equipment. Electrical engineers also design the electrical systems of automobiles and aircraft.

The electrical engineers are the basic loop that keeps the circle of technology growth moving. India is one of the most fast-paced industrial countries in the world has made progress in the demand for electrical engineers whether in the public sector or private sector.
Students having the diploma in Electrical engineering experience and expansive skill set needed to design and operate electrical systems, such as circuitry, power station generators, flight systems, and computers.

The NSQF Level – 3 pass out students are expected to recall and demonstrate practical routine and repetitive skills, in narrow range of Electrical Engineering. In government and private sectors related to Electrical Engineering, "Semi Skilled workers" are required to carry out a limited range of predictable tasks under close supervision. They are normally expected to communicate clearly in speech and along with knowledge of arithmetic and algebraic processes.

Electrical diploma holder works in variety of environments including manufacturing facilities, government agencies and engineering firms. They have wide scope in Manufacturing Industry: Electrical Power Distribution and Maintenance, Maintenance of Industrial Electrical System, Repair and Maintenance of Electrical Machines and Equipment, Quality Control for Electrical systems, Electrical Safety Measures, Estimate for Electrical Installations

Government Departments such as Electricity Board, MES, PWD, Railways, Air bases, Airports, Defence, Thermal, Hydro and Nuclear Power Stations and other Boards and Corporations: Construction, erection and commissioning of lines and Sub-stations, Electrical Safety measures, Operation and Maintenance of Lines and Sub-stations/underground cables, Tariffs and Calculations of bills for consumption of electricity, Inventory Management, Repair and Maintenance of Electrical Machines/ Equipment, Assist in Operation and maintenance of Generating and sub-stations Hospitals, Commercial Complexes, Service Sector Organizations like Hotels, Tourist-Resorts, high-rise buildings, Cinema/Theater Halls etc: Layout of wiring circuit, planning and execution for Electrical Installation, Standby or captive Power Generation and its Distribution, Preventive maintenance of Electrical Systems of Lifts, Air-Conditioning Plants etc.

9. PROGRAMME OUTCOMES

The programme outcomes are derived from five domains of NSQF Level – 3 namely Process, Professional Knowledge, Professional Skill, Core Skill, Responsibility. After completing this programme, the student will be able to:

PO1: Perform out a task which may require limited range of predictable activities related to the Electrical engineer.

PO2: Acquire knowledge of facts, process and principles related to Electrical engineering for sustainability and employment.

PO3: Demonstrate the ability to identify, formulate and analyze real-life electrical engineering problems.

PO4: Communicate accurately and appropriately and demonstrate professional behavior along with skill of basic arithmetic and algebraic principles, and basic understanding of social and natural environment.

PO5: Be responsible to perform task under close supervision with some responsibility within defined limit.

10.ASSESSMENT OF PROGRAMME AND COURSE OUTCOMES

Programme Outcomes to be Assessed	Assessment Criteria for the Course Outcomes
PO1: Perform out a task which may require limited range of predictable activities related to the Electrical engineer.	• Illustrate the geometric shapes used in engineering problems by Co-ordinate Geometry and Trigonometry. • Formulate engineering problems into mathematical formats with the use matrices, co-ordinate geometry and trigonometry. • Identify physical quantities, select their units for use in engineering solutions, and make measurements with accuracy. • Represent physical quantities as scalar and vector and identify type of motions, various forms of energy, their conversion and applications. • Comprehend properties of matter and effect of temperature on various matter and phenomenon. • Acquire knowledge and understand the elements of electricity and DC circuits. • Remember the circuit elements and the laws governing the electrical circuits. • Acquire the concept of Electromagnetic Induction and its uses in engineering field.
PO2: Acquire knowledge of facts, process and principles related to Electrical engineering for sustainability and employment.	• Formulate engineering problems into mathematical formats with the use matrices, co-ordinate geometry and trigonometry • Calculate the approximate value of roots of certain expressions in engineering problems by application of binomial theorem. • Explore the idea of location, graph, and linear relationships between two variables. • Learn about basic fundamentals about MATLAB/ SciLab and mathematical calculation with MATLAB/ SciLab software.

	• Elaborate scientific work, energy and power, forms of friction and solve problems related to them. • Comprehend properties of matter and effect of temperature on various matter and phenomenon. • Formulate the engineering problems into mathematical format with the use of differential equations and differential. • Use the differentiation and Integration in solving various Mathematical and Engineering problems. • Discuss the purposes of measures of central tendency and calculate the measures of central tendency (mode, median, mean) for a set of data. • Acquire knowledge and understand the elements of electricity and DC circuits. • Comprehend the concept of Electrostatics and Magentostatics and apply the knowledge. • Explain the various batteries as storage devices and be aware of safe disposal of batteries. • Comprehend various renewable and non-renewable sources of energy. • Gain knowledge about working principle of various solar energy systems. • Acquire the detailed concepts of power generation with the wind energy, ocean energy, hydro, geothermal energy, tidal energy, fuel cell.
PO3: Demonstrate the ability to identify, formulate and analyze real-life electrical engineering problems.	• Apply the knowledge of basic circuital law and simplify the network. • Use various batteries as storage devices and be aware of safe disposal of batteries. • Draw Orthographic views of different objects viewed from different angles. • Draw and interpret sectional views of an object which are otherwise not visible in normal view. • Draw Isometric views of different solids and develop their surfaces. • Identify conventions for different engineering materials, symbols, sections of regular objects and

	general fittings used in Civil and Electrical household appliances/ fittings. • Draw orthographic views of different objects by using basic commands of AutoCAD. • Characterize properties of material to prepare new materials for various engineering applications. • Demonstrate a strong foundation on Modern Physics to use at various technical and engineering applications. • Apply the basic principles and solve the A.C. series and parallel circuit. • Recognize the concept of Poly-phase system and compute the electrical parameters. • Identify electronics components like resistors, capacitors, diodes, transistors etc. • Detail the safety precautions and different tools and apply their skills for society. • Detect and rectify various types of faults in house wiring, and contactor control circuits. • Repair various domestic appliances and apply knowledge of earthing. • Perform wiring, testing and fault finding of the control circuit process. • Perform single phase and three phase supply and wiring system.
PO4: Communicate accurately and appropriately and demonstrate professional behavior along with skill of basic arithmetic and algebraic principles, and basic understanding of social and natural environment.	• Identify the nuances of Communication, both Oral and Written. • Acquire knowledge of the meaning of communication, communication process and speaking skills. • Acquire enhanced vocabulary and in-depth understanding of Grammatical Structures and their usage in the communication. • Communicate effectively with an increased confidence to read, write and speak in English language fluently.

	• Illustrate the geometric shapes used in engineering problems by Co-ordinate Geometry and Trigonometry. • Formulate engineering problems into mathematical formats with the use matrices, co-ordinate geometry and trigonometry. • Calculate the approximate value of roots of certain expressions in engineering problems by application of binomial theorem. • Explore the idea of location, graph, and linear relationships between two variables. • Explain the basic components of Computers, Internet and issues of abuses/ attacks on information and computers. • Handle the computer/laptop/mobiles/Internet Utilities and Install/Configure OS. • Assemble a PC and connect it to external devices. • Manage and Use Office practiced Automation Tools. • Develop worksheets and Prepare presentations. • Comprehend the importance of sustainable ecosystem. • Clarify interdisciplinary nature of environmental issues. • Describe corrective measures for the abatement of pollution. • Identify the role of non-conventional energy resources in environmental protection. • Recognize various types of disasters.
PO5: Be responsible to perform task under close supervision with some responsibility withindefined limit.	• Apply the knowledge of basic circuital law and simplify the network. • Use various batteries as storage devices and be aware of safe disposal of batteries. • Calculate the approximate area under a curve by applying integration and numerical methods. • Discuss the purposes of measures of central tendency and calculate the measures of central tendency (mode, median, mean) for a set of data.

	• Learn about basic fundamentals about MATLAB/ SciLab and mathematical calculation with MATLAB/ SciLab software. • Demonstrate a strong foundation on Modern Physics to use at various technical and engineering applications. • Comprehend the concept of Electrostatics and Magentostatics and apply the knowledge. • Acquire the concept of Electromagnetic Induction and its uses in engineering field • Explain the various batteries as storage devices and be aware of safe disposal of batteries. • Illustrate mesh, nodal methods, different network theorems and applying them to solve DC circuits. • Apply the basic principles and solve the A.C. series and parallel circuit. • Recognize the concept of Poly-phase system and compute the electrical parameters. • Develop basic design of bio gas plant. • Gain knowledge of different energy storage devices used in renewable energy resources • Know the safety precautions and different tools and apply their skills for society. • Detect and rectify various types of faults in house wiring, and contactor control circuits. • Repair various domestic appliances and apply knowledge of earthing • Perform wiring, testing and fault finding of the control circuits process • Perform single phase and three phase supply and wiring system.

11. SUBJECTS & DETAILED CONTENTS

FIRST SEMESTER

1.1	English & Communication Skill-I	22-24
1.2	Applied Mathematics-I	25-28
1.3	Applied Physics-I	29-32
1.4	Principles of Electrical Engineering	33-36
1.5	Fundamentals of IT	37-40
1.6	Engineering Graphics	41-43

1.1 ENGLISH & COMMUNICATION SKILLS – I

L	P
2	2

RATIONALE

Language as the most commonly used medium of self-expression remains indispensable in all spheres of human life –personal, social and professional. This course is intended to break fresh ground in teaching of Communicative English as per the requirements of National Skill Quality Framework. This course is designed to help students to acquire the concept of communication and develop an ability or skills to use them effectively to communicate with the individuals and community.

COURSE OUTCOMES

After undergoing this subject, the students will be able to:

CO1: Identify the nuances of Communication, both Oral and Written.

CO2: Acquire knowledge of the meaning of communication, communication process and speaking skills.

CO3: Acquire enhanced vocabulary and in-depth understanding of Grammatical Structures and their usage in the communication.

CO4: Communicate effectively with an increased confidence to read, write and speak in English language fluently.

DETAILED CONTENTS

UNIT I

Reading

1.1 Techniques of reading: Skimming and Scanning

1.2 Extensive and Intensive Reading: Textual Study

1.3 Homecoming – R.N. Tagore

1.4 Life Sketch of Sir Mokshagundam Visvesvarayya

1.5 Life Sketch of Dr. Abdul Kalam

1.6 Narayan Murthy's speech at LBSNA, Dehradun

UNIT II

Fundamentals of Communication

2.1 Concept and Process of Communication

2.2 Types of Communication (Verbal Communication)

2.3 Barriers to Communication
2.4 Speaking Skill: Significance and essentials of Spoken Communication
2.5 Listening Skill: Significance and essentials of Listening

UNIT III

Grammar and Usage

3.1 Nouns
3.2 Pronouns
3.3 Articles
3.4 Verbs(Main and Auxiliary)
3.5 Tenses

UNIT IV

Writing Skills

4.1 Significance, essentials and effectiveness of Written Communication
4.2 Notice Writing
4.3 Official Letters and E-mails.
4.4 Frequently-used Abbreviations used in Letter-Writing
4.5 Paragraph Writing
4.6 Netiquettes

PRACTICAL EXERCISES

1. Reading

Reading Practice of lessons in the Lab Activity classes.

i. Comprehension exercises of unseen passages along with the lessons prescribed.
ii. Vocabulary enrichment and grammar exercises based on the selected readings.
iii. Reading aloud Newspaper headlines and important articles.

2. Fundamentals of Communication

i. Introducing oneself, others and leave- taking(talking about yourself)
ii. Just a minute (JAM) sessions: Speaking extempore for one minute on given topics
iii. Situational Conversation: Offering-Responding to offers; Congratulating; Apologizing and Forgiving; Complaining; Talking about likes and dislikes, Self-introduction Mock Interviews

3. Grammar and Usage

i. Written and Oral Drills will be undertaken in the class to facilitate holistic linguistic competency among learners.
ii. Exercises on the prescribed grammar topics.

4. Writing Skills

i. Students should be given Written Practice in groups so as to inculcate team-spirit and collaborative learning .
ii. Group exercises on writing paragraphs on given topics.
iii. Opening an e-mail account, receiving and sending emails

RECOMMENDED BOOKS

1) Alvinder Dhillon and Parmod Kumar Singla, "Text Book of English and Communication Skills Vol – 2", M/S Abhishek Publications, Chandigarh.
2) V Sasikumar & PV Dhamija, "Spoken English", Tata MC Graw Hills, New Delhi, Second Edition.
3) JK Gangal, "A Practical Course in Spoken English", PHI Learning Pvt. Ltd., New Delhi.
4) NK Aggarwal and FT Wood, "English Grammar, Composition and Usage", Macmillan Publishers India Ltd., New Delhi.
5) RC Sharma and Krishna Mohan, "Business Correspondence & Report writing", Tata MC Graw Hills, New Delhi, Fourth Edition.
6) Kavita Tyagi & Padma Misra, "Professional Communication", PHI Learning Pvt. Ltd., New Delhi.
7) Nira Konar, "Communication Skills for professionals", PHI Learning Pvt. Ltd., New Delhi.
8) Krishna Mohan & Meera Banerji, "Developing Communication Skills", Macmillan Publishers India Ltd., New Delhi, Second Edition
9) M. Ashraf Rizwi, "Effective Technical Communication", Tata MC Graw Hills, New Delhi.
10) Andrea J Rutherfoord, "Basic Communication Skills for Technology", Pearson Education, New Delhi.

INSTRUCTIONAL STRATEGY

This is practice based subject and topics taught in the class should be practiced as exercises in the Lab regularly for development of communication skills in the students. The students should be involved in activities to enhance their personality skills. This subject contains four units of equal weightage.

1.2 APPLIED MATHEMATICS - I

L	P
4	-

RATIONALE

Contents of this course provide fundamental base for understanding engineering problems and their solution algorithms. Contents of this course will enable students to use basic tools like logarithm, binomial theorem, matrices, t-ratios and co-ordinates for solving complex engineering problems with exact solutions in a way which involve less computational task. By understanding the logarithm, they will be able to make long calculations in short time and it is also a pre-requisite for understanding Calculus.

COURSE OUTCOMES

After undergoing this subject, the students will be able to:

CO1: Illustrate the geometric shapes used in engineering problems by Co-ordinate Geometry and Trigonometry.

CO2: Formulate engineering problems into mathematical formats with the use matrices, co-ordinate geometry and trigonometry

CO3: Calculate the approximate value of roots of certain expressions in engineering problems by application of binomial theorem.

CO4: Explore the idea of location, graph, and linear relationships between two variables.

CO5: Learn about basic fundamentals about MATLAB/ SciLab and mathematical calculation with MATLAB/ SciLab software.

DETAILED CONTENTS

UNIT I

Algebra

1.1 Complex Numbers: definition of complex number, real and imaginary parts of a complex number, Polar and Cartesian Form and their inter conversion, Conjugate of a complex number, modulus and amplitude, addition subtraction, multiplication and division of complex numb

1.2 Logarithms and its basic properties

UNIT II

Binomial Theorem, Determinants and Matrices

2.1 Meaning of ${}^{n}P_{r}$ & ${}^{n}C_{r}$ (mathematical expression). Binomial theorem (without proof) for positive integral index (expansion and general form); binomial theorem for any index

(expansion up to 3 terms - without proof), first binomial approximation with application to engineering problems.

2.2 Determinants and Matrices – Evaluation of determinants (upto 2nd order), solution of equations (upto 2 unknowns) by Crammer's rule, definition of Matrices and its types, addition, subtraction and multiplication of matrices (upto 2nd order).

UNIT III

Trigonometry

3.1 Concept of angle, measurement of angle in degrees, grades, radians and their conversions.

3.2 T-Ratios of Allied angles (without proof), Sum, Difference formulae and their applications (without proof). Product formulae (Transformation of product to sum, difference and vice versa

3.3 Applications of Trigonometric terms in engineering problems such as to find an angle of elevation, height, distance etc.

UNIT-IV

Co-ordinate Geometry

4.1 Cartesian and Polar co-ordinates (two dimensional), Distance between two points, mid-point, centroid of vertices of a triangle.

4.2 Slope of a line, equation of straight line in various standards forms (without proof); (slope intercept form, intercept form, one-point form, two-point form, symmetric form, normal form, general form), intersection of two straight lines, concurrency of lines, angle between straight lines, parallel and perpendicular lines, perpendicular distance formula, conversion of general form of equation to the various forms.

UNIT V

Geometry of Circle and Software

Circle

5.1 General equation of a circle and its characteristics. To find the equation of a circle, given:

i. Centre and radius
ii. Three points lying on it
iii. Coordinates of end points of a diameter

Software

5.2 **MATLAB Or SciLab software –** Theoretical Introduction, MATLAB or Scilab as Simple Calculator (Addition and subtraction of values –Trigonometric and Inverse Trigonometric functions) – General Practice

RECOMMENDED BOOKS

1. R. D. Sharma, "Applied Mathematics – I & II for Diploma Courses", Dhanpat Rai Publications.
2. "Mathematics for Class XI", NCERT Publication, New Delhi.
3. "Mathematics for Class XII", NCERT Publication, New Delhi.
4. H. K Dass, "Applied Mathematics for Polytechnics", CBS Publishers & Distributers.
5. A Ganesh and G Balasubramanian, "Textbook of Engineering Mathematics – I", CBS Publisher, New Delhi.
6. A Ganesh and G Balasubramanian, "Textbook of Engineering Mathematics –II", CBS Publisher, New Delhi.
7. G. B. Thomas, R. L. Finney, "Calculus and Analytic Geometry", Addison Wesley, Ninth Edition.
8. B S Grewal, "Elementary Engineering Mathematics", Khanna Publishers, Delhi, Thirty-fifth Edition.
9. R.K. Jain and S.R.K. Iyengar, "Advanced Engineering Mathematics", Narosa Publishing House, New Delhi, Second Edition, 2003.
10. SS Sabharwal & Dr Sunita Jain, "Applied Mathematics Vol. I & II", Eagle Parkashan, Jalandhar.
11. S Kohli, "Engineering Mathematics Vol. I & II", IPH, Jalandhar.
12. Reena Garg & Chandrika Prasad, "Advanced Engineering Mathematics", Khanna Publishing House, New Delhi
13. R. Pratap, "Getting Started with MATLAB 7", Oxford University Press, Seventh Edition.
14. E-books/e-tools/relevant software to be used as recommended by AICTE/HSBTE/NITTTR.

SUGGESTED WEBSITES

1. http://swayam.gov.in
2. https://www.scilab.org

INSTRUCTIONAL STATREGY

This is theoretical subject and contains five units of equal weight age.

Basic elements of algebra, trigonometry and co-ordinate geometry can be taught in the light of their applications in the field of engineering and technology. By laying more emphasis on applied part, teacher can also help in providing a good continuing education base to the students. Students need to be taught the skills needed to use software tools built by experts through multiple problem

solving based on the topics related to Algebra, Trigonometry and Coordinate Geometry that the industry requires. Examples to be used should be related to engineering. Useful software MATLAB or open source software SciLab can be taught theoretically by books/online literatures and basic operations can be shown practically with practical software laboratory or small mobile apps of these software or authentic Trial version of MATLAB/ SciLab software. Students should be able to relate to the actual use of these examples and the way mathematical calculations will help them in doing their job.

1.3 APPLIED PHYSICS-I

L	P
2	2

RATIONALE

Applied physics includes the study of a large number of diverse topics all related to things that go on in the world around us. It aims to give an understanding of this world both by observation and by prediction of the way in which objects will behave. Concrete use of physical principles and analysis in various fields of technical are given prominence in the course content.

COURSE OUTCOMES

After completing this subject, student should be able to:

CO1: Identify physical quantities, select their units for use in engineering solutions, and make measurements with accuracy.

CO2: Represent physical quantities as scalar and vector and identify type of motions, various forms of energy, their conversion and applications.

CO3: Elaborate scientific work, energy and power, forms of friction and solve problems related to them.

CO4: Comprehend properties of matter and effect of temperature on various matter and phenomenon.

CO5: Demonstrate the use of physical principles and analysis in various fields of technology.

DETAILED CONTENTS

UNIT I

Unit and Dimensions

1.1 Definition of Physics, physical quantities- fundamental and derived

1.2 Units: fundamental and derived

1.3 System of units: CGS, FPS, MKS, SI

1.4 Dimension, dimensional formulae and SI units of physical quantities-distance, displacement, area, volume, density, velocity, acceleration, linear momentum, force, impulse, work, power, energy, pressure, surface tension, stress, strain)

1.5 Dimensional equations, principle of homogeneity of dimensional equation

1.6 Application of dimensional analysis: checking the correctness of physical equation, conversion of system of unit (force, work, acceleration)

UNIT II

Force and Motion

2.1 Scalar and vector quantities– definition and examples, representation of vector, types of vector (unit vector, position vector, co-initial vector, collinear vector, co-planar vector)

2.2 Vector algebra- addition of vectors, Triangle & Parallelogram law (statement and formula only),

2.3 Scalar and vector product (statement and formula only)

2.4 Force and its units, resolution of force (statement and formula only)

2.5 Newton's laws of motion (statement and examples)

2.6 Linear momentum, Law of conservation of linear momentum (statement and examples), Impulse

2.7 Circular motion: definition of angular displacement, angular velocity, angular acceleration, frequency, time period; Relation between linear and angular velocity, centripetal and centrifugal forces (definition and formula only), application of centripetal force in banking of road

2.8 Rotational motion: definition with examples

2.9 Definition of torque, angular momentum, moment of inertia and its physical significance

UNIT III

Work, Power and Energy

3.1 Work- definition, symbol, formula and SI unit, types of work (zero work, positive work and negative work) with example

3.2 Friction– definition and its simple daily life applications

3.3 Power- definition, formula and units

3.4 Energy- definition and its SI unit, examples of transformation of energy.

3.5 Kinetic energy- definition, examples, formula and its derivation

3.6 Potential energy- definition, examples, formula and its derivation

3.7 Law of conservation of mechanical energy for freely falling bodies (with derivation)

3.8 Simple numerical problems based on formula of Power and Energy

UNIT IV

Properties of Matter

4.1 Elasticity and plasticity- definition, deforming force, restoring force, example of elastic and plastic body

4.2 Definition of stress and strain, Hooke's law, modulus of elasticity

4.3 Pressure- definition, atmospheric pressure, gauge pressure, absolute pressure, Pascal's law

4.4 Surface tension- definition, SI unit, applications of surface tension, effect of temperature on surface tension

4.5 Viscosity: definition, unit, examples, effect of temperature on viscosity

UNIT V

Heat and Temperature

5.1 Definition of heat and temperature (on the basis of kinetic theory)

5.2 Difference between heat and temperature

5.3 Principle and working of mercury thermometer

5.4 Modes of transfer of heat- conduction, convection and radiation with examples.

5.5 Properties of heat radiation

5.6 Different scales of temperature and their relationship

PRACTICAL EXERCISES

1. Familiarization of measurement instruments and their parts (for example - vernier calliper, screw gauge, spherometer, travelling microscope etc.), and taking a reading. (compulsory to all students)
2. To find diameter of solid cylinder using a vernier calliper
3. To find internal diameter and depth of a beaker using a vernier calliper and hence find its volume.
4. To find the diameter of wire using screw gauge
5. To find thickness of paper using screw gauge.
6. To determine the thickness of glass strip using a spherometer
7. To determine radius of curvature of a given spherical surface by a spherometer.
8. To verify parallelogram law of force
9. To determine the atmospheric pressure at a place using Fortin's Barometer
10. To determine force constant of spring using Hooke's law
11. Measuring room temperature with the help of thermometer and its conversion in different scale.

RECOMMENDED BOOKS

1. "Text Book of Physics for Class XI (Part-I, Part-II)", N.C.E.R.T., Delhi.
2. Dr. HH Lal, "Applied Physics, Vol. I and Vol. II", TTTI Publications, Tata McGraw Hill, Delhi.
3. AS Vasudeva, "Applied Physics – I", Modern Publishers, Jalandhar.
4. R A Banwait, "Applied Physics – I", Eagle Prakashan, Jalandhar.
5. E-books/e-tools/relevant software to be used as recommended by AICTE/ HSBTE/ NITTTR.

6. C. L. Arora, “Practical Physics”, S Chand Publication.

SUGGESTED WEBSITES

1. http://swayam.gov.in
2. The Physics Classroom
3. https://www.khanacademy.org/science/physics

INSTRUCTIONAL STATREGY

This is hands-on practice based subject and topics taught in the class should be practiced in the Lab regularly for development of required skills in the students. This subject contains five units of equal weightage.

Teacher may use various teaching aids like models, charts, graphs and experimental kits etc. for imparting effective instructions in the subject. Students need to be exposed to use of different sets of units and conversion from one unit type to another. Software may be used to solve problems involving conversion of units. The teacher should explain about field applications before teaching the basics of mechanics, work, power and energy, rotational motion, properties of matter etc. to develop proper understanding of the physical phenomenon. Use of demonstration can make the subject interesting and develop scientific temper in the students. Teachers should give examples of engineering/technology applications of various concepts and principles in each topic so that students are able to appreciate learning of these concepts and principles. In all contents, SI units should be followed. Working in different sets of units can be taught through relevant software.

1.4 PRINCIPLES OF ELECTRICAL ENGINEERING

L	P
3	4

RATIONALE

This is a basic technology subject. This subject will help the students to develop certain technology related skill. This subject includes DC, magnetism, electromagnetism etc. This is one of the important core engineering subjects for electrical engineers. The main objective of this subject is to enhance the basic knowledge and skill. Learning of this course will also help the students to understand the basics of electrical engineering i. e. basic concept in electrical & magnetic circuits.

COURSE OUTCOMES

At the end of this subject, the student will be able to:

CO1: Acquire knowledge and understand the elements of electricity and DC circuits.
CO2: Remember the circuit elements and the laws governing the electrical circuits.
CO3: Comprehend the concept of Electrostatics and Magentostatics and apply the knowledge.
CO4: Acquire the concept of Electromagnetic Induction and its uses in engineering field.
CO5: Explain the various batteries as storage devices and be aware of safe disposal of batteries.

DETAILED CONTENTS

UNIT I

Electrical Fundamentals

1.1 Nature of Electricity, Charge, free electrons, Electric potential and potential difference, Electric current, Electrical Energy, Electrical power and their unit.
1.2 Resistance: Definition, Unit, Laws of resistance, conductivity and resistivity, Effect of temperature on resistance, Temperature coefficient of resistance, Types of resistance & their applications, Color coding of resistance.
1.3 Rating and wattages of Electrical appliances, heating effect of Electrical current.
1.4 Introduction to Capacitors, capacitance, Variable capacitor, Factors affecting capacitance of a capacitor.
1.5 Capacitance of parallel plate capacitor
1.6 Grouping of capacitors: capacitors in series, parallel, series-parallel.
1.7 Energy stored in capacitor, Charging and discharging of a capacitor.

UNIT II

DC Circuits

2.1 Ohm's law with practical implementation.

2.2 Definition of DC circuit, types of DC circuits: series circuit, parallel circuit, series-parallel circuit.

2.3 Concept of voltage source & current source, connections and their conversions.

2.3 Wheatstone Bridge.

2.4 Kirchhoff's Laws-KVL and KCL.

2.5 Star – Delta connections and their conversion.

UNIT III

Electrostatics & Magnetostatics

3.1 Concepts of Electrostatics, Coulomb's law.

3.2 Concept of magnetism, Magnetic field, Magnetic lines of force

3.3 Definition of Electromagnetism, magnetic effect of electric current, direction of magnetic field and current: right hand rule, right hand cork screw rule.

3.4 Magnetic field due to circular coil, solenoid,

3.5 Current carrying conductors in a magnetic field and methods to find its direction, applications.

3.6 Force between two parallel current carrying conductors. Analogy between electric and magnetic circuit. Definition of Magnetic circuit, terms related to magnetic circuits: magneto-motive force (MMF), flux, magnetic flux density, reluctance, permeability, field intensity, relation between magnetic flux density, permeability, field intensity.

UNIT IV

Electro-Magnetic Induction

4.1 Determination of Ampere Turns, Series & parallel magnetic circuits, Concept of magnetic leakage, useful flux & Air Gap.

4.2 Magnetic curve (B-H curve) - cause of Hysteresis, Hysteresis loss, significance of Hysteresis loss, magnetic hysteresis loop for hard and soft magnetic materials.

4.3 Faraday's laws of electro-magnetic induction.

4.4 Direction of Induced emf and current: Lenz's law, Fleming's right Hand rule

4.5 E.M.F induced in a conductor: Dynamically induced emf, Statically induced emf: Self-induced emf and Mutual induced emf, Expression for self-inductance, mutual inductance.

4.6 Energy stored in an Inductor, Eddy currents, Eddy current losses.

UNIT V

Batteries

5.1 Electrolysis, Faradays law of electrolysis, important terms related to electrolysis, electroplating.

5.2 Concept of Cell: definition, emf of cell, internal resistance of cell, terminal potential of cell, types of cell (primary and secondary cell), grouping of cell (series grouping, parallel grouping, series-parallel grouping).

5.3 Concept of Battery: Definition, types of battery like Lead-Acid, Nickel-Cadmium, Lithium ion batteries with their Construction, working principle and applications.

5.4 Charging methods of storage battery and charging indications.

5.5 Characteristics of battery: voltage, capacity, efficiency

5.6 Care and maintenance of battery

5.7 Introduction to maintenance free batteries.

5.8 Disposal of batteries

PRACTICAL EXERCISES

1. Familiarization of basic components/equipment like ammeter, voltmeter, watt meter, resistance, capacitor, inductor, energy meter, power factor meter, CRO, multi-meter etc and their operation, uses .
2. Determine the value of resistance using colour coding method.
3. Observation of change in resistance of a bulb in hot and cold conditions, using voltmeter and ammeter.
4. To charge and discharge a capacitor and to show the graph on C.R.O.
5. Verification of laws of capacitors in series and parallel.
6. To verify ohm's law by drawing a graph between voltage and current.
7. Verification of Kirchhoff’s Current Law in a dc circuit.
8. Verification of Kirchhoff’s Voltage Laws in a dc circuit.
9. Measurement of current and voltage in series resistive circuit.
10. Measurement of current and voltage in parallel resistive circuit.
11. To find the ratio of inductance of a coil having air-core and iron-core respectively and to observe the effect of introduction of a magnetic core on coil inductance.
12. Verification of Faraday's law of electromagnetic induction.
13. To obtain BH curve of a magnetic material.
14. Demonstration of parts of a battery and find the specific gravity of battery.
15. Demonstration of charging and discharging of Battery and measure the terminal voltage during charging and discharging condition.

RECOMMENDED BOOKS

1. B. L. Theraja and A. K. Theraja, "ABC of Electrical Engineering", S Chand Publishers, New Delhi, 2014 Edition.
2. S. K. Bhattacharya, "Basic Electrical and Electronics Engineering", Pearson Education India, 2012 Edition.
3. DP Kothari and Nagrath, "Basic Electric Engineering", Tata McGraw Hill, 2009.
4. V. Mittle and Arvind Mittle, "Basic Electrical Engineering", Mc Graw Hill Companies, 2005 Edition.
5. V. K. Mehta & Rohit Mehta, "Basic Electrical Engineering", S. Chand & Co, 2006.
6. Tarlok Singh, "Fundamentals of Electrical Engineering", S. K. Kataria & Sons, 2020.
7. SK Bhattacharya, KM Rastogi, "Experiments in Basic Electrical Engineering", New Age International (P) Ltd. Publishers, New Delhi, 2011.

SUGGESTED WEBSITES

1. http://swayam.gov.in

INSTRUCTIONAL STRATEGY

This is hands-on practice based subject and topics taught in the class should be practiced in the Lab regularly for development of required skills in the students. This subject contains five units of equal weightage.

1. Teachers may take help of various models and charts, you-tubes video's, e-learning resources while studying the contents of the subject to the students so that the concepts should be clear. More emphasis should be laid on discussing and explaining practical applications.
2. Teachers should give examples from daily routine as well as, engineering/technology applications on various concepts and principles in each topic so that students are able to understand and grasp these concepts and principles.
3. Teachers should motivate students to solve the numerical problems of subject. Teachers must ask 30% of numerals problems in sessional test and final semester exam.
4. Teachers should expose to different learning tools used in respective labs, Operational safety and Procedure to be followed in the laboratory. Students may ask to make micro projects by using the idea as learning in the subject.
5. Activity- Theory - Demonstrate/practice approach may be followed throughout the courses so that learning may be skill and employ-ability based.
6. Teachers take assignments, seminar, quiz, viva-voce etc. to enhance the learning ability of the students.
7. Students must have to perform at least 12 experiment in the laboratory.

1.5 FUNDAMENTALS OF IT

L	P
2	4

RATIONALE

Information technology has great influence on all aspects of life. Almost all work places and living environment are being computerized. In order to prepare diploma holders to work in these environments, it is essential that they are exposed to various aspects of information technology such as understanding the concepts of information technology and its scope, operating a computer: use of various office management tools, using internet and mobile applications etc. This course is intended to make new students comfortable with computing environment - Learning basic computer skills, learning basic application software tools, Understanding Computer Hardware, Cyber security awareness.

COURSE OUTCOMES

At the end of the subject student will be able to:

CO1: Explain the basic components of Computers, Internet and issues of abuses/ attacks on information and computers
CO2: Handle the computer/laptop/mobiles/Internet Utilities and Install/Configure OS
CO3: Assemble a PC and connect it to external devices
CO4: Manage and Use Office practiced Automation Tools
CO5: Develop worksheets and Prepare presentations

DETAILED CONTENTS

UNIT I

Basics of Computer

Brief history of development of computers, Definition of Computer, Block diagram of a Computer, Hardware, Software, Booting: Cold and Hot Booting, Interaction between the CPU and Memory with Input/ Output devices, Function of CPU and major functional parts of CPU.

Memory, Bit, Nibble, Byte, KB, MB, GB, TB, PB, Functions of memory, Use of storage devices in a Computer, List types of memory used in a Computer, Importance of cache memory, CPU speed and CPU word length

UNIT II

Basic Internet Skills

Understanding browser, Introduction to WWW, efficient use of search engines, awareness about Digital India portals (state and national portals) and college portals. Advantages of Email, Various email service providers, Creation of email id, sending and receiving emails, attaching documents with email and drive.

Effective use of Gmail, G-Drive, Google Calendar, Google Sites, Google Sheets, Online mode of communication using Google Meet & WebEx.

UNIT III

Basic Logic building

Introduction to Programming, Steps involved in problem solving, Definition of Algorithm, Definition of Flowchart, Steps involved in algorithm development, differentiate algorithm and flowchart, symbols used in flowcharts, algorithms for simple problems, flowcharts for simple problems, Practice logic building using flowchart/algorithms

UNIT IV

Office Tools

Office Tools like LibreOffice/OpenOffice/MSOffice.

OpenOffice Writer – Typesetting Text and Basic Formatting, Inserting Images, Hyperlinks, Bookmarks, Tables and Table Properties in Writer

Introducing LibreOffice/OpenOffice *Calc*, Working with Cells, Sheets, data, tables, using formulae and functions, using charts and graphics.

OpenOffice Impress – Creating and Viewing Presentations, Inserting Pictures and Tables, Slide Master and Slide Design, Custom Animation.

UNIT V

Use of Social Media

Introduction to Digital Marketing – Why Digital Marketing, Characteristics of Digital Marketing, Tools for Digital Marketing, , Effective use of Social Media like LinkedIn, Google+, Facebook, Twitter, etc.: Features of Social media, Advantages and Disadvantages of Social Media.

PRACTICAL EXERCISES

1. Browser features, browsing, using various search engines, writing search queries
2. Visit various e-governance/Digital India portals, understand their features, services offered
3. Read Wikipedia pages on computer hardware components, look at those components in lab, identify them, recognize various ports/interfaces and related cables, etc.

4. Using Administrative Tools/Control Panel Settings of Operating Systems
5. Connect various peripherals (printer, scanner, etc.) to computer, explore various features of peripheral and their device driver software.
6. Explore features of Open Office tools and MS-Office, create documents, create presentation, create spread sheet, using these features, do it multiple times
7. Working with Conversion Software like pdfToWord, WordToPPT, etc.
8. Working with Mobile Applications – Searching for Authentic Mobile app, Installation and Settings, Govt. of India Mobile Applications
9. Creating email id, sending and receiving mails with attachments.
10. Using Google drive, Google calendar
11. Create Flow chart and Algorithm for the following

i. Addition of n numbers and display result
ii. To convert temperature from Celsius to Fahrenheit
iii. To find Area and Perimeter of Square
iv. Swap Two Numbers
v. find the smallest of two numbers
vi. Find whether given number is Even or Odd
vii. To print first n even Numbers
viii. find sum of series 1+2+3+…..+N
ix. print multiplication Table of a number
x. generate first n Fibonacci terms 0,1,1,2,3,5…n (n>2)
xi. sum and average of given series of numbers
xii. Factorial of number n (n!=1x2x3x…n)
xiii. Armstrong Number
xiv. Find whether given number is Prime or not

RECOMMENDED BOOKS

1. R.S. Salaria, “Computer Fundamentals”, Khanna Publishing House.
2. Ramesh Bangia, “PC Software Made Easy – The PC Course Kit”, Khanna Publishing House.
3. Online Resources, Linux man pages, Wikipedia
4. Mokhtar Ebrahim and Andrew Mallett, “Mastering Linux Shell Scripting: A practical guide to Linux command-line, Bash scripting, and Shell programming”.
5. Vikas Gupta, “Comdex Hardware and Networking Course Kit” Dream Tech press, New Delhi, 2008.
6. Sumitabha Das, “UNIX concepts and applications” Tata McGraw Hill, New Delhi, 2008, Fourth Edition.

SUGGESTED WEBSITES

1. https://nptel.ac.in/courses/106/106/106106222/ - NPTEL Course on Modern Application Development
2. https://onlinecourses.swayam2.ac.in/aic19_de01/preview -
3. https://spoken-tutorial.org/ - Tutorials on Introduction to Computers, HTML, LibreOffice Tools, etc.
4. NOTEPAD++
5. https://tms-outsource.com/blog/posts/web-development-ide/

INSTRUCTIONAL STRATEGY

This is a skill based subject and topics taught in the class should be practiced in the Lab regularly for development of required skills in the students. This subject contains five units of equal weight age.

1.6 ENGINEERING GRAPHICS

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RATIONALE

Drawing is the language of engineers and technicians. Reading and interpreting engineering drawings is their day to day responsibility. The subject is aimed at developing basic graphic skills in the students so as to enable them to use these skills in preparation of engineering drawings, their reading and interpretation. The emphasis, while imparting instructions, should be to develop conceptual skills in the students following BIS SP 46 – 1988.

COURSE OUTCOMES

After undergoing the subject, the students will be able to:

CO1: Draw Orthographic views of different objects viewed from different angles.

CO2: Draw and interpret sectional views of an object which are otherwise not visible in normal view.

CO3: Draw Isometric views of different solids and develop their surfaces.

CO4: Identify conventions for different engineering materials, symbols, sections of regular objects and general fittings used in Civil and Electrical household appliances /fittings.

CO5: Draw orthographic views of different objects by using basic commands of AutoCAD.

DETAILED CONTENTS

UNIT I

1. Introduction to Engineering Drawing and Graphics

1.1 Introduction to use and care of drawing instruments, drawing materials, layout and sizes of drawing sheets and drawing boards.

1.2 Symbols and conventions-

a) Conventions of Engineering Materials, Sectional Breaks and Conventional lines.
b) Civil Engineering Sanitary fitting symbols
c) Electrical fitting symbols for domestic interior installations.

1.3 Geometrical construction-geometrical figures such as triangles, rectangles, circles, ellipses and curves, hexagons, pentagons bisecting a line and arc , division of line and circle with the help of drawing instruments.

2. Technical Lettering of Alphabet and Numerals

Definition and classification of lettering, Free hand (of height of 5,8,12 mm) and instrumental

lettering (of height 20 to 35 mm): upper case and lower case, single and double stroke, vertical and inclined (Gothic lettering) at 75 degree to horizontal and with suitable height to width ratio 7:4.

3. Dimensioning

3.1 Necessity of dimensioning, method and principles of dimensioning (mainly theoretical instructions).

3.2 Dimensioning of overall sizes, circles, threaded holes, chamfered surfaces, angles, tapered surfaces, holes, equally spaced on P.C.D., countersunk holes, counter bored holes, cylindrical parts, narrow spaces and gaps, radii, curves and arches.

4. Scales

4.1 Scales –Needs and importance (theoretical instructions), Type of scales, Definition of Representative Fraction (R.F.) and Length of Scale.

4.2 To draw/construct plain and diagonal scales.

UNIT II

1. Orthographic Projections

1.1 Theory of orthographic projections (Elaborate theoretical instructions).

1.2 Three views of orthographic projections of different objects of given pictorial view of a block in 1st and 3rd angle.

1.3 Projection of Points in different quadrant

1.4 Projection of Straight Line (1^{st} angle)

i. Line parallel to both the planes.

ii. Line perpendicular to any one of the reference plane and parallel to others

iii. Line inclined to any one of the references and parallel to another plane.

1.5 Projection of Plane – Different lamina like square rectangular, triangular, circle and Hexagonal pentagon. Trace of planes (HT and VT).

1.6 Identification of surfaces.

2. Sectioning

2.1 Importance and salient features

2.2 Drawing of full section, half section, partial or broken out sections, Offset sections, revolved sections and removed sections (theoretical only).

2.3 Orthographic sectional views of different objects.

UNIT III

1. Introduction of projection of right solids such as prism & pyramid (square, Pentagon, Hexagonal) cube, cone & cylinder (Axes perpendicular to H.P and parallel to V.P.)

2. Introduction of sections of right solids - Section planes, Sections of Hexagonal prism, pentagon pyramid, cylinder and cone (Section plane parallel to anyone reference planes and perpendicular to V.P. and inclined to H.P.)

3. Development of Surfaces – Development of lateral surfaces of right solids like cone, cylinder, pentagonal prism, pyramid and hexagonal pyramid (Simple problems)

UNIT IV

Isometric Views

1. Fundamentals of isometric projections and isometric scale.
2. Isometric views of different laminas like circle, pentagon and hexagon.
3. Isometric views of different regular solids like cylinder, cone, cube, cuboid, pyramid and prism.
4. Isometric views from given different orthographic projections(front, side and top view)

UNIT V

Introduction to AutoCAD

Basic introduction and operational instructions of various commands in AutoCAD. At least two sheets of different objects on AutoCAD (given pictorial/isometric view of a block). AutoCAD skill of student is evaluated in internal assessment only not in external exam.

RECOMMENDED BOOKS

1. A Text Book of Engineering Drawing by Surjit Singh; Dhanpat Rai & Co.,Delhi
2. Engineering Drawing by PS Gill; SK Kataria & Sons, NewDelhi
3. Elementary Engineering Drawing in First Angle Projection by ND Bhatt;Charotar Publishing House Pvt. Ltd.,Anands
4. Engineering Drawing and Graphics using AutoCAD by T. Jeyapoovan,Vikas Publishing House Pvt, Ltd Noida.
5. A Text Book of Engineering Drawing by S.R.Singhal and O.P.Saxena, Asian Publisher, Delhi.
6. Engineering Drawing by RB Gupta, Satya Prakashan, New Delhi

INSTRUCTIONAL STRATEGY

Teacher should show model of realia of the component/part whose drawing is to be made. Emphasis should be given on cleanliness, dimensioning and layout of sheet. Focus should be on proper selection of drawing instruments and their proper use. First angle projection is to be followed. Minimum of 20 sheets to be prepared and at least 2 sheets on AutoCAD**.** Instructions relevant to various drawings may be given along with appropriate demonstrations, before assigning drawing practice to students. This subject contains five units of equal weight age.

SECOND SEMESTER

2.1	Applied Mathematics -II	44-46
2.2	Applied Physics-II	47-50
2.3	Electrical Networks	51-54
2.4	Non-conventional Sources of Energy	55-58
2.5	Environmental Studies and Disaster Management	59-61
2.6	Basic Electrical Workshop	62-64

2.1 APPLIED MATHEMATICS – II

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RATIONALE

Applied mathematics forms the backbone of engineering students. Basic elements of Differential calculus, Integral calculus and Differential Equations have been included in this course. This will develop analytical abilities to apply in engineering field and will provide continuing educational base to the students.

COURSE OUTCOMES

After undergoing the subject, the students will be able to:

CO1: Formulate the engineering problems into mathematical format with the use of differential equations and differential

C02: Use the differentiation and Integration in solving various Mathematical and Engineering problems.

CO3: Calculate the approximate area under a curve by applying integration and numerical methods.

CO4: Discuss the purposes of measures of central tendency and calculate the measures of central tendency (mode, median, mean) for a set of data.

CO5: Learn about basic fundamentals about MATLAB/ SciLab and mathematical calculation with MATLAB/ SciLab software.

DETAILED CONTENTS

UNIT I

Differential Calculus

1.1 Definition of function; Concept of limits (Introduction only) and problems related to four standard limits only.

1.2 Differentiation of x^n, sin x, cos x, e^x by first principle.

1.3 Differentiation of sum, product and quotient of functions.

UNIT II

Differential Calculus and Its Applications

2.1 Differentiation of trigonometric functions, inverse trigonometric functions. Logarithmic differentiation, successive differentiation (upto 2nd order)

2.2 Application of differential calculus in:

(a) Rate measures (b) Maxima and minima

UNIT III

Integral Calculus

3.1 Integration as inverse operation of differentiation with simple examples.

3.2 Simple standard integrals and related problems, Integration by Substitution method and Integration by parts.

3.3 Evaluation of definite integrals with given limits.

$$\text{Evaluation of } \int_0^{\pi/2} \sin^n x.\, dx, \quad \int_0^{\pi/2} \cos^n x\, dx, \quad \int_0^{\pi/2} \sin^m x\, \cos^n x\, dx$$

using formulae without proof (m and n being positive integers only) using pre-existing mathematical models.

UNIT IV

Application of Integration, Numerical Integration and Differential Equations

4.1 Applications of integration: for evaluation of area under a curve and axes (Simple problems).

4.2 Numerical integration by Trapezoidal Rule and Simpson's $1/3^{rd}$ Rule using pre-existing mathematical models.

Differential Equations

4.3 Definition, order, degree, Type of differential Equations, linearity, Formulation of ordinary differential equation (up to 1^{st} order), solution of ODE (1^{st} order) by variable separation method.

UNIT V

Statistics and Software

Statistics

5.1 Measures of Central Tendency: Mean, Median, Mode

5.2 Measures of Dispersion: Mean deviation, Standard deviation

Software

5.3 SciLab software – Theoretical Introduction.

5.4 Basic difference between MATLAB and SciLab software,

5.5 Calculations with MATLAB or ScilLab - (a) Representation of matrix (2×2 order), (b) Addition, Subtraction of matrices (2×2 order) in MATLAB or SciLab

RECOMMENDED BOOKS

1. R. D. Sharma, "Applied Mathematics – I & II for Diploma Courses", Dhanpat Rai Publications.
2. "Mathematics for Class XI", NCERT Publication, New Delhi.
3. "Mathematics for Class XII", NCERT Publication, New Delhi.

4. H. K Dass, "Applied Mathematics for Polytechnics", CBS Publishers & Distributers.
5. A Ganesh and G Balasubramanian, "Textbook of Engineering Mathematics –I", CBS Publisher, New Delhi.
6. A Ganesh and G Balasubramanian, "Textbook of Engineering Mathematics –II", CBS Publisher, New Delhi.
7. G. B. Thomas, R. L. Finney, "Calculus and Analytic Geometry", Addison Wesley, Ninth Edition.
8. B S Grewal, "Elementary Engineering Mathematics", Khanna Publishers, Delhi, Thirty-fifth Edition.
9. R.K. Jain and S.R.K. Iyengar, "Advanced Engineering Mathematics" Narosa Publishing House, New Delhi, Second Edition, 2003.
10. SS Sabharwal & Dr Sunita Jain, "Applied Mathematics Vol. I & II", Eagle Parkashan, Jalandhar.
11. S Kohli, "Engineering Mathematics Vol. I & II", IPH, Jalandhar.
12. Reena Garg & Chandrika Prasad, "Advanced Engineering Mathematics", Khanna Publishing House, New Delhi.
13. R. Pratap, "Getting Started with MATLAB 7", Oxford University Press, Seventh Edition.
14. E-books/e-tools/relevant software to be used as recommended by AICTE/HSBTE/NITTTR.

SUGGESTED WEBSITES

1. https://www.scilab.org
2. http://swayam.gov.in

INSTRUCTIONAL STRATEGY

This is theoretical subject and contains five units of equal weight age.

Basic elements of Differential Calculus, Integral Calculus, and Differential Equations can be taught in the light of their applications in the field of engineering and technology. By laying more stress on applied part, teachers can also help in providing continuing education base to the students. Students need to be taught the skills needed to use software tools built by experts through multiple problem solving based on the topics that the industry requires. For example they need to know how to use mathematical models that use integration as opposed to learning how integration can be used. Useful authenticated software MATLAB or open source software SciLab can be taught theoretically by books/online literatures and basic operations can be shown practically with practical software laboratory or small mobile apps of these software or authentic Trial version of MATLAB/ SciLab software. Diploma students need to know which tools to use and how to do the job.

2.2 APPLIED PHYSICS-II

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RATIONALE

Applied physics includes the study of a large number of diverse topics all related to things that go on in the world around us. It aims to give an understanding of this world both by observation and by prediction of the way in which objects will behave. Concrete use of physical principles and analysis in various technical fields are given prominence in the course content to prepare students for various technical applications.

COURSE OUTCOMES

At the end of this subject, the students will be able to:

CO1: Differentiate between types of waves and their motion.
CO2: Illustrate laws of reflection and refraction of light.
CO3: Demonstrate competency in phenomena of electrostatics and electricity.
CO4: Characterize properties of material to prepare new materials for various technical applications.
CO5: Demonstrate a strong foundation on Modern Physics to use at various technical applications.

DETAILED CONTENTS

UNIT I

Wave Motion and its Applications

1.1 Waves: definition, types (mechanical and electromagnetic wave)
1.2 Wave motion- transverse and longitudinal with examples, terms used in wave motion like displacement, amplitude, time period, frequency, wavelength, wave velocity; relationship among wave velocity, frequency and wave length
1.3 Simple harmonic motion (SHM): definition, examples
1.4 Cantilever: definition, formula of time period (without derivation)
1.5 Free, forced and resonant vibrations with examples
1.6 Sound waves: types (infrasonic, audible, ultrasonic) on the basis of frequency, noise, coefficient of absorption of sound, echo

UNIT II

Optics

2.1 Reflection and refraction of light with laws, refractive index

2.2 Lens: introduction, lens formulae (no derivation), power of lens and simple numerical problems

2.3 Total internal reflection and its applications, critical angle and conditions for total internal reflection

2.4 Superposition of waves (concept only), definition of Interference, Diffraction and Polarization of waves

2.5 Introduction to Microscope, Telescope and their applications

UNIT III

Electrostatics and Electricity

3.1 Electric charge, unit of charge, conservation of charge

3.2 Coulomb's law of electrostatics

3.3 Electric field, electric lines of force (definition and properties), electric field intensity due to a point charge

3.4 Definition of electric flux, Gauss law (statement and formula)

3.5 Capacitor and capacitance (with formula and unit)

3.6 Electric current and its SI Unit, direct and alternating current

3.7 Resistance, conductance (definition and unit)

3.8 Series and parallel combination of resistances

3.9 Ohm's law (statement and formula)

UNIT IV

Classification of Materials and their Properties

4.1 Definition of energy level, energy bands

4.2 Types of materials (conductor, semiconductor, insulator and dielectric) with examples, intrinsic and extrinsic semiconductors (introduction only)

4.3 Introduction to magnetism, type of magnetic materials: diamagnetic, paramagnetic and ferromagnetic materials with examples

4.4 Magnetic field, magnetic lines of force, magnetic flux

4.5 Electromagnetic induction (definition)

UNIT V

Modern Physics

5.1 Laser: introduction, principle, absorption, spontaneous emission, stimulated emission, population inversion

5.2 Engineering and medical applications of laser

5.3 Fibre optics**:** introduction to optical fibers (definition, principle and parts), light propagation, fiber types (mono-mode, multi-mode), applications in medical, telecommunication and sensors

5.4 Nanotechnology: introduction, definition of nanomaterials with examples, properties at nanoscale, applications of nanotechnology (brief)

PRACTICAL EXERCISES

1. Familiarization with apparatus (resistor, rheostat, key, ammeter, voltmeter, telescope, microscope etc.)
2. To find the time period of a simple pendulum.
3. To study variation of time period of a simple pendulum with change in length of pendulum.
4. To determine and verify the time period of Cantilever.
5. To verify Ohm's laws by plotting a graph between voltage and current.
6. To study colour coding scheme of resistance.
7. To verify laws of resistances in series combination.
8. To verify laws of resistance in parallel combination.
9. To find resistance of galvanometer by half deflection method.
10. To verify laws of reflection of light using mirror.
11. To verify laws of refraction using glass slab.
12. To find the focal length of a concave lens, using a convex lens.

RECOMMENDED BOOKS

1. "Text Book of Physics for Class XII (Part-I, Part-II)", N.C.E.R.T., Delhi.
2. Dr. HH Lal, "Applied Physics, Vol. I & II", TTTI Publications, Tata McGraw Hill, Delhi.
3. AS Vasudeva, "Applied Physics –II", Modern Publishers, Jalandhar.
4. R A Banwait, "Applied Physics – II", Eagle Prakashan, Jalandhar.
5. N Subrahmanyam, Brij Lal and Avadhanulu, "A text book of OPTICS", S Chand Publishing, New Delhi.
6. E-books/e-tools/relevant software to be used as recommended by AICTE/ HSBTE/ NITTTR.
7. M H Fulekar, "Nanotechnology: Importance and Applications", IK International Publishing House (P) Ltd., New Delhi.
8. C. L. Arora, "Practical Physics", S Chand Publication.

SUGGESTED WEBSITES

1. http://swayam.gov.in

INSTRUCTIONAL STATREGY

This is hands-on practice based subject and topics taught in the class should be practiced in the Lab regularly for development of required skills in the students. This subject contains five units of equal weightage.

Teacher may use various teaching aids like models, charts, graphs and experimental kits etc. for imparting effective instructions in the subject. Students need to be exposed to use of different sets of units and conversion from one unit type to another. Software may be used to solve problems involving conversion of units. The teacher should explain about field applications before teaching the basics of mechanics, work, power and energy, rotational motion, properties of matter etc. to develop proper understanding of the physical phenomenon. Use of demonstration can make the subject interesting and develop scientific temper in the students.

Teachers should give examples of engineering/technology applications of various concepts and principles in each topic so that students are able to appreciate learning of these concepts and principles. In all contents, SI units should be followed. Working in different sets of units can be taught through relevant software.

2.3 ELECTRICAL NETWORKS

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RATIONALE

This course intends to teach the students facts, concepts and principles of circuits and circuit analysis so that he/she can use the knowledge in acquiring supervisory skill to assist in carrying out the analysis & investigation work.

COURSE OUTCOMES

At the end of this subject, the student will be able to:

CO1: Understand mesh, nodal methods, different network theorems and applying them to solve DC circuits.

CO2: Remember the concept of ac circuit, resonance, power factor and their significance.

CO3: Apply the basic principles and solve the A.C. series and parallel circuit.

CO4: Recognize the concept of Poly-phase system and compute the electrical parameters.

DETAILED CONTENTS

UNIT I

DC Network Theorems

1.1 Mesh analysis

1.2 Nodal analysis using voltage and current sources

1.3 Superposition theorem

1.4 Thevenin theorem

1.5 Norton theorem

1.6 Maximum power transfer theorem

1.7 Active and passive network, Linear and Non Linear network

UNIT II

AC Fundamentals

2.1 Generation of alternating Voltage and current. Difference between ac and dc, Equation of alternating quantity.

2.2 AC Terminology: waveform, cycle, frequency, time period, amplitude, instantaneous value, alternation, and their important relations (time period and frequency, angular velocity and frequency etc.)

2.3 Values of alternating voltage and current: Instantaneous value, peak value average value, r.m.s. value, form factor and peak factor
2.4 Vector representation of alternating quantities
2.5 Concept of phase, phase difference and phasors
2.6 Representation of electrical quantities through phasors
2.7 Addition of two alternating quantities: parallelogram method, component method

UNIT III

Single Phase AC Series Circuits

3.1 A.C circuit containing pure Resistance, Inductance, Capacitance with the concept of power consumed, phase Angle, inductive and capacitive reactance etc.
3.2 AC series circuit: R-L, R-C, R-L-C along with the concept of phasor diagram, phase angle , Impedance, impedance triangle, power, power triangle etc.
3.3 Concept of True power, apparent power and reactive power, Power factor and its significance, disadvantages of low power factor, cause of low power factor, improvement of power factor.
3.4 Active and reactive components of current
3.5 Resonance in RLC series circuit, Quality (Q) factor

UNIT IV

Single Phase AC Parallel Circuits

4.1 Concept of AC parallel circuit
4.2 Methods of solving parallel AC circuit: vector method, admittance method, symbolic or J-method
4.3 Parallel Resonance, Q-factor
4.4 Comparison of series and parallel resonance.
4.5 Introduction to transient and Harmonics in A.C. circuits

UNIT V

Polyphase Circuit

5.1 Principle of generation of 3 –ø alternating emf.
5.2 Advantages of Polyphase circuit over single phase circuit, Phase Sequence.
5.3 Types of three phase connections-Star connection and delta connection.
5.4 Concept of balanced and unbalanced load.
5.5 Relation between phase and line quantities of star and delta connection.

PRACTICAL EXERCISES

1. Use voltmeter, ammeter to determine current through the given branch of a electric network by applying mesh analysis.
2. Use voltmeter, ammeter to determine current through the given branch of a electric network by applying node analysis.
3. Verification of Superposition Theorem.
4. Verification of Thevenin's theorem.
5. Verification of Norton's Theorems.
6. Verification of Maximum Power transfer Theorem.
7. Observe the wave shape of an alternating supply on CRO and calculate average, RMS value, frequency and time period.
8. Measure input current, power, power factor of R-L series circuit and draw the power triangle.
9. Measure input current, power, power factor of R-C series circuit and draw the power triangle.
10. Measure input current, power, power factor of R-L-C series circuit and draw the power triangle.
11. Use variable frequency supply to create resonance in given series R-L-C circuit or by using variable inductor or variable capacitor.
12. To determine current, p.f., active, reactive and apparent power in R-C parallel A.C. circuit.
13. To determine current, p.f., active, reactive and apparent power for given R-L-C parallel circuit with series connection of resistor and inductor in parallel with capacitor.
14. Use variable frequency supply create resonance in given parallel R-L-C circuit or by using variable inductor or capacitor.
15. Verify the relationship between phase and line values of current and voltages and power in balanced and unbalanced star connected load.
16. Verify the relationship between phase and line values of current and voltages and power in balanced and unbalanced delta connected load.

RECOMMENDED BOOKS

1. Ashfaq Husain, "Networks & Systems", Khanna Book Publishing, New Delhi, 2019.
2. D.Roy Chouhary, "Networks and System", New Age International Publishers, 1988.
3. S.B Lal Saxena, K Dasgupta, "Fundamentals of Electrical Engineering", Cambridge University Press Pvt. Ltd., New Delhi, ISBN: 978-11-0746-435-3.
4. B. L Theraja, A. K Theraja, "A Text Book of Electrical Technology Vol-I", S. Chand & Co. Ramnagar, New Delhi, ISBN: 9788121924405.

5. A Sudhakar, S. Palli Shyammohan, “Circuit and Network”, McGraw Hill Education, New Delhi, ISBN: 978-93-3921-960-4.
6. David A Bell, “Electric Circuits”, Oxford University Press New Delhi, ISBN: 978-01-954-2524-6.
7. R.L Boylested, “Introductory Circuit Analysis”, Wheeler, New Delhi, ISBN: 978-00-231-3161-5.
8. S.N Sivanandam, “Electric Circuit Analysis”, Vikas Publishing House Pvt. Ltd, Noida, ISBN: 978-81259-1364-1.
9. S. Salivahanan, S Pravinkumar, “Circuit Theory”, Vikas Publishing House Pvt. Ltd, Noida; ISBN:978-93259-7418-0.

SUGGESTED WEBSITES

1. http://swayam.gov.in

INSTRUCTIONAL STRATEGY

This is hands-on practice based subject and topics taught in the class should be practiced in the Lab regularly for development of required skills in the students. This subject contains five units of equal weightage.

1. Teachers may take help of various models and charts, you-tubes video’s, e-learning resources while studying the contents of the subject to the students so that the concepts should be clear. More emphasis should be laid on discussing and explaining practical applications.
2. Teachers should give examples from daily routine as well as, engineering/technology applications on various concepts and principles in each topic so that students are able to understand and grasp these concepts and principles.
3. Preparing students to apply the technological method of problem solving to a real life problems. This quality is buildup in the students when students practice the numerical problems of the subject. Teachers should motivate students to solve the numerical problems of subject. Teachers must ask 30% of numerals problems in sessional test and final semester exam of this subject.
4. Teachers should expose to different learning tools used in respective labs, Operational safety and Procedure to be followed in the laboratory. Students may ask to make micro projects by using the idea as learning in the subject.
5. Activity- Theory - Demonstrate/practice approach may be followed throughout the coursesso that learning may be skill and employ-ability based.
6. Teachers take assignments, seminar, quiz, viva -voce etc. to enhance the learning ability of the students.
7. Students must have to perform at least 12 experiment in the laboratory.

2.4 NON-CONVENTIONAL SOURCES OF ENERGY

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RATIONALE

Since the conventional energy resources are under fast depletion, it is high time to tap the non-conventional energy sources. The electrical Diploma holder must be aware about the renewable energy resources like solar energy, wind energy, geothermal energy, ocean energy, hydro energy which is used for number of applications such as power generation, heating, cooling etc. This subject aim is to develop the skill required for renewable energy resource, so that they help the society for fulfilling the energy demand which is increasing day by day.

COURSE OUTCOMES

After undergoing the subject, the students will be able to:

CO1: Comprehend various renewable and non-renewable sources of energy

CO2: Gain knowledge about working principle of various solar energy systems

CO3: Acquire the detailed concepts of power generation with the wind energy, ocean energy, hydro, geothermal energy, tidal energy, fuel cell.

CO4: Develop basic design of bio gas plant.

CO5: Gain knowledge of different energy storage devices used in renewable energy resources.

DETAILED CONTENTS

UNIT I

Introduction to Energy and Solar Energy

1.1 **Classification of Energy Resources:** Conventional Energy Resources, Non-conventional Energy Resources, Roles and responsibility of Ministry of New and Renewable Energy Sources. Needs of renewable energy. Targets and Present Status of Renewable Energy Sources in India.

1.2 **Solar Energy:** Introduction, potential of solar energy in India, Solar Radiation, Principle of conversion of solar radiation into heat, construction and working principle of photo-voltaic cell. Solar cell materials, Difference between solar cell, panel, array, module, Characteristics, important terms related to solar energy, Efficiency of Solar Cells. Applications of solar energy like solar PV system (standalone and grid connected), solar water heating system, solar furnaces, solar cookers, solar lighting, solar water pumping system, solar still. Government schemes and policies.

UNIT II

Bio-Energy and Hydro Energy

2.1 **Bio-Energy:** Introduction, Biomass energy, Photosynthesis process, Biomass fuels, Biomass energy conversion technologies and applications, Biomass Gasification, Types and application of gasifier, Types of biogas plants, Factors affecting biogas generation, Environmental impacts and benefits, Future role of biomass , Biomass potential and programs in India.

2.2 **Hydro Energy:** Introduction, Capacity and Potential, Hydro Power Plant (mini and micro), Environmental and social impacts.

UNIT III

Wind Energy and Geothermal Energy

3.1 **Wind Energy:** Introduction, Wind energy conversion system, windmills, types of wind mills, selection of site, electricity generation from wind energy, Wind Energy potential and Scenario in India.

3.2 **Geothermal Energy:** Introduction , Geothermal Resource Utilization like hydrothermal, Geo-pressured hot dry rock, magma, Geothermal based Electric Power Generation, Associated Problems, environmental Effects, prospects of geothermal energy in India.

UNIT IV

Tidal Energy and Mhd

4.1 **Tidal Energy:** Introduction, Capacity and Potential, Principle of Tidal Power, Components of Tidal Power Plant, Classification of Tidal Power Plants.

4.2 **Ocean Energy:** Introduction, Ocean Thermal Energy Conversion (OTEC), Principle of OTEC system, Methods of OTEC power generation, prospects of OTEC in India.

4.3 **MHD power generation**: Principle of working of Magneto Hydro Dynamic (MHD) Power Generation, materials for MHD generators and future prospects, performance and limitations.

UNIT V

Fuel Cell and Energy Storage Devices

5.1 **Fuel Cells:** Fuel cell definition, difference between batteries and fuel cells, Principle of working of fuel cells ,types of fuel cell, power generation by fuel cell ,conversion efficiency, applications, advantages and disadvantages of fuel cell .

5.2 **Energy Storage:** Need of energy storage, Different modes of energy storage, Flywheel storage, Superconducting Magnet Energy Storage (SMES) systems, Capacitor, battery, Super capacitor. Comparison and application.

PRACTICAL EXERCISES

1. Visit the website of Ministry of New and Renewable Energy Sources and prepare the Datasheet of Potential, Present and Future Scenario of Renewable energy sources in India.
2. Familiarization with the different components used in solar PV plant (standalone and grid connected system), solar water heating system, solar cooker, solar lighting etc.
3. Calculate power flow of a stand-alone PV system with DC load, AC load and battery.
4. To demonstrate "I-V Characteristics and Efficiency of 1kWp Solar PV System" with varying radiation and temperature level.
5. Assemble the components of solar home lighting system & study the system.
6. Assemble the components of solar water heating system system & study the system.
7. Identify Troubleshoot solar PV panel, inverter and solar smart metering system.
8. Identify the specified components of a 1 KW Small Wind Turbine (SWT) system and study them.
9. Estimation of wind speed using anemometer.
10. Study of charging and discharging behavior of a capacitor.
11. Study of charging characteristics of a Ni-Cd battery using solar photovoltaic panel.
12. Identify the prime mover /turbines used in different renewable energy sources for power generation and study them.
13. Study the Performance of fuel cell.
14. Identify the routine maintenance parts of the micro hydro power plant after watching a video.

- Visit nearby renewable power plant and write specification of each components used in that plant.

RECOMMENDED BOOKS

1. S. P. Sukhatme, "Solar Energy", Tata McGraw Hill Publishing Company Ltd., New Delhi, 1997.
2. B. H. Khan, "Non-Conventional Energy Resources", The McGraw Hill.
3. J. W. Twidell & A. Weir, "Renewable Energy Sources", EFN Spon Ltd., UK, 2006.
4. S. P. Sukhatme and J.K. Nayak, "Solar Energy – Principles of Thermal Collection and Storage", Tata McGraw-Hill, New Delhi.
5. Garg, Prakash, "Solar Energy, Fundamentals and Applications", Tata McGraw Hill.
6. G.D. Rai, "Non-Conventional Energy Sources", Khanna Publications, New Delhi, 2011.
7. Godfrey Boyle, "Renewable Energy, Power for a Sustainable Future", Oxford University Press, U.K., 1996.
8. K. C. Khandelwal & S. S. Mahdi, "Biogas Technology – A Practical Handbook", Tata Mc Graw Hill.

9. G. N. Tiwari, "Solar Energy – Fundamentals Design, Modeling & Applications", Narosa Publishing House, New Delhi, 2002.
10. Freris. L.L., "Wind Energy Conversion Systems", Prentice Hall, UK, 1990.
11. Frank Krieth & John F Kreider, "Principles of Solar Energy", John Wiley, New York.
12. N. K. Bansal, "Renewable Energy Sources and Conversion Technology", Manfred Kleemann, Michael Meliss, Tata McGraw Hill Publishing Co. Ltd New Delhi.

SUGGESTED WEBSITES

1. http://swayam.gov.in

INSTRUCTIONAL STRATEGY

This is hands-on practice based subject and topics taught in the class should be practiced in the Lab regularly for development of required skills in the students. This subject contains five units of equal weightage.

The teacher should make the students aware about the depletion of energy sources and the availability of alternate sources of energy their feasibility and limitations. The need for adopting non-conventional energy sources should be made clear to students. Teacher must give practical application of these energy sources in nearby surrounding areas. Visit nearby renewable energy source plants to enhance the real time practical skill in the students.

2.5 ENVIRONMENTAL STUDIES AND DISASTER MANAGEMENT

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RATIONALE

A diploma holder must have knowledge of different types of pollution caused due to industrial and construction activities so that he/she may help in balancing the ecosystem and controlling pollution by various control measures. The course is intended to provide a general concept in the dimensions of environmental pollution and disasters caused by nature beyond the human control as well as the disasters and environmental hazards induced by human activities with emphasis on disaster preparedness, response and recovery.

COURSE OUTCOMES

After undergoing the subject, the student will be able to:

CO1: Comprehend the importance of sustainable ecosystem.
CO2: Clarify interdisciplinary nature of environmental issues.
CO3: Describe corrective measures for the abatement of pollution.
CO4: Identify the role of non-conventional energy resources in environmental protection.
CO5: Recognize various types of disasters.

DETAILED CONTENTS

UNIT I

Introduction

1.1 Basics of ecology, eco system- concept, and sustainable development, Sources, advantages, disadvantages of renewable and nonrenewable energy.
1.2 Rain water harvesting
1.3 Deforestation – its effects & control measures

UNIT II

Air and Noise Pollution

2.1 Air Pollution: Source of air pollution. Effect of air pollution on human health, economy, Air pollution control methods.
2.2 Noise Pollution: Source of noise pollution, Unit of noise, Effect of noise pollution, Acceptable noise level, Different method of minimizing noise pollution.

UNIT III

Water and Soil Pollution

3.1 Water Pollution: Impurities in water, Cause of water pollution, Source of water pollution. Effect of water pollution on human health, Concept of DO, BOD, COD. Prevention of water pollution- Water treatment processes, Sewage treatment. Water quality standard.

3.2 Soil Pollution :Sources of soil pollution, Effects and Control of soil pollution, Types of Solid waste- House hold, Industrial, Agricultural, Biomedical, Disposal of solid waste, Solid waste management E-waste, E – waste management

UNIT IV

Impact of Energy Usage on Environment

Global Warming, Green House Effect, Depletion of Ozone Layer, Acid Rain. Eco-friendly Material, Recycling of Material, Concept of Green Buildings, Concept of Carbon Credit & Carbon footprint.

UNIT V

Disaster Management

A. Different Types of Disaster:

Natural Disaster: such as Flood, Cyclone, Earthquakes and Landslides etc.

Man-made Disaster: such as Fire, Industrial Pollution, Nuclear Disaster, Biological Disasters, Accidents (Air, Sea Rail & Road), Structural failures(Building and Bridge), War & Terrorism etc.

B.Disaster Preparedness:

Disaster Preparedness Plan

Prediction, Early Warnings and Safety Measures of Disaster

Psychological response and Management (Trauma, Stress, Rumour and Panic)

RECOMMENDED BOOKS

1. S.C. Sharma & M.P. Poonia, “Environmental Studies”, Khanna Publishing House, New Delhi.
2. BR Sharma, “Environmental and Pollution Awareness”, Satya Prakashan, New Delhi.
3. Dr. RK Khitoliya, “Environmental Pollution”, S Chand Publishing, New Delhi.
4. Erach Bharucha, “Environmental Studies”, University Press (India) Private Ltd., Hyderabad.
5. Suresh K Dhamija, “Environmental Engineering and Management”, S K Kataria and Sons, New Delhi.

6. E-books/e-tools/relevant software to be used as recommended by AICTE/BTE/NITTTR, Chandigarh.
7. Dr. Mrinalini Pandey, "Disaster Management", Wiley India Pvt. Ltd.
8. Tushar Bhattacharya, "Disaster Science and Management", McGraw Hill Education (India) Pvt. Ltd.

INSTRUCTIONAL STRATEGY

In addition to theoretical instructions, different activities pertaining to Environmental Studies and Disaster Management like expert lectures, seminars, visits etc. may also be organized This subject contains five units of equal weightage.

2.6 BASIC ELECTRICAL WORKSHOP

L	P
-	8

RATIONALE

An electrical diploma holder will be required to inspect, test and modify the work done by skilled workers or artisans working under him. In addition to these persons, many a times, it will become necessary for him to demonstrate the correct method and procedure of doing a job. In order to carry out this function effectively in addition to conceptual understanding of the method or procedure he must possess appropriate manual skills. The subject aims at developing special skills required for repairing, faultfinding, wiring in electrical appliances and installations.

COURSE OUTCOMES

After undergoing the subject, students will be able to:

CO1: Know the safety precautions and different tools and apply their skills for society.
CO2: Detect and rectify various types of faults in house wiring, and contactor control circuits.
CO3: Repair various domestic appliances and apply knowledge of earthing
CO4: Perform wiring, testing and fault finding of the control circuits process
CO5: Perform single phase and three phase supply and wiring system.

PRACTICAL EXERCISES

UNIT I

Electrical Safety Measures and Identification of Common Electrical Materials/Tools

1.1 Study safety measures while working or handing the electrical equipments.
1.2 Use of fire extinguisher during electric fire.
1.3 Study the methods to take restoration of person suffering from electric shock.
1.4 Identification of common electrical materials with standard ratings and specifications such as wires, cables, switches, 1-pole, 2-pole and 3-pole MCB, RCCB & ELCB, fuses, cleats, clamps and allied items, tools and accessories.
1.5 Identification ,use and connections of various types of switches such as: normal/miniature toggle, slide, push button piano key, rotary, SPST, SPDT, DPST, DPDT, band selector, multi-way Master Mains Switch.
1.6 Identification of phase, Neutral and Earth wires for connection to domestic electrical appliances and their connections to three pin plugs.
1.7 Identification and familiarization of following electrical wiring tools with respect to their usage: Screw drivers (different sizes), Insulated Pliers, Cutter, Sniper, Screw Driver (Star

Screw Driver), L- Keys, Soldering Iron, soldering wire, flux, Drilling machines and Drilling Bits, Voltage/line tester, Insulation remover, Standard Wire Gauge .

UNIT II

House Wiring

2.1 Soldering wire jointing of different types such as straight joint/ married joint, T joint, Western union joint, pigtail joint.

2.2 Making of extension board containing two 5A and one 15A plug points.

2.3 To make a single phase main distribution board with five outgoing circuits for light and fan load including main switch and fuse (only internal connection).

2.4 Fault detection and repair of domestic electric installation.

2.5 Fault detection and its repair in institution's workshop installations.

2.6 Carrying out house wiring circuits using fuse, switches, sockets, ceiling rose etc. in batten or P.V.C. casing-caping. Demo of conduit wiring through junctions.

UNIT III

Domestic Appliances

3.1 Winding/re-winding of a fan (ceiling and table)/ motor and BLDC

3.2 Repair and maintenance of domestic electric appliances, i.e. electric iron, geyser, fan, heat convector, desert cooler, room heater, electric kettle, electric oven, electric furnace etc.

3.3 Dismantling and assembly of voltage stabilizers

3.4 Assembly and interchange wiring of fluorescent tube light, CFL lamp etc.

3.5 Earth resistance measurement and earthing processes.

3.6 To carry out pipe/plate earthing for a small house and 3-phase induction motor. Testing the earthing using earth tester.

UNIT IV

Professional Equipments and Control

4.1 Coil winding for small transformer or alarm bell.

4.2 Assembling small transformer cores from the given lamination plates.

4.3 Assembling small battery charger.

4.4 Connections of single phase and 3-phase motors, through an appropriate starter and to change their direction of rotation.

4.5 Wiring, testing and fault finding of the following contactor control circuits operating on 3-phase supply:

a) Remote control circuits

b) Time delay circuits

c) Inter locking circuits

d) Sequential operation control circuits

4.6 Dismantling/assembly of star-delta and DOL starter.
4.7 Design a printed circuit Board (PCB) for voltage regulator using zener diode.
4.8 Armature winding of 3 phase induction motor.

UNIT V

Power Supply Connection

5.1 Connecting single phase energy meter with supply and load. Reading and working out power consumption and cost of energy.
5.2 Introduction to single phase and three phase supply and wiring system. Importance of three phase supply (RYB) & its sequence and wiring system.
5.3 Connecting Generator and 3 phase wiring through Change over Switch.
5.4 Power cable jointing using epoxy based jointing kits.
5.5 Demonstration of laying of underground cables at worksite.

RECOMMENDED BOOKS

1. SK Bhattacharya, "Electrical and Electronic Engineering Materials", Khanna Publishers, New Delhi.
2. Grover and Jamwal, "Electronic Components and Materials", Dhanpat Rai and Co., New Delhi.
3. Sahdev, "Electrical Engineering Materials", Uneek International Publications, Jalandhar.
4. SM Dhir, "Electronic Components and Materials", Tata Mc Graw Hill, New Delhi.
5. PL Kapoor, "Electrical Engineering Materials", Khanna Publishers, New Delhi.
6. BR Sharma and Others, "Electrical and Electronics Engineering Materials", Satya Parkashan, New Delhi.
7. E-books/e-tools/relevant software to be used as recommended by CTE/HSBTE/NITTTR.

SUGGESTED WEBSITES

1. http://swayam.gov.in

INSTRUCTIONAL STRATEGY

This is hands-on practice based workshop for development of required skills in the students. All the experiments are to be performed by the students. There are five units of equal weightage. The teacher should also engage the students in various Hands on Practice/Training of Students during Educational Tour, Seminar/ Assignment Event, Students Quiz**.**

SECOND YEAR
NSQF LEVEL - 4

13. STUDY AND EVALUATION SCHEME

THIRD SEMESTER

Sr. No.	SUBJECTS	STUDY SCHEME Periods/Week		Credits L+P= C	MARKS IN EVALUATION SCHEME						Total Marks of Internal & External
					INTERNAL ASSESSMENT			EXTERNAL ASSESSMENT			
		L	P		Th	Pr	Total	Th	Pr	Total	
3.1	Industrial/In-HouseTraining - I	-	2	**0+1 =1**	-	40	40	-	60	60	100
3.2	Electric Machines –I	3	4	**3+2=5**	40	40	80	60	60	120	200
3.3	Electrical Measurement & Instrumentation	3	4	**3+2=5**	40	40	80	60	60	120	200
3.4	Analog & Digital Electronics	3	2	**3+1=4**	40	40	80	60	60	120	200
3.5	Electrical Engineering Materials	3	-	**3+0=3**	40	-	40	60	-	60	100
3.6	Open Elective (MOOCs+/Offline)	2	-	**2+0=2**	40	-	40	60	-	60	100
3.7	Electrical Engineering Drawing	-	6	**0+3=3**	-	40	40	-	60	60	100
# Student Centered Activities (SCA)		-	3	-	-	-	-	-	-	-	-
Total		**14**	**21**	**23**	**200**	**200**	**400**	**300**	**300**	**600**	**1000**

+ Assessment of Open Elective through MOOCs shall be based on assignments out of 100 marks.

Student Centered Activities will comprise of co-curricular activities like extension lectures on Constitution of India, Electoral Literacy, Motor Vehicles (Driving) Regulations 2017 etc., games, hobby clubs e.g. photography etc., seminars, declamation contests, educational field visits, N.C.C., NSS, Cultural Activities and self-study etc.

FOURTH SEMESTER

Sr. No.	SUBJECTS	STUDY SCHEME Periods/Week		Credits (C) L + P = C	MARKS IN EVALUATION SCHEME						Total Marks of Internal & External
					INTERNAL ASSESSMENT			EXTERNAL ASSESSMENT			
		L	P		Th	Pr	Total	Th	Pr	Total	
4.1	*English and Communication Skills - II	2	2	**2+1=3**	40	40	80	60	60	120	200
4.2	Electric Machines -II	3	4	**3+2=5**	40	40	80	60	60	120	200
4.3	PLC & Microcontrollers	3	4	**3+2=5**	40	40	80	60	60	120	200
4.4	Estimating and Costing in Electrical Engineering	3	2	**3+1=4**	40	40	80	60	60	120	200
4.5	Utilization of Electrical Energy	3	-	**3+0=3**	40	-	40	60	-	60	100
4.6	Programming Skills	-	6	**0+3=3**	-	40	40	-	60	60	100
# Student Centered Activities (SCA)		-	3	**-**	-	-	-	-	-	-	-
Total		**14**	**21**	**23**	**200**	**200**	**400**	**300**	**300**	**600**	**1000**

* Common with other diploma programmes

Student Centered Activities will comprise of co-curricular activities like extension lectures on Constitution of India, Electoral Literacy, Motor Vehicles (Driving) Regulations 2017 etc., games, hobby clubs e.g. photography etc., seminars, declamation contests, educational field visits, N.C.C., NSS, Cultural Activities and self-study etc.

Industrial/In-house Training: After 4th Semester, students shall undergo Summer Training of 4 Week

13. HORIZONTAL AND VERTICAL SUBJECTS ORGANISATION

Sr. No.	Subjects/Areas	Hours Per Week	
		Third Semester	Fourth Semester
1.	Industrial/In-House Training - I	2	-
2.	Electric Machines –I	7	-
3.	Electrical Measurement & Instrumentation	7	-
4.	Analog & Digital Electronics	5	-
5.	Electrical Engineering Materials	3	-
6.	Open Elective	2	-
7.	Electrical Engineering Drawing	6	-
8.	English and Communication Skills - II	-	4
9.	Electric Machines -II	-	7
10.	PLC & Microcontrollers	-	7
11.	Estimating and Costing in Electrical Engineering	-	5
12.	Utilization of Electrical Energy	-	3
13.	Programming Skills	-	6
14.	Student Centered Activities	3	3
	Total	**35**	**35**

14. COMPETENCY PROFILE & EMPLOYMENT OPPORTUNITIES

Industry and government sector pertaining to **Electrical Engineering** require **skilled workers** to work in familiar, predictable, routine situations of clear choice. They should be able to communicate in writing and speaking with required clarity and fluency. Students after passing level 4 shall have understanding of basic arithmetic, algebraic principles along with basic understanding of social and natural environment. They are expected to recall and demonstrate quality skill in narrow range of applications using appropriate rules and tools. Students having the diploma in Electrical engineering experience and expansive skill set needed to design and operate electrical systems, such as circuitry, power station generators, flight systems, and computers.

Skilled workers will be responsible for carrying out a range of jobs, some of which will require them to make choices about the approaches they adopt. They will be expected to learn and improve their practice on the job. They should know what constitutes quality in the occupation and should distinguish between good and bad quality in the context of their job roles. Skilled worker at this level will be expected to carry out their work safely and securely and take full account of the health and safety on colleagues and customers. They should work hygienically and in ways which show an understanding of environmental issues. In working with others, they will be expected to conduct themselves in ways which show a basic understanding of the social and political environment.

NSQF Level – 4 pass out students are expected have need to have a strong understanding of electrical principles and safety standards. Electricians are responsible for installing and repairing electrical systems in buildings, homes, and other structures. This includes wiring, lighting, and other electrical components.

Overall, the job opportunities for diploma holders in electrical engineering are quite diverse, and employment can be found in a wide range of industries, including manufacturing, construction, telecommunications, and more. An electrical technician is responsible for installing, maintaining, and repairing electrical equipment and systems.

Government Departments such as Electricity Board, MES, PWD, Railways, Air bases, Airports, Defence, Thermal, Hydro and Nuclear Power Stations and other Boards and Corporations: Construction, erection and commissioning of lines and Sub-stations, Electrical Safety measures, Operation and Maintenance of Lines and Sub-stations/underground cables, Tariffs and Calculations of bills for consumption of electricity, Inventory Management, Repair and Maintenance of Electrical Machines/ Equipment, Assist in Operation and maintenance of Generating and sub-stations

15. PROGRAMME OUTCOMES

The program outcomes are derived from five domains of NSQF Level – 4 namely Process, Professional Knowledge, Professional Skill, Core Skill, Responsibility. After completing this level, the student will be able to:

PO1: Perform out task in familiar, predictable, routine situation of clear choice.

PO2: Acquire factual knowledge in the field of Electrical engineering for employment.

PO3: Demonstrate quality skills in routine and repetitive in narrow range of Electrical Engineering applications.

PO4: Communicate in writing and speaking with required clarity and demonstrate Professional behavior.

PO5: Adopt self-study learning and acquire knowledge aiming towards holistic development of learners through MOOCs.

12. ASSESSMENT OF PROGRAMME AND COURSE OUTCOMES

Programme Outcomes to be assessed	Assessment criteria for the Course Outcomes
PO1: Perform out task in familiar, predictable, routine situation of clear choice.	• Understand the working environment of industries. • Take necessary safety precautions and measures. • Learn about present and future requirement of industries. • Work in team for solving industrial problems. • Develop required competencies and skills for relevant industries. • Comprehend the concepts of D.C. Machines, construction, armature reaction and characteristics. • Summarize the basics of Single and Three Phase transformers. • Comprehend how different types of meters work and their construction. • Measure different electrical parameters using measuring instruments and interpret the data. • Measure frequency, phase with Oscilloscope and DSOs. • Describe different Semiconductor devices and explain their characteristics • Acquire the knowledge of different types of transistor and transistor as an amplifier. • Comprehend the concept and properties of different Electrical Engineering materials. • Describe different types of constructional materials, use and apply the knowledge testing. • State the basic concepts and principles about the subject of interest. • Select and learn the subject related to own

	interest. • Recognize various electrical devices and their symbols and knowledge of placement of panels/distribution boards in domestic, industrial and commercial installation. • Draw and read the installation plane, wiring and control diagram of electrical circuits. • Read schematic and wiring diagrams of electrical machine and devices • Communicate effectively with an increased confidence; read, write and speak in English language fluently. • Illustrate use of communication to build a positive self-image through self-expression and develop more productive interpersonal relationships. • Acquire knowledge about various components of PLC. • Interpret the salient features of microcontrollers IC 8051 • Operate and control three phase synchronous generator and motor • Identify and connect starters for starting three phase and single phase induction motors • Differentiate between normal and Energy Efficient Motors • Comprehend the concept of estimation, costing and purchasing, tender, EMD, and tender document and prepare a tender document for a particular job. • Estimate and calculate costing of overhead & underground transmission distribution line and substations. • Identify most appropriate heating and welding techniques for suitable applications. • Learn the basic Principle of Electric Drive and apply as per applications.

PO2: Acquire factual knowledge in the field of Electrical engineering for employment.	• Learn about present and future requirement of industries. • Develop required competencies and skills for relevant industries. • Comprehend the concepts of D.C. Machines, construction, armature reaction and characteristics. • Analyze the speed-torque characteristics, testing of DC motor. • Illustrate the working of different types of special purpose transformer. • Determine the efficiency and Regulation of Transformer by various tests. • Summarize the basics of Single and Three Phase transformers. • Comprehend how different types of meters work and their construction. • Apply their knowledge to measure electrical quantities using standard analog and digital measuring instruments. • Measure different electrical parameters using measuring instruments and interpret the data. • Measure frequency, phase with Oscilloscope and DSOs. • Describe the working principle, selection criteria and applications of various transducers used in measurement systems. • Describe different Semiconductor devices and explain their characteristics • Acquire the knowledge of different types of transistor and transistor as an amplifier. • Evaluate and realize the various digital circuits by using number system and logic gates. • Comprehend the concept and properties of

	different Electrical Engineering materials. • Apply knowledge of practical applications of materials in Electrical Engineering. • Describe different types of constructional materials, use and apply the knowledge testing. • Select and learn the subject related to own interest. • Explore latest developments in the field of interest. • Recognize various electrical devices and their symbols and knowledge of placement of panels/distribution boards in domestic, industrial and commercial installation. • Draw and read the installation plane, wiring and control diagram of electrical circuits. • Read schematic and wiring diagrams of electrical machine and devices • Illustrate use of communication to build a positive self-image through self-expression and develop more productive interpersonal relationships. • Acquire knowledge about various components of PLC. • Interface I/O devices with the PLC modules. • Develop PLC ladder programs for various applications. • Operate and control three phase synchronous generator and motor • Operate and control speed of three phase squirrel cage and three phase slip ring induction motor. • Identify and connect starters for starting three phase and single phase induction motors

	• Control speed of single phase induction motors • Differentiate between normal and Energy Efficient Motors • Comprehend the concept of estimation, costing and purchasing, tender, EMD, and tender document and prepare a tender document for a particular job. • Design the level of illumination based on applications • Identify most appropriate heating and welding techniques for suitable applications. • Illustrate the fundamentals on electrolytic and electrometallurgical processes. • Learn the basic Principle of Electric Drive and apply as per applications. • Familiarize with MATLAB programming and Simulink.
PO3: Demonstrate quality skills in routine and repetitive in narrow range of Electrical Engineering applications.	• Learn about present and future requirement of industries. • Develop required competencies and skills for relevant industries. • Comprehend the concepts of D.C. Machines, construction, armature reaction and characteristics. • Analyze the speed-torque characteristics, testing of DC motor. • Illustrate the working of different types of special purpose transformer. • Determine the efficiency and Regulation of Transformer by various tests. • Summarize the basics of Single and Three Phase transformers. • Comprehend how different types of meters

	work and their construction. • Apply their knowledge to measure electrical quantities using standard analog and digital measuring instruments.
PO4: Communicate in writing and speaking with required clarity and demonstrate Professional behavior.	• Develop required competencies and skills for relevant industries. • Develop required competencies for effective communication and presentation • Perform in a better way in the professional world. • Select and learn the subject related to own interest. • Develop the habit of self-learning through online courses. Communicate effectively with an increased confidence; read, write and speak in English language fluently. • Comprehend special features of format and style of formal communication through various modes. • Write a Report, Resume, make a Presentation, Participate in GDs and Face Interviews • Illustrate use of communication to build a positive self-image through self-expression and develop more productive interpersonal relationships. • Create user interfaces with charts, graphs, and buttons using LabView.
PO5: Adopt self-study learning and acquire knowledge aiming towards holistic development of learners through MOOCs.	• Learn about present and future requirement of industries. • Work in team for solving industrial problems. • Develop required competencies and skills for relevant industries. • Develop required competencies for effective

	communication and presentation • State the basic concepts and principles about the subject of interest. • Perform in a better way in the professional world. • Select and learn the subject related to own interest. • Explore latest developments in the field of interest. • Develop the habit of self-learning through online courses. • Communicate effectively with an increased confidence; read, write and speak in English language fluently. • Comprehend special features of format and style of formal communication through various modes. • Write a Report, Resume, make a Presentation, Participate in GDs and Face Interviews • Illustrate use of communication to build a positive self-image through self-expression and develop more productive interpersonal relationships.

17. SUBJECTS & CONTENTS

(SECOND YEAR)

THIRD SEMESTER

3.1	Industrial/In-House Training – I	78-79
3.2	Electrical Machines – I	80-83
3.3	Electrical Measurement & Instrumentation	84-87
3.4	Analog & Digital Electronics	88-91
3.5	Electrical Engineering Materials	92-94
3.6	Open Elective	95-96
3.7	Electrical Engineering Drawing	97-99

3.1 INDUSTRIAL / IN–HOUSE TRAINING-I

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RATIONALE

Industrial training / In – house training will help the students to understand the working environment of relevant industries. The student will learn to work in team to solve the industrial problems. It will also give exposure about the present and future requirements of the relevant industries. This training is very import and for development of required competencies and skills for employment and start– ups.

COURSE OUTCOMES

After undergoing the training, the students will be able to:

CO1: Familiarize the working environment of industries
CO2: Take necessary safety precautions and measures.
CO3: Learn about present and future requirement of industries.
CO4: Work in team for solving industrial problems
CO5: Develop competencies and skills required by relevant industries.
CO6: Develop writing, speaking and presentations skills.

PRACTICAL EXERCISES

1. Report writing based on industrial training.
2. Preparation of Power Point Slides based on industrial training and presentation by the candidate.
3. Internal Evaluation based on quality of Report, PPT preparation, PPT presentation and answer to queries.
4. External Evaluation based on quality of Report, PPT preparation, PPT presentation and answer to queries.

GUIDELINES

Students will be evaluated based on Industrial training / In – house training report and their presentation using Power Point about the knowledge and skills gained during the training. The Head of the Department will depute faculty coordinators by assigning a group of students to each. The coordinators will mentor and guide the students in preparing the PPTs for final presentation.

The following performance parameters are to be considered for assessment of the students out of 100 marks:

	Parameter	**Weightage**
i	Industrial / In-house assessment of the candidate by the trainer	40%
ii	Report Writing	20%
iii	Power Point Presentation	20%
iv	Viva-voce	20%

3.2 ELECTRICAL MACHINES – I

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3	4

RATIONALE

Electrical machines is a subject where a student will deal with various types of electrical machines which are employed in industries, power stations, domestic and commercial appliances etc. After studying this subject, an electrical diploma holder must be competent to repair and maintain these machines and give suggestions to improve their performance. Practical aspects of the subject will make the students capable of performing various tests on the machines as per latest BIS specifications

COURSE OUTCOMES

After undergoing the subject, student will be able to:

CO1: Comprehend the concepts of D.C. Machines, construction, armature reaction and characteristics.
CO2: Analyze the speed-torque characteristics, testing of DC motor.
CO3: Illustrate the working of different types of special purpose transformer.
CO4: Determine the efficiency and Regulation of Transformer by various tests.
CO5: Summarize the basics of Single and Three Phase transformers.

DETAILED CONTENTS

UNIT I

DC Generators

1.1 Introduction to Electrical Machines: Definition of motor and generator, Torque development due to alignment of two fields and the concept of torque angle, Generalized theory of electrical machines.

1.2 DC generator: construction, parts, materials and their functions. Principle of operation of DC generator, e.m.f. equation of generator, armature reaction, commutation. Various types of DC generator. Applications of DC generators.

UNIT II

DC Motors

2.1 DC motor: Types of DC motors, Principle of operation, characteristics, Back e.m.f. and its significance, Voltage equation of DC motor. Torque and Speed; Armature torque, Shaft torque, BHP, losses, efficiency, Electric Braking. Applications of DC motors.

2.2 DC motor starters: Necessity, three point and four point starters. Speed control of DC shunt and series motor: Flux and Armature control. Determination of losses by Swinburne's test. Brushless DC Motor: Construction and working, rating and specifications of DC machines

UNIT III

Single Phase Transformers

3.1 Introduction, Types of transformers: Shell type and core type; Construction: Parts and functions, materials used for different parts; Principle of operation, EMF equation of transformer: Derivation, Voltage transformation ratio.

3.2 Transformer No-load and on-load phasor diagram. Mutual and leakage fluxes, Leakage reactance. Equivalent circuit of transformer: Equivalent resistance and reactance. Voltage regulation and Efficiency. Open circuit and short circuit tests , all day efficiency. Rating and Specifications of single phase transformer.

UNIT IV

Three Phase Transformers

4.1 Construction of three phase transformers and accessories of transformers such as Conservator, breather, Buchholtz Relay, Tap Changer (off load and on load) (Brief idea) .Types of three phase transformer i.e. delta-delta, delta-star, star-delta and star-star.

4.2 Need of parallel operation of three phase transformer, Conditions for parallel operation. Polarity tests. Criteria for selection of distribution transformer, and power transformer, Amorphous Core type Distribution Transformer. Cooling of transformer. Specifications of three-phase distribution transformers.

UNIT V

Special Purpose Transformers

5.1 Single phase and three phase auto transformers: Construction, working and applications. Instrument Transformers: Construction, working and applications of Current transformer and Potential transformer.

5.2 Isolation transformer: Constructional Features and applications. Single phase welding transformer: constructional features and applications. 'K' factor of transformers: overheating due to non-linear loads and harmonics.

PRACTICAL EXERCISES

1. To measure the angular displacement of rotor of the three phase synchronous machine with respect to the stator on application of DC to the field winding and simultaneously to each phase-winding in sequence

   OR

   Measurement of the angular displacement of the rotor of a slip-ring induction motor on application of DC to stator of motor winding in sequence and simultaneously to each phase of rotor winding
2. Speed control of DC shunt motor (i) Armature control method (ii) Field control method
3. Study of DC series motor with starter (to operate the motor on no load for a moment)
4. Determine efficiency of DC motor by Swinburne's Test at (i) rated capacity (ii) half full load
5. To perform open circuit and short circuit test for determining: (i) equivalent circuit (ii) the regulation and (iii) efficiency of a transformer from the data obtained from open circuit and short circuit test at full load
6 To find the efficiency and regulation of single phase transformer by actually loading it.
7. Checking the polarity of the windings of a three phase transformer and connecting the windings in various configurations
8. Finding the voltage and current relationships of primary and secondary of a three phase transformer under balanced load in various configurations conditions such as (a) Star-star (b) Star-delta (c) Delta-star (d) Delta - Delta configuring conditions.

RECOMMENDED BOOKS

1. SK Bhattacharya, "Electrical Machines", Tata Mc Graw Hill, Education Pvt Ltd. New Delhi.
2. SK Sahdev, "Electrical Machines", Uneek Publications, Jalandhar.
3. Nagrath and Kothari, "Electrical Machines", Tata Mc Graw Hill, New Delhi.
4. JB Gupta, "Electrical Machines", SK Kataria and Sons, New Delhi.
5. Smarajit Ghosh, "Electrical Machines", Pearson Publishers, Delhi.

SUGGESTED WEBSITES

1. http://swayam.gov.in
2. https://nptel.ac.in/

INSTRUCTIONAL STRATEGY

Electrical machines being a core subject of electrical diploma curriculum, where a Student will deal with various types of electrical machines which are employed in industry, power stations, domestic and commercial appliances etc. After studying this subject, an electrical diploma holder must be competent to repair and maintain these machines and give suggestions to improve their performance. Special care has to be taken on conceptual understanding of concepts and principles in the subject. For this purpose exposure to industry, work places, and utilization of various types of electrical machine for different applications may be emphasized. Explanation of practical aspects of the subject will make the students capable of performing various tests on the machines as per latest BIS specifications. This subject contains five units of equal weightage.

3.3 ELECTRICAL MEASURMENT & INSTRUMENTATION

L	P
3	4

RATIONALE

Diploma holders in Electrical Engineering have to work on various jobs in the field as well as in testing laboratories and on control panels, where he performs the duties of installation, operation, maintenance and testing by measuring instruments. Persons working on control panels in power plants, substations and in industries will come across the use of various types of instruments and have to take measurements. Instruments used to read and observe the general electrical quantities like current, voltage, power, energy, frequency, resistance etc and their wave shapes, have been incorporated in this subject.

COURSE OUTCOMES

After undergoing the subject, student will be able to:

CO1: Comprehend how different types of meters work and their construction.

CO2: Apply their knowledge to measure electrical quantities using standard analog and digital measuring instruments.

CO3: Measure different electrical parameters using measuring instruments and interpret the data.

CO4: Measure frequency, phase with Oscilloscope and DSOs.

CO5: Describe the working principle, selection criteria and applications of various transducers used in measurement systems.

DETAILED CONTENTS

UNIT I

Measurements of Voltage and Current

1.1 Significance of measurement, errors in measurement, types of error, Classification of measuring instruments: indicating, recording and integrating instruments; Essential requirements of an indicating instruments.

1.2 Concept of Ammeter, voltmeter, ammeter, construction, working principle, merits, demerits and comparison of moving coil, moving iron meter, rectifier type – Extension of range and calibration of voltmeter and ammeter – Errors and compensation..

UNIT II

Measurement of Power and Electrical Energy

2.1 Construction, working principle, merits and demerits of dynamometer wattmeter, Digital wattmeter, Active and reactive power measurement by , two and three wattmeter method. Effect of Power factor on wattmeter reading in two wattmeter method, Maximum Demand indicator.

2.2 Construction, working principle, merits and demerits of single-phase and three-phase energy meters (Induction type), Errors and their compensations, Calibration of energy meter using direct loading. Digital energy meter (diagram, construction and application).

UNIT III

Measurement of other Instruments

3.1 Construction, working principle and application of Meggar, Earth tester (analog and digital), multi-meter (analog and digital), Frequency meter (dynamometer type), single power factor meter (Electrodynamometer type). Working principle of synchroscope and phase sequence indicator, tong tester (Clamp-on meter), Study of LCR meters and their applications .Construction, working and applications of CT and PT.

3.2 Cathode Ray Oscilloscope: Block diagram, working principle of CRO and its various controls. Digital Storage Oscilloscope (DSO).

UNIT IV

Transducer

4.1 Introduction, Types of Transducers, Construction and principle of resistive transducer-Potentiometer –variac and strain gauges -No derivation. Only definition and formula for gauge factor, Types of strain gauges like unbonded, bonded and semiconductor. Construction and principle of Inductive transducers-L.V.D.T. and R.V.D.T, their applications.

4.2 Construction, principle and applications of transducers – Piezoelectric transducer, photo-conductive cells, photo voltaic cells.

UNIT V

Measurement of Non-Electrical Quantities

5.1 Temperature measurement - Construction and Working of RTD, Thermistor and Thermocouple, radiation pyrometer, technical specifications and ranges. Thermal Imager Camera (Concept).

5.2 Pressure measurement – Construction and working of bourdon tube, bellow diaphragm strain gauge. Measurement of pH Level.

PRACTICAL EXERCISES

1. Use of analog and digital multimeter for measurement of voltage, current (A.C/D.C) and resistance.
2. To measure the value of earth resistance using earth tester.
3. To measure power, power factor in a single-phase circuit, using wattmeter and power factor meter and to verify results with calculations.
4. Measurement of power and power factor of a three-phase balanced load by two wattmeter method.
5. Measurement of voltage and frequency of a sinusoidal signal using CRO and draw wave shape of signal.
6. Measurement of power in a 3 phase circuit using CT, PT and 3-phase wattmeter.
7. Use of LCR meter for measuring inductance, capacitance and resistance.
8. To record all electrical quantities from the meters installed in the institution premises.
9. To measure Energy at different Loads using Single Phase Digital Energy meter.
10. Calibration of single phase and three-phase energy meter.
11. Measurement of pressure by using LVDT.
12. To measure temperature using a thermo-couple
13. Measurement of temperature by using thermister/Thermal Imager.
14. To measure the strain using electrical strain gauge
15. To measure the pH level using pH meter.

RECOMMENDED BOOKS

1. A.K. Sawhney, “Electric and Electronic Measurement and Instrumentation”, Dhanpat Rai and Co. Author, 2014.
2. C.S Rangan, G.R.Sharma. and V.S.V.Mani, “Instrumentation Devices and System”, Pen Ram International Publishing India Pvt. Ltd., Fifth Edition.

3. V.K. Mehta, "Electronics and Instrumentation", S. Chand and Company Pvt. Ltd. Reprint, 2010.
4. S.K. Singh, "Industrial Instrumentation and Control", Tata McGraw-Hill, 1987.
5. J.G. Joshi, "Electronic Measurement and Instrumentation", Khanna Publishing House, New Delhi .
6. SK Sahdev, "Electrical Measurements and Measuring Instruments", Uneek International Publications, Jalandhar.
7. SK Bhattacharya, and KM Rastogi, "Experiments in Basic Electrical Engineering", New Age International (P) Ltd., Publishers, New Delhi.
8. JB Gupta, "Electrical Measurement and Measuring Instruments", SK Kataria and Sons, New Delhi.
9. ML Anand, "Electrical Measurement and Measuring Instruments", SK Kataria and Sons, New Delhi.

SUGGESTED WEBSITES

1. http://swayam.gov.in
2. https://nptel.ac.in/

INSTRUCTIONAL STRATEGY

After making the student familiar with measuring instruments, they should be made conceptually clear about the constructional features and make them confident in making connection of various measuring instruments. Teacher should demonstrate the application of each measuring instrument in laboratory and encourage students to use them independently. This subject contains five units of equal weightage.

3.4 ANALOG & DIGITAL ELECTRONICS

L	P
3	2

RATIONALE

This subject gives the knowledge of fundamental concepts and principles of basic electronics and aims at providing the students with basic understanding of various types of materials based on their conductivity. Students will study p-n junction, rectifiers and their significance, filters, basic structure and working principle of transistors in various configurations. This course also gives the knowledge to make the students know about the fundamental principles of digital electronics and gain familiarity with the available IC chips.

COURSE OUTCOMES

After completing this course, student will be able to:

CO1: Describe different Semiconductor devices and explain their characteristics

CO2: Acquire the knowledge of different types of transistor and transistor as an amplifier.

CO3: Evaluate and realize the various digital circuits by using number system and logic gates.

CO4: Analyze sequential and combinational digital circuits and converters.

DETAILED CONTENTS

UNIT I

Semiconductor Devices

1.1 Concept of insulators, conductors and semiconductors. Intrinsic and extrinsic semiconductor, P and N type semiconductor and their conductivity. Effect of temperature on conductivity of intrinsic semiconductor etc.

1.2 PN junction diode, mechanism of current flow in PN junction, forward and reverse biased PN junction, potential barrier, drift and diffusion currents, depletion layer. V-I

characteristics of diodes. Diode as half-wave, full wave and bridge rectifiers. Peak Inverse Voltage, rectification efficiencies and ripple factor calculations, Concept of filters. Types of diode, characteristics and applications of Zener diodes.

UNIT II

Bipolar-Transistors and Field Effect Transistors

2.1 Concept of a bipolar transistor, PNP and NPN transistors. CB, CE, CC configurations of a transistor. Transistor as an amplifier in CE Configuration, Current amplification factors, Comparison of CB, CE and CC Configurations.

2.2 Construction, operation and characteristics of FETs. FET as an amplifier. Construction, operation and characteristics of a MOSFET. Comparison of JFET, MOSFET and BJT.

UNIT III

Digital Electronics

3.1 Distinction between analog and digital signal. Decimal, Binary, octal and hexadecimal number system. Conversion from decimal and hexadecimal to binary and vice-versa. Binary addition and subtraction.

3.2 Definition, symbols and truth tables of Logic gates (AND, OR, XOR, NOT, NAND, NOR and XNOR).

UNIT IV

Sequential and Combinational Circuit

4.1 Sequential Circuits such as Half adder, Full adder, Mux, De-Mux, Encoder and Decoder. Combinational Circuits like Latch, Flip Flops, shift registers and counters.

4.2 A/D and D/A Converters and its Applications.

PRACTICAL EXERCISES

1. To Plot V-I characteristics of a PN junction diode.
2. To Plot V-I characteristics of a Zener diode.

3. Observe the output of waveform:
4. Half-wave rectifier circuit using one diode
5. Full-wave rectifier circuit using two diodes
6. Observe the output of waveform of Bridge-rectifier circuit using four diodes.
7. Plotting of input and output characteristics and calculation of parameters of transistors in CE configuration.
8. Plotting of input and output characteristics and calculation of parameters of transistors in CB configuration.
9. Plotting of V-I characteristics of a FET.
10. Basic logic operations of AND, OR, NOT gates.
11. Verification of truth tables for NAND, NOR and Exclusive OR (EX-OR) and Exclusive NOR (EX-NOR) gates.
12. Realization of logic functions with the help of NAND or NOR gates.
13. To design a half adder using XOR and NAND gates and verification of its operations.
14. Construction of a fu Construction of a full adder circuit using XOR and NAND gates and verify its operation
15. Verification of truth table for IC flip-flops (At least one IC each of D latch, D flip-flop, JK flip-flops).
16. Verification of truth table for encoder and decoder ICs.
17. Verification of truth table for Mux and De-Mux.

RECOMMENDED BOOKS

1. Kulshreshta and S.C. Gupta, Basic Electronics and linear circuit by Tata Mc Graw Hill Education Pvt. Ltd., New Delhi.
2. V.K. Mehta, Principles of Electrical and Electronics Engineering by S Chand Co., New Delhi.
3. Millman and Halkias, Electronics Device and Circuit by Mc Graw Hill.
4. Albert Paul Malvino,"Principles of Electronics" by Tata Mc Graw Hill Education Pvt Ltd
5. S K Sahdev," Electronic Principles "by Dhanpat Rai & Co., New Delhi.
6. J B Gupta," Basic Electronics "by S K Kataria and Sons, New Delhi
7. Schultz Grob's, Basic Electronics, Altext Lab Manual by Tata Mc Graw Hill Education Pvt. Ltd., New Delhi.
8. Anand Kumar" Fundamentals of Digital Circuits" PHI
9. Anil K. Maini "Digital Electronics: Principles And Integrated Circuit", Wiley Publications
10. R P Jain- "Modern Digital Electronics"-Tata McGraw Hill.

SUGGESTED WEBSITES

1. http://swayam.gov.in
2. https://nptel.ac.in/

INSTRUCTIONAL STRATEGY

After making the student familiar with semiconductors, they should be made conceptually clear about the constructional features and make them confident in making connection of various electronic devices. This subject contains four units of equal weightage.

3.5 ELECTRICAL ENGINEERING MATERIALS

L	P
3	-

RATIONALE

A diploma holder in Electrical Engineering will be involved in maintenance, repair and production of electrical equipment and systems. A sound knowledge of the properties, characteristics, applications and limitation of engineering materials is a must for every Engineer and Technologist. In this subject, effort is made to develop skill in the Electrical diploma students to inspect and select the right material as per engineering applications.

COURSE OUTCOME

After undergoing the subject, student will be able to:

CO1: Comprehend the concept and properties of different Electrical Engineering materials.

CO2: Apply knowledge of practical applications of materials in different Electrical Engineering field.

CO3: Describe different types of constructional materials, use and apply the knowledge testing.

DETAILED CONTENTS

UNIT I

Introduction to Materials

Classification of materials such as conducting, semi conducting, insulating materials, magnetic material. Atomic theory, Energy band theory. Classifications of materials on the basis of atomic structure and energy bands. Characteristics of materials.

UNIT II

Conducting and Semi-Conducting Materials

2.1 Types of conducting material such as low resistivity and high resistivity materials.

2.2 Properties and applications of different low resistivity materials such as silver, Gold, copper (hard drawn, annealed copper), aluminum, steel, ACSR and its alloys like copper

alloy (brass, bronze) etc. Properties and applications of different high resistivity material such as carbon, tungsten, platinum, mercury, lead, and its alloys like Constantan or eureka, Brass phosphor bronze, nichrome, manganin, tin-lead alloy etc.

2.3 Semi-conductors Materials and their Applications, Commonly used semiconducting material Germanium and silicon and their properties. Types of Semiconductor etc.

UNIT III

Insulating Materials

3.1 Characteristics of good Insulating material, Electrical, thermal, chemical, visual, mechanical, physical properties of Insulating materials. Types of Insulating materials. classification of insulating material on the basis of temperature.

3.2 Gaseous Insulating Materials: Properties and applications of air, nitrogen and sulphur hexafluoride (SF-6) gases. Liquid Insulating Materials: Properties and applications of Mineral and Insulating oil for transformers (mineral oil), switchgears etc, synthetic insulating liquid (Pyranol).

3.3 Solid Insulating Materials: Properties, types and applications of Plastics such as poly-vinyl chloride (PVC), Polyethylene, polystyrene, epoxy resin, Bakelite, Melamines, silicon resins etc. Natural Insulating materials, properties and their applications: Mica, asbestos, ceramic materials (porcelain and steatite), Glass, Cotton, Silk, Jute, Paper (dry and impregnated) Rubber, Bitumen, Teflon, Silicon Grease , Insulating varnishes for coating and impregnation, Enamels for winding wires, wood etc.

UNIT IV

Magnetic Materials

Characteristics and types of magnetic material, Properties of soft magnet material like Iron silicon alloy, Nickel iron alloy, Mu metal, soft ferrites, grain orientation, Cold rolled grain oriented silicon steels (C.R.G.O) etc. and their applications. Properties of hard magnet material like Tungsten steel alloy, chromium steel, cobalt steel, Hard ferrites etc. and their applications.

UNIT V

Special Purpose Materials

Thermocouples, Bimetals, soldering, fuse, materials and their applications. Material used in fabrications of electrical machines such as motors, generators, transformers etc

RECOMMENDED BOOKS

1. SK Bhattacharya, “Electrical and Electronic Engineering Materials”, Khanna Publishers, New Delhi.
2. Grover and Jamwal, “Electronic Components and Materials”, Dhanpat Rai and Co., New Delhi.
3. SK Sahdev, “Electrical Engineering Materials”, Unique International Publications, Jalandhar.
4. SM Dhir, “Electronic Components and Materials”, Tata Mc Graw Hill, New Delhi.
5. PL Kapoor, “Electrical Engineering Materials”, Khanna Publishers, New Delhi.
6. BR Sharma and Others, “Electrical and Electronics Engineering Materials”, Satya Parkashan, New Delhi.
7. e-books/e-tools/relevant software to be used as recommended by AICTE/HSBTE/NITTTR.

SUGGESTED WEBSITES

1. http://swayam.gov.in
2. https://nptel.ac.in/

INSTRUCTIONAL STRATEGY

The teacher should bring different materials, electronic components and devices in the class while taking lectures and explain and make students familiar with them. Also he may give emphasis on practical applications of these devices and components in the field. In addition, the students should be given exercises on identification of materials used in various electronic gadgets etc .and be encouraged to do practical work independently and confidently. This subject contains five units of equal weightage.

3.6 OPEN ELECTIVE

L	P
2	-

RATIONALE

Open electives are very important and play major role in implementation of National Education Policy. These subjects provide greater autonomy to the students in the curriculum, giving them the opportunity to customize it to reflect their passions and interests. The system of open electives also encourages cross learning, as students pick and choose subjects from the different streams.

COURSE OUTCOMES

At the end of the open elective, the students will be able to:

CO1: State the basic concepts and principles about the subject of interest.
CO2: Perform in a better way in the professional world.
CO3: Select and learn the subject related to own interest.
CO4: Explore latest developments in the field of interest.
CO5: Develop the habit of self-learning through online courses.

LIST OF OPEN ELECTIVES

(The list is indicative and not exhaustive)

1. Computer Application in Business
2. Introduction to NGO Management
3. Basics of Event Management
4. Event Planning
5. Administrative Law
6. Introduction to Advertising
7. Moodle Learning Management System
8. Linux Operating System
9. E-Commerce Technologies
10. NCC
11. Marketing and Sales

12. Graphics and Animations
13. Digital Marketing
14. Human Resource Management
15. Supply Chain Management
16. TQM

GUIDELINES

Open Elective shall be offered preferably in online mode. Online mode open elective shall preferably be through Massive Open Online Courses (MOOCs) from Swayam, NPTEL, Upgrad, Udemy, Khan Academy or any other online portal to promote self-learning. A flexible basket of large number of open electives is suggested which can be modified depending upon the availability of courses at suggested portals and requirements. For online open electives, department coordinators shall be assigned to monitor and guide the group of students for selection of minimum 20 hours duration online course of their choice. For offline open electives, a suitable relevant subject shall be offered by the respective department to the students with minimum 40% of the total class strength as per present and future requirements.

Assessment of MOOCs open elective shall be based on continuous evaluation by the respective coordinator. The coordinator shall consider the submitted assignments by the students from time to time during the conduct of MOOCs. The MOOCs assessment shall be conducted by the coordinator along with one external expert by considering submitted assignments out of 100 marks.

In case, no suitable open elective is available online, only then the course may be conducted in offline mode. The assessment of offline open elective shall be internal and external. The offline open elective internal assessment of 40 marks shall be based on internal sessional tests; assignments etc. and external assessment of 60 marks shall be based on external examination at institute level.

SUGGESTED WEBSITES

1. https://swayam.gov.in/
2. https://www.udemy.com/
3. https://www.upgrad.com/
4. https://www.khanacademy.org/

3.7 ELECTRICAL ENGINEERING DRAWING

L	P
-	6

RATIONALE

A student of electrical engineering is supposed to have ability to: -

i. Read, understand and interpret engineering drawings.
ii. Communicate and co-relate through sketches and drawings.
iii. Prepare working drawings of panels, transmission and distribution

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

COURSE OUTCOMES

After undergoing the subject, students will be able to:

CO1: Recognize various electrical devices and their symbols and knowledge of placement of panels/distribution boards in domestic, industrial and commercial installation.
CO2: Draw and read the installation plane, wiring and control diagram of electrical circuits.
CO3: Read schematic and wiring diagrams of electrical machine and devices.
CO4: Communicate about circuits and devices through sketches and drawings.

PRACTICAL EXERCISES

UNIT I

Simple Electrical Circuits

1.1 Electrical Symbols used in Electrical installation; Schematic , single line and wiring diagrams of light and fan point controlled by individual switches, fluorescent tube controlled by one-way switch, one lamp controlled by two switches (staircase circuit) three lamps controlled by four switches (Corridor light circuit).

1.2 Design and Drawing of panels/Distribution board using MCB, ELCB main switches and change over switches for domestic installation, industrial and commercial installation.

UNIT II

Contractor Control Circuits

Design of circuit drawing of schematic diagram and power wiring diagram of following circuits, specification of contactors:-

2.1 DOL starting of 3-phase induction motor
2.2 3-phase induction motor getting supply from selected feeder
2.3 Forwarding/reversing of a 3-phase induction motor
2.4 Two speed control of 3-phase induction motor
2.5 Sequential operating of two motors using time delay relay
2.6 Manually generated star delta starter for 3-phase induction motor
2.7 Automatic star delta starter for 3-phase Induction Motor

UNIT III

Professional Control Circuits

3.1 Draw the wiring diagram of battery and inverter connected to residential load.
3.2 Draw the wiring diagram of standalone solar light system with battery for a residential house.
3.3 Draw the wiring diagram of solar water heating system.
3.4 Key diagram of 11kV, 33kV, 66kV, 132 kV sub-stations
3.5 Draw pipe and plate Earthing.

UNIT IV

Orthographic Projections of Simple Electrical Parts

4.1 Bus bar post
4.2 Kit Kat Fuse
4.3 Pin type insulator (Pin Type 11kV/66kV)
4.4 Rotor of a squirrel cage induction motor
4.5 Stator of 3 phase Induction motor (Sectional View)

RECOMMENDED BOOKS

1. Surjeet Singh, “Electrical Engineering Design and Drawings, Dhanpat Rai and Co, New Delhi.
2. SK Bhattacharya, “Electrical Engineering Design and Drawings”, SK Kataria and Sons, New Delhi.
3. Ubhi & Marwaha, “Electrical Engineering Design and Drawings”, IPH, New Delhi.

4. SK Sahdev, “Electrical Design and Drawing”, Uneek Publications, Jalandhar.
5. Surjit Singh, “Electrical Engineering Drawing”, SK Kataria and Sons, New Delhi.
6. Surjit Singh, “Electrical Design and Drawing”, North Publication, Jalandhar.

SUGGESTED WEBSITES

1. http://swayam.gov.in
2. https://nptel.ac.in/

INSTRUCTIONAL STRATEGY

Teacher should identify/prepare more exercises on the pattern shown above. The teacher should make the students confident in making drawing and layouts of electrical wiring installations and doing estimation and costing. This capability will lead the students to become a successful entrepreneur. Take the students to field/laboratory and show the material and equipment, take the Assignments and class tests in reference to Design and Drawing. This subject contains five units of equal weightage.

FOURTH SEMESTER

4.1	English & Communication Skills – II	100-104
4.2	Electrical Machines - II	105-108
4.3	PLC & Microcontrollers	109-112
4.4	Estimating and Costing in Electrical Engineering	113-116
4.5	Utilization of Electrical Energy	117-119
4.6	Programming Skills	120-121

4.1 ENGLISH AND COMMUNICATION SKILLS - II

L	P
2	2

RATIONALE

Communication II moves a step further from Communication Skills I and is aimed at enhancing the linguistic competency of the students. Language as the most commonly used medium of self-expression remains indispensable in all spheres of human life – personal, social and professional. This course is intended to make fresh ground in teaching of Communicative English as per the requirements of National Skill Quality Framework.

COURSE OUTCOMES

After undergoing this course, the learners will be able to:

CO1: Communicate effectively with an increased confidence; read, write and speak in English language fluently.

CO2: Comprehend special features of format and style of formal communication through various modes.

CO3: Write a Report, Resume, make a Presentation, Participate in GDs and Face Interviews

CO4: Illustrate use of communication to build a positive self-image through self-expression and develop more productive interpersonal relationships.

DETAILED CONTENTS

UNIT I

Reading

1.1 Portrait of a Lady - Khushwant Singh

1.2 The Doctor's Word by R K Narayan

1.3 Speech by Dr Kiran Bedi at IIM Indore2007 Leadership Concepts

1.4 The Bet - by Anton Chekov

UNIT II

Effective Communication Skills

2.1 Modern means of Communication (Video Conferencing, e- mail, Teleconferencing)

2.2 Effective Communication Skills: 7 C's of Communication

2.3 Non-verbal Communication – Significance, Types and Techniques for Effective Communication
2.4 Barriers and Effectiveness in Listening Skills
2.5 Barriers and Effectiveness in Speaking Skills

Unit III

Professional Writing

3.1 Correspondence: Enquiry letters, placing orders, complaint letters
3.2 Report Writing
3.3 Memos
3.4 Circulars
3.5 Press Release
3.6 Inspection Notes and tips for Note-taking
3.7 Corrigendum writing
3.8 Cover Letter

UNIT IV

Grammar and Vocabulary

4.1 Prepositions
4.2 Conjunctions
4.3 Punctuation
4.4 Idioms and Phrases: A bird of ill omen, A bird's eye view, A burning question, A child's play, A cat and dog life, A feather in one's cap, A fish out of water, A shark, A snail's pace, A snake in the grass, A wild goose chase, As busy as a bee, As faithful as dog, Apple of One's eye, Behind one's back, Breath one's last, Below the belt, Beat about the bush, Birds of a feather flock together, Black Sheep, Blue blood, By hook or crook, Chicken hearted, Cut a sorry figure ,Hand in glove, In black and white, In the twinkling, In full swing ,Is blind as a bat, No rose without a thorn, Once in a blue moon, Out of the frying pan in to the fire, know no bounds ,To back out, To bell the cat, To blow one's trumpet, To call a spade a spade, To cut one's coat according to one's cloth, To eat humble pie, To give ear to, To have a thing on one's finger tips, To have one's foot in the grave, To hold one's tongue, To kill two birds with one stone, To make an ass of oneself, To put two and two together, To the back bone, Turn coat, ups and downs.
4.5 Pairs of words commonly misused and confused: Accept-except, Access-excess, Affect-effect, Artificial- artful, Aspire-expire, Bail-bale, Bare-bear, Berth-birth, Beside-besides, Break-brake, Canvas-canvass, Course- coarse, Casual-causal, Council-counsel, Continual-continuous, Coma-comma, Cue- queue, Corpse- corps-core, Dairy-diary,

Desert-dessert, Dual-duel, Dew- due, Die-dye, Draft- draught-drought, Device-devise, Doze-dose, Eligible-illegible, Emigrant- immigrant, Envelop-envelope, Farther-further, Gate-gait, Goal-goal, Human-humane, Honorable-honorary, Hail-hale, Hair-heir-hare, Industrial-industrious, Impossible- impassable, Idle-idol-ideal, Lose-loose, Later-latter, Lesson-lessen, Main-Mane, Mental-mantle, Metal-mettle, Meter-metre, Oar-ore, Pray-prey, Plain-plan, Principal - principle, Personal- personnel, Roll- role, Route-rout- roote, Stationary-stationery, Union- unity, Urban- urbane, Vocation- vacation, Vain- vein-vane, Vary- very.

4.6 Translation of Administrative and Technical Terms in Hindi or Mother tongue: Academy, Abandon, Acting in official capacity, Administrator, Admission, Aforesaid, Affidavit, Agenda, Alma Master, Ambiguous, Appointing Authority, Apprentice, Additional, Advertisement, Assistant, Assumption of charge, Assurance, Attested copy, Bonafide, Bond, Cashier, Chief Minister, Chief Justice Clerical error, Commanding ,Officer, Consent, Contractor, corruption, Craftsman, Compensation, Code, Compensatory allowance, Compile, Confidential letter, Daily Wager, Data, Dearness allowance, Death - Cum Retirement, Dispatch, Dispatch Register, Disciplinary, Disciplinary Action, Disparity Department, Dictionary, Director, Director of Technical Education, Earned Leave, Efficiency Bar, Estate, Exemption, Executive Engineer, Extraordinary, Employment Exchange, Flying Squad, General Body, Head Clerk, Head Office, High Commission, Inconvenience, Income Tax, Indian Assembly Service, Justify, Legislative Assembly, Negligence, Officiating ,Office Record, Office Discipline, On Probation, Part Time, Performance, Polytechnic, Proof Reader Precautionary, Provisional, Qualified, Regret, Responsibility, Self-Sufficient, Senior, Simultaneous ,Staff, Stenography ,Superior, Slate, Takeover, Target Data Technical Approval, Tenure, Temporary, Timely Compliance, Under Investigation, Under Consideration, Verification, Viva-voce, Write off, Working Committee, Warning, Yours Faithfully , Zero Hour.

UNIT V

Employability Skills

5.1 Presentation Skills: How to prepare and deliver a good presentation

5.2 Telephone Etiquettes

5.3 Importance of developing employable and soft skills

5.4 Resume Writing: Definition, Kinds of Resume, Difference between Bio-data and Curriculum Vitae and Preparing a Resume for Job/ Internship

5.5 Group discussions: Concept and fundamentals of GD, and learning Group Dynamics.

5.6 Case Studies and Role Plays

PRACTICAL EXERCISES

1. Reading Practice of the above lessons in the Lab Activity classes.
2. Comprehension exercises of unseen passages along with the given lessons.
3. Vocabulary enrichment and grammar exercises based on the above selective readings.
4. Situational Conversation: Requesting and responding to requests; Expressing sympathy and condolence.
5. Warning; Asking and giving information.
6. Getting and giving permission.
7. Asking for and giving opinions.
8. A small formal and informal speech.
9. Seminar.
10. Debate.
11. Interview Skills: Preparing for the Interview and guidelines for success in the Interview and significance of acceptable body-language during the Interview.
12. Written Drills will be undertaken in the class to facilitate a holistic linguistic competency among learners.
13. Participation in a GD, Functional and Non-functional roles in GD, Case Studies and Role Plays
14. Presentations, using audio-visual aids (including power-point).
15. Telephonic interviews, face to face interviews.
16. Presentations as Mode of Communication: Persuasive Presentations using multi-media aids.
17. Practice of idioms and phrases on: Above board , Apple of One's eye , At sea, At random, At large, A burning question, A child's play, A wolf in sheep's clothing, A deal, Breath one's last, Bid fair to, Beat about the bush, Blue Blood, Big Gun, Bring to Book, Cut a sorry figure, Call names, Carry weight, Dark Horse, Eat Humble pie, Feel small, French leave, Grease the palm, Go against the grains, Get One's nerves, Hard and Fast, Hue and Cry, Head and ears, In full swing, Jack of all trades, know no bounds, kiss the dust, Keep an eye on, Lion's share, learn by rote, Null and void, on the cards, Pull a long face, Run amuck, Right and Left, Rain on Shine, Small talk, Take to one's heels, Tooth and nail, to take by storm, , Wet blanket, Yearn for.

RECOMMENDED BOOKS

1. Alvinder Dhillon and Parmod Kumar Singla, "Text Book of English and Communication Skills Vol – 1, 2", M/s Abhishek Publications, Chandigarh.
2. J Sethi, Kamlesh Sadanand & DV Jindal, "Course in English Pronunciation", PHI Learning Pvt. Ltd., New Delhi.
3. Wren and Martin, "High School English Grammar and Composition" .
4. NK Aggarwal and FT Wood, "English Grammar, Composition and Usage", Macmillan Publishers India Ltd., New Delhi.
5. RC Sharma, and Krishna Mohan, "Business Correspondence & Report Writing", (4^{th} Edition), by Tata MC Graw Hills, New Delhi.
6. Varinder Kumar, Bodh Raj & NP Manocha, "Business Communication Skills", Kalyani Publisher, New Delhi.
7. Kavita Tyagi & Padma Misra, "Professional Communication", PHI Learning Pvt. Ltd., New Delhi.
8. Nira Konar, "Communication Skills for Professionals", PHI Learning Pvt. Ltd., New Delhi.
9. Krishna Mohan & Meera Banerji, "Developing Communication Skills", (2^{nd} Edition), Macmillan Publishers India Ltd., New Delhi.
10. M. Ashraf Rizwi, "Effective Technical Communication", Tata MC Graw Hills, New Delhi.
11. Andrea J Rutherford, "Basic Communication Skills for Technology", Pearson Education, New Delhi.

INSTRUCTIONAL STRATEGY

This is practice based subject and topics taught in the class should be practiced in the Lab regularly for development of required communication skills in the students. Emphasis should be given on practicing of communication skills. This subject contains five unit of equal weightage.

4.2 ELECTRICAL MACHINES - II

L	P
3	4

RATIONALE

Electrical machines is a subject where a student will deal with various types of electrical machines which are employed in industries, power stations, domestic and commercial appliances etc. After studying this subject, an electrical diploma holder must be competent to repair and maintain these machines and give suggestions to improve their performance. Explanation of practical aspects of the subject will make the students capable of performing various tests on the machines as per latest BIS specifications

COURSE OUTCOMES

After undergoing the subject, students will be able to:

CO1: Operate and control three phase synchronous generator and motor

CO2: Operate and control speed of three phase squirrel cage and three phase slip ring induction motor.

CO3: Identify and connect starters for starting three phase and single phase induction motors

CO4: Control speed of single phase induction motors

CO5: Differentiate between normal and Energy Efficient Motors

DETAILED CONTENTS

UNIT I

Synchronous Machines

1.1 Main constructional features of synchronous machine including commutator

1.2 Generation of three phase emf

1.3 Production of rotating magnetic field in a three phase winding

1.4 E.M.F. Equation, Concept of distribution factor and coil span factor

1.5 Operation of single synchronous machine independently supplying a load, voltage regulation by synchronous impedance method

1.4 Need and necessary conditions of parallel operation of alternators, synchronizing an alternator (Synchroscope method) with the bus bars

1.7 Operation of synchronous machine as motor, Starting methods of Synchronous Motor
1.8 Concept and Cause of hunting and its prevention
1.9 Specification of Synchronous Machine
1.10 Cooling of synchronous machines
1.11 Application of synchronous machines (as a synchronous condenser)

UNIT II

Three Phase Induction Motors

2.1 Salient constructional features of 3 phase squirrel cage and slip ring induction motors
2.2 Principle of operation, slip and its significance
2.3 Locking of rotor and stator fields
2.4 Rotor resistance, inductance, e.m.f. and current
2.5 Relationship between copper loss and the motor slip
2.6 Power flow diagram of an induction motor
2.7 Factors determining the torque
2.8 Torque-slip curve, stable and unstable zones
2.9 Effect of rotor resistance upon the torque slip relationship
2.10 Starting of 3-phase induction motors by DOL, star-delta and auto transformer starter
2.11 Causes of low power factor of induction motors
2.12 Speed control of induction motor
2.13 Cogging and Crawling in Induction Motors.

UNIT III

Single Phase Induction Motors:

3.1 Single phase induction motors; Construction characteristics and applications
3.2 Nature of field produced in single phase induction motor
3.3 Split phase induction motor: Capacitors start and run motor, Shaded pole motor and Reluctance start motor
3.4 Alternating current series motor and universal motors

UNIT IV

Special Purpose Machines

4.1 Working principle of Linear induction motor, Stepper motor and Servomotor
4.2 Introduction to Energy efficient Motors.

PRACTICAL EXERCISES

1. To Plot relationship between no load terminal voltage and excitation current in a synchronous generator at constant speed.
2. Determination of the relationship between the terminal voltage and load current of an alternator, keeping excitation and speed constant.
3. Determination of the efficiency of alternator from the open circuit and short circuit test.
4. Parallel operation of three phase alternators.
5. Study of ISI/BIS code for 3-phase induction motors.
6. Perform at least two tests on a 3-phase induction motor as per BIS code.
7. To reverse the direction of rotation of three phase induction motor.
8. To control speed of three phase induction motor.
9. Determination of efficiency of three phase induction motor by
   (a) No load test and blocked rotor test.
   (b) Direct loading (refer BIS code).
10. Determination of effect of rotor resistance on torque speed curve of an induction motor.
11. To Plot Torque-Slip Characteristics of three phase induction Motor.
12. Study of performance of a ceiling fan with and without capacitor.
13. Study the effect of change in capacitor on the performance of single phase induction motor.
14. To reverse the direction of rotation of single phase induction motor.

RECOMMENDED BOOKS

1. Bhattacharya, SK, “Electrical Machines”, Tata Mc Graw Hill, Education Pvt Ltd. New Delhi.
2. Sahdev, SK, “Electrical Machines”, Uneek Publications, Jalandhar.
3. Gupta, JB, “Electrical Machines”, SK Kataria and Sons, New Delhi.
4. Marwaha, G L, “Electrical Machines”, Eagles Publication, Jalandhar.
5. Arora, D R, “Electrical Machines I”, Ishan Publications, Ambala City.
6. Bimbra, P.S., “Electrical Machines”, Khanna Publishers.
7. Nagrath, I.J., & D.P. Kothari, “Electric Machines”, Tata Mc Graw –Hill Publishers.

INSTRUCTIONAL STRATEGY

Teacher should lay-emphasis on development of understanding amongst students about basic principles of operation and control of electrical machines. This may be achieved by conducting quiz tests and by giving home assignments. The teachers should also conduct laboratories classes themselves encouraging each should to perform with his/her own hands and draw conclusions. This subject contains four units of equal weight age.

4.3 PLC & MICROCONTROLLERS

L	P
3	4

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. Looking at the industrial applications of PLCs in the modern industry, this subject finds its usefulness in the present curriculum. The microprocessor has been with us for some Twenty Five years but it has limited applications, more complicated hardware, limited use with computer and more cost resulted in failure in market on other hand micro controller which is a true computer on a chip more simple in hardware, millions of application more general purpose device and capable of having several different functions depending on the wishes of the programme. So now a day, use of micro controller is increasing in industries and therefore, it is necessary for the students to study this course.

COURSE OUTCOMES

After undergoing the subject, students will be able to:

CO1: Acquire knowledge about various components of PLC.
CO2: Interface I/O devices with the PLC modules.
CO3: Develop PLC ladder programs for various applications.
CO4: Interpret the salient features of microcontroller IC 8051
CO5: Programme micro controllers for different operations and applications in industries.

DETAILED CONTENTS

UNIT I

Fundamentals of PLC

Introduction, Definition and advantage; Building blocks of PLC**:** CPU, Memory organization, Input- output modules (discrete and analog), Specialty I/O Modules, Power supply; I/O module selection criteria; Interfacing different I/O devices with appropriate I/O modules

UNIT II

PLC Instructions and Programming

PLC programming Instructions**:** Relay type instructions, Timer instructions: On delay, off delay, retentive, counter instructions: Up, Down, High speed, Logical instructions, Comparison Instructions, Data handling Instructions, Arithmetic instructions. Simple Programming examples using ladder logic**:** Language based on relay, timer counter, logical, comparison, arithmetic and data handling instructions.

UNIT III

Applications of PLC

PLC Based Applications: Motor sequence control, Motor in forward and reverse direction, Star-Delta, DOL Starters Traffic light control, Elevator control, Conveyor system, Stepper motor control, packaging etc.

UNIT IV

Architecture of Microcontroller 8051

Difference between micro processor and micro controller, Block diagram of 8051, function of each block, Pin diagram, function of each pin, Concept of Internal memory and External memory (RAM and ROM), Internal RAM structure, Reset and clock circuit, Various registers and SFRs of 8051.

UNIT V

Microcontroller Instruction and Programming

Instruction set and addressing modes: Timer operation, Serial Port operation, interrupts: Data Transfer operations, Input/output operations. Design and Interface: keypad interface, 7- segment interface, LCD, stepper motor; applications.

PRACTICAL EXERCISES

1. Introduction to PLC building blocks and Ladder Programming.
2. Installation and programming using OpenPLC.
3. Logic operations in PLC using ladder language e.g. AND, OR, NOT etc.
4. Timers and Counters instructions in PLC using ladder language.
5. Sequence control system e.g. in lifting a device for packaging and counting.
6. Use of PLC in any two applications (teacher may decide):

a) Traffic Lights System

b) Doorbell Operation

c) Home Automation
d) Sorting of Objects
7. Demonstration and comparison of various 8051/8052 microcontrollers.
8. Introduction to 8051 programming using C.
9. Testing of GPIO on Micro controller board using C.
10. Interfacing of 7 segment LED with 8051 using C.
11. Interfacing of 4x3/4x4 Keypad with 8051 using C.
12. Any three application circuits using 8051/8052 (teacher may decide):
a) Car Parking with Counter
b) Temperature controlled Fan
c) RTC based digital clock
d) Agriculture Automation using Humidity, Soil Moisture and Temperature sensors

NOTE: List in Experiment No. 6 and 12 are indicative in nature and teacher may choose any other circuit as well.

RECOMMENDED BOOKS

1. G., Dunning, "Introduction to Programmable Logic Controllers", Thomson /Delmar Learning, New Delhi.
2. F.D. Petruzella, "Programmable Logic Controllers", McGraw Hill India, New Delhi.
3. John Hackworth, and Federic Hackworth, "Programmable Logic Controllers", PHI Learning, New Delhi.
4. Job Dan Otter, "Programmable Logic Controller", P.H. International, Inc, USA.
5. Gary Dunning, "Introduction to PLCs", McGraw Hill.
6. Gurpreet Kaur and SK Sahdev, "Programmable Logic Controller and Microcontrollers", Uneek Publications, Jalandhar.
7. Ayala Kenneth, "8051 Microcontroller Architecture Programming and Application", PHI Learning, New Delhi.
8. Mohmad Ali Mazidi, Janice Gelispe Mazidi, and D. MckinlayRoline, "The 8051 Microcontroller and Embedded System", Pearson Education, Delhi.
9. Ajay Deshmukh, "Microcontroller Theory and Application", McGraw Hill., New Delhi.
10. Raj Kamal, "Microcontroller Architecture Programming, Interfacing and System Design", Pearson Education India, Delhi.
11. Krishna Kant, "Microprocessors and Microcontrollers: Architecture Programming and System Design", PHI Learning, New Delhi.

SUGGESTED WEBSITES

1. http://swayam.gov.in
2. https://nptel.ac.in/

INSTRUCTIONAL STRATEGY

Introduce the subject and make the students familiar with applications of PLCs and Microcontrollers. The inputs shall start with theoretical inputs to architecture, instruction set, assembly language programming, Small projects may be identified, be designed and implemented. PLC ladder diagram and programming should be supplemented with visits to industry. More emphasis may be given to practical work, assignments and quiz/class tests, mid-term and end-term written tests. This subject contains five units of equal weight age.

4.4 ESTIMATING AND COSTING IN ELECTRICAL ENGINEERING

L	P
3	2

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.

COURSE OUTCOMES

After undergoing the subject, student will be able to:

CO1: Comprehend the concept of estimation, costing and purchasing, tender, EMD, and tender document and prepare a tender document for a particular job.

CO2: Prepare details estimation and costing of domestic, industrial and street light electrical installation as per IE.

CO3. Detail and prepare detail estimation and costing for single and three phase service connection, also installation of service connection.

CO4: Estimate and calculate costing of overhead & underground transmission distribution line and substations.

DETAILED CONTENTS

UNIT I

Essentials of Estimation and Costing

1.1 **Introduction** :Purpose of estimating and costing, proforma for making estimates, preparation of materials schedule, costing, price list, net price list, market survey, overhead charges, labour charges, electrical point method and fixed percentage method, contingency, profit.

1.2 **Tenders and Quotations**-Type of tender, tender notice, preparation of tender document, and method of opening of tender, Quotation-quotation format, comparison between tender and quotation, Comparative statement, format comparative statement. Earnest money deposit (EMD), purchase system, orders for supply, payment of bills.

UNIT II

Domestic Installation

2.1 **Wiring and accessories:** Introduction, types of wiring**:** Cleat, batten, casing capping and conduit wiring, comparison of different wiring systems, selection and design of wiring schemes. Selection of wires and cables, wiring accessories and use of protective devices i.e. MCB, ELCB etc. Use of wire-gauge and tables (to be prepared/arranged).

2.2 **Domestic installations:** standard practice as per IS and IE rules. Planning of circuits, sub-circuits and position of different accessories, electrical layout, preparing estimates including cost as per schedule rate pattern and actual market rate (single story and multi- story buildings having similar electrical load).

UNIT III

Industrial Installation

3.1 **Industrial installations:** relevant IE rules and IS standard practices, planning, designing and estimation of installation for single phase motors of different ratings, electrical circuit diagram, starters, preparation of list of materials, estimating and costing exercises on workshop with singe-phase, 3-phase motor load and the light load (3-phase supply system).

3.2 Design electrical installation scheme of factory/ small industrial unit, Preparation of material schedule and detailed estimation.

UNIT IV

Street Lighting Installation

4.1 Classification of outdoor installations streetlight/ public lighting installation, Street light pole structures. Selection of equipments, sources used in street light installations. Cables, recommended types and sizes of cable. Control of street light installation.

4.2 Design, estimation and costing of streetlight, Preparation of tenders.

UNIT V

Distribution Line and LT Substation

4.1 Transmission and distribution lines (overhead and underground) planning and designing of lines with different fixtures, earthing etc. based on unit cost calculations .Service line connections estimate for domestic and industrial loads (overhead and underground connections) from pole to energy meter.

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.

PRACTICAL EXERCISES

1. Prepare a tender notice for purchasing a transformer of 200 KVA for commercial installation.
2. Prepare a quotation for purchasing different electrical material required.
3. Prepare a comparative statement for above material. Prepare purchase order for the same.
4. Prepare an estimate for a Two room residential building as per given plan.
5. Design electrical installation scheme for any one factory / small industrial unit. Draw detailed wiring diagram. Prepare material schedule and detailed estimate. Prepare report and draw sheet.
6. Estimate with a proposal of the electrical Installation of streetlight scheme for small premises after designing.
7. Prepare an estimate for service connection for residential building having connected load ---- kW.
8. Estimate with a proposal of the L.T. line installation. Prepare report and draw sheet.
9. Estimate with a proposal of the 500 KVA, 11/0.433 KV outdoor substation and prepare a report.
10. Visit a nearby substation and list the components with diagram

RECOMMENDED BOOKS

1. K.B Raina, and Dr. S. K. Bhattacharya, “Electrical Design Estimating and Costing”, New Age International Publisher First, Reprint 2010, ISBN: 978-81-224-0363-3.
2. Allagappan,, N. S. Ekambarram, “Electrical Estimating and Costing”, Tata Mc-Graw Hill Publishing Co. Ltd, ISBN 13: 9780074624784.
3. JB Gupta, “Electrical Installation, Estimating and Costing”, SK Kataria and Sons, New Delhi.
4. Surjit Singh, and Ravi Deep Singh, “Electrical Estimating and Costing”, Dhanpat Rai and Sons, ISBN 13:1234567150995.
5. SL Uppal, “Estimating and Costing”, Khanna Publishers, New Delhi.
6. J.B. Gupta, “A Course in Electrical Installation Estimating and Costing”, S.K. Kataria and Sons Reprint Edition, ISBN 10: 935014279113: 978-9350142790.
7. Bureau of Indian Standard. IS: 732-1989, Code of Practice for Electrical Wiring Installation.
8. Bureau of Indian Standard. SP-30:2011, National Electrical Code 2011.

SUGGESTED WEBSITES

1. http://swayam.gov.in
2. https://nptel.ac.in/

INSTRUCTIONAL STRATEGY

Teacher should identify/prepare more exercises on the pattern shown above. The teacher should make the students confident in making drawing and layouts of electrical wiring installations and doing estimation and costing leading to preparation of small tender document. This capability will lead the students to become a successful entrepreneur. Take the students to field/laboratory and show the material and equipment. Show video or animation of working of various types of wiring system and electrical transmission and distribution network. Students will use supplementary resources such as online videos, NPTEL videos, e-courses, Virtual Laboratory.
This subject contains five units of equal weight age.

4.5 UTILIZATION OF ELECTRICAL ENERGY

L	P
3	-

RATIONALE

This subject assumes importance in view of the fact that an electrical technician has to work in a wide spectrum of activities wherein he has to make selection from alternative schemes making technical and economical 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 contents have 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

COURSE OUTCOMES

After undergoing the subject, the student will be able to:

CO1: Design the level of illumination based on applications
CO2: Identify most appropriate heating and welding techniques for suitable applications.
CO3: Illustrate the fundamentals on electrolytic and electrometallurgical processes.
CO4: Detail electrolytic principle for various applications
CO5: Apply principle of electric traction system & speed– time curves of different traction Systems.

DETAILED CONTENTS

UNIT I
Illumination

Introduction, terms used in illumination, laws of illumination, indoor and outdoor illumination levels. Discharge lamps, MV and SV lamps. General ideas about time switches, street lighting, flood lighting and decorative lighting.

UNIT II
Electric Heating & Electric Welding

Advantages and methods of electric heating, resistance heating, induction heating, and dielectric heating. Electric welding, resistance and arc welding, electric welding equipment, comparison between A.C. and D.C, Welding.

UNIT III
Electrolytic Processes

Need of electro-deposition; Laws of electrolysis; process of electro-deposition - clearing, operation, deposition of metals, polishing and buffing; Principle of galvanizing and its applications; Principles of anodizing and its applications; Electroplating of non-conducting materials, Electrical Circuits used in Refrigeration and Air Conditioning and Water Coolers.

UNIT IV
Electric Drives

Electric Drive and its part, Advantages of electric drives, Types of electric Drives, Characteristics of different mechanical loads, Types of motors used in used in Industrial Drives, Factors affecting selection of motors, Applications of Electric Drive. Introduction to Energy efficient drives.

UNIT V
Electrical Traction

Advantages of electric traction, Concept of diesel electric Traction system, Systems of Track Electrification (DC & AC system), types of services – urban, sub-urban, and main line and their speed-time curves. Electrical block diagram and accessories of an electric locomotive and different accessories for track electrification such as overhead centenary wire, conductor rail system, current collector / pentagraph etc. Power supply arrangements and types of motors used for electric traction. Starting and braking of electric locomotives. Introduction to EMU and metro railways

SUGGESTED WEBSITES

1. http://swayam.gov.in
2. https://nptel.ac.in/

RECOMMENDED BOOKS

1. H Partap, "Art and Science of Utilization of Electrical Energy",Dhanpat Rai &Sons, Delhi
2. JB Gupta, "Utilization of Electrical Energy", Kataria Publications, Ludhiana
3. Sahdev, "Utilization of Electrical Energy", Uneek Publication, Jalandhar
4. Dr. SL Uppal, "A Text Book. of Electrical Power" Khanna Publications, Delhi
5. H Partap, "Modern Electric Traction", Dhanpat Rai & Sons, Delhi
6. OS Taylor, "Utilization of Electrical Energy" Pitman Publications
7. CL Wadhwa, "Generation, Distribution and Utilization if Electrical Power" Wiley Eastern Ltd., New Delhi

INSTRUCTIONAL STRATEGY

It is desired to give ample practical examples in the class while teaching this subject. Teacher must supplement his/her classroom teaching with aids such as models, charts, and video films from time to time. This subject requires demonstrations and exposure to actual workplace/industry/field. For this purpose, the subject teacher should do advance planning for visits/studies related to each topic in consultation with HOD and Principal of the polytechnic/institution. Students should be taken for visits to nearest electrified railway track and railway station to study the electric traction system. This subject contains four units of equal weight age.

4.6 PROGRAMMING SKILLS

L	P
-	6

RATIONALE

Computer plays a very vital role in present day life, more so, in the professional life of Diploma engineers. In order to enable the students use the computers effectively, this course offers exposure to various engineering applications of computers in electrical engineering. The practical exercises and demonstration of application software in the field of electrical engineering during the course of study will help the students in getting the employment.

COURSE OUTCOMES

After undergoing the subject, students will be able to:

CO1: Make and edit their own AutoCAD Drawings.

CO2: Familiarize with MATLAB programming and Simulink.

CO3: Develop a program and graphs for computations the data using Matlab.

CO4: Create user interfaces with charts, graphs, and buttons using Open Software

PRACTICAL EXERCISES

UNIT I

AUTOCAD Electrical

- Introduction to electrical CAD interface
- Preparing circuits using electrical components

UNIT II

Electrical Circuit Simulation (Using Qucs/Similar Open Source Application)

- Introduction to simulator interface
- Preparing Resistive circuit with voltage and current probes
- Preparing R-L circuit with voltage and current probes
- Preparing R-L-C circuit with voltage and current probes
- Preparing Diode based circuits e.g. clipper, rectifier etc.
- Preparing logic gates based circuits

UNIT III

My Open Lab/PyLab Works

- Introduction to My Open Lab
- My Open Lab Interface
- Virtual circuit design using My Open Lab

UNIT IV

MATLAB/SciLab

- Introduction to MATLAB
- MATLAB Programming – input/output, graphs, functions, loops, structures
- MATLAB programs for simple electrical circuits

RECOMMENDED BOOKS

1. Prof. Sham Tickoo, "Auto CAD Electrical", BPB Publication.
2. "Auto CAD Electrical 2010 for Engineers", Cadcim Technologies Sham, Pearson Education India.
3. Agam Kumar Tyagi, "MATLAB and SIMULINK for Engineers", Oxford.
4. Rudra Pratap, "MATLAB 7", Oxford University Press.
5. Stephen J. Chapman, "MATLAB Programming for Engineers".
6. R.K. Bansal, and A.K. Goel, "MATLAB and Its Applications In Engineering".

SUGGESTED WEBSITES

1. http://swayam.gov.in
2. https://nptel.ac.in/

INSTRUCTIONAL STRATEGY

The subject is totally practice oriented and requires efforts of the student to gain expertise in the programming. Students should be given enough exposure to the software and make them practice at every platform elaborately. Software installation, operation, development should also be the part of practice. The teacher should conduct viva voice of the students too.

THIRD YEAR
NSQF LEVEL - 5

18. STUDY AND EVALUATION SCHEME

FIFTH SEMESTER

Sr. No.	SUBJECTS	STUDY SCHEME Periods/Week		Credits (C) L+P = C	MARKS IN EVALUATION SCHEME						Total Marks of Internal & External
					INTERNAL ASSESSMENT			EXTERNAL ASSESSMENT			
		L	P		Th	Pr	Tot	Th	Pr	Tot	
5.1	Industrial/ In-House Training - II	-	2	0+1=1	-	40	40	-	60	60	100
5.2	Industrial Electronics and Control of Drives	3	4	3+2=5	40	40	80	60	60	120	200
5.3	Electric Vehicle Technology	2	2	2+1=3	40	40	80	60	60	120	200
5.4	Power system	3	4	3+2=5	40	40	80	60	60	120	200
5.5	Multi-disciplinary Elective (MOOCs+/Offline)	2	-	2+0=2	40	-	40	60	-	60	100
5.6	Programme Elective-I	3	-	3+0=3	40	-	40	60	-	60	100
5.7	Minor Project	-	8	0+4=4	-	40	40	-	60	60	100
#Student Centred Activities (SCA)		-	2		-	-	-	-	-	-	-
Total		**13**	**22**	**23**	**200**	**200**	**400**	**300**	**300**	**600**	**1000**

Programme Elective-I: **5.6.1** Solar Panel Installation and Maintenance, **5.6.2** Electrical Traction system,

\+ Assessment of Open Elective through MOOCs shall be based on assignments out of 100 marks.

Student Centered Activities will comprise of co-curricular activities like extension lectures on Constitution of India, Electoral Literacy, Motor Vehicles (Driving) Regulations 2017 etc., games, hobby clubs e.g. photography etc., seminars, declamation contests, educational field visits, N.C.C., NSS, Cultural Activities and self-study etc.

SIXTH SEMESTER

Sr. No.	SUBJECTS	STUDY SCHEME Periods/Week		Credits (C) L+P = C	MARKS IN EVALUATION SCHEME						Total Marks of Internal & External
					INTERNAL ASSESSMENT			EXTERNAL ASSESSMENT			
		L	P		Th	Pr	Tot	Th	Pr	Tot	
6.1	Power System Protection	3	2	**3+1=4**	40	40	80	60	60	120	200
6.2	***Entrepreneurship Development and Management	3	-	**3+0=3**	40	-	40	60	-	60	100
6.3	Installation and Maintenance of Electrical Equipment	2	2	**2+1=3**	40	40	80	60	60	120	200
6.4	Energy Conservation and Audit	2	2	**2+1=3**	40	40	80	60	60	120	200
6.5	Programme Elective-II	3	-	**3+0=3**	40	-	40	60	-	60	100
6.6	Major Project / Industrial Training	-	14	**0+7=7**	-	40	40	-	60	60	100
#Student Centred Activities (SCA)		-	2	-	-	-	-	-	-	-	-
Total		**13**	**22**	**23**	**200**	**160**	**360**	**300**	**240**	**540**	**900**

* Common with other diploma programmes

Professional Elective-II: 6.5.1 HVDC & Flexible AC Transmission Systems, 6.5.2 Smart Grid and Distributed Generation System

Student Centered Activities will comprise of co-curricular activities like extension lectures on Constitution of India, Electoral Literacy, Motor Vehicles (Driving) Regulations 2017 etc., games, hobby clubs e.g. photography etc., seminars, declamation contests, educational field visits, N.C.C., NSS, Cultural Activities and self-study etc.

19. HORIZONTAL AND VERTICAL SUBJECTS ORGANISATION

Sr. No.	Subjects/Areas	Hours Per Week	
		Fifth Semester	Sixth Semester
1.	Industrial/In-House Training - II	2	
2.	Industrial Electronics and Control of Drives	7	
3.	Electric Vehicle Technology	4	
4.	Power system	7	
5.	Multi-disciplinary Elective	2	
6.	Programme Elective-I	3	
7.	Minor Project	**8**	
8.	Power System Protection		5
9.	Entrepreneurship Development and Management		3
10	Installation and Maintenance of Electrical Equipment		4
11.	Energy Conservation and Audit		4
12.	Programme Elective-II		3
13.	Major Project / Industrial Training		14
14.	Student Centered Activities	**2**	2
	Total	**35**	**35**

20. COMPETENCY PROFILE & EMPLOYMENT OPPORTUNITIES

Government and private sectors related to **ELECTRICAL ENGINEERING** require **supervisors** having well developed skills with clear choice of procedures. They are expected to have complete knowledge and practical skills related to their field. They shall be able to communicate clearly with others. Diploma holders after passing level 5 shall haveunderstanding of desired mathematical skills and understanding of social and naturalenvironment. They should be able to apply knowledge and skills to provide solutions to Electrical Engineering problems in industry and governmental organizations or to enhance student learning in educational institutions. They are expected to collect, organize and communicate information effectively. They are expected to have good exposure of humanities, life skills, entrepreneur development and management to establish small start-ups.

Work requiring knowledge, skills and aptitudes at level 5 will also be carried out in familiar situations, but also ones where problems may arise. Job holders will be able to make choices about the best procedures to adopt to address problems where the choices are clear. Individuals in jobs which require level 5 qualifications will normally be responsible for the completion of their own work and expected to learn and improve their performance on the job. They may also have some responsibility for others' work and learning. Diploma engineers should depict ability to design a System, Component, or Process to meet desired needs with in realistic constraints such as Economic, Environmental, Social, Ethical, Manufacturability, and Sustainability.

Electrical engineers are tasked with inventing cutting-edge electrical products, overlooking repairs of electrical devices, operating electrical equipment and maintaining the same. They can work with different clients to install, repair and maintain electrical equipment in residential or commercial spaces. These professionals are extremely necessary as malfunctioning electrical equipment and products can lead to serious injury or loss of life. Quality assurance engineers are responsible for running tests and checks to detect faulty equipment.

Overall, the job opportunities for diploma holders in electrical engineering are quite diverse, and employment can be found in a wide range of industries, including manufacturing, construction, telecommunications, and more. One can also pursue higher education in electrical engineering after gaining a Diploma in the field. Undergraduate courses like B.E. Electrical Engineering and B.Tech Electrical Engineering followed by postgraduate programs like M.E. Electrical Engineering and M.Tech Electrical Engineering can help you elevate your profile and opportunities by a large margin.

Government Departments such as Electricity Board, MES, PWD, Railways, Air bases, Airports, Defence, Thermal, Hydro and Nuclear Power Stations and other Boards and Corporations: Construction, erection and commissioning of lines and Sub-stations, Electrical Safety measures, Operation and Maintenance of Lines and Sub-stations/underground cables, Tariffs and Calculations of bills for consumption of electricity, Inventory Management, Repair and Maintenance of Electrical Machines/ Equipment, Assist in Operation and maintenance of Generating and sub-stations

21.PROGRAMME OUTCOMES

The program outcomes are derived from five domains of NSQF Level – 5 namely Process, Professional Knowledge, Professional Skill, Core Skill, Responsibility. After completing this level, the student will be able to:

PO1: Demonstrate skills to use modern devices, software and equipment to analyse & solve problems in Electrical engineering.

PO2: Acquire knowledge of facts, principles and processes related to Electrical engineering

PO3: Demonstrate cognitive and practical skills to complete tasks and solve problems of Electrical Engineering applications.

PO4: Develop skills to collect, organize and communicate information.

PO5: Accomplish own work and supervise others work in various electrical applications

PO6: Adopt self-study learning by choosing multidisciplinary electives of own interest

22. ASSESSMENT OF PROGRAMME AND COURSE OUTCOMES

Programme Outcomes to be assessed	Assessment criteria for the Course Outcomes
PO1: Demonstrate skills to use modern devices, software and equipment to analyse & solve problems in Electrical engineering.	• Familiarize with the working environment of industries • Comprehend about present and future requirement of industries. • Work in team for solving industrial problems • Develop competencies and skills required by relevant industries. • Illustrate the working of various power converters. • Apply knowledge of AC and DC Drive control with thyristor. • Apply the appropriate power converters for commercial and industrial applications. • Control various drives in Electric Vehicles. • Detail and analyze the battery management system in EV. • Identify various components & know their functions. • Apply safety measures during installation and maintenance of PV system. • Apply various speed control methods applicable to traction motors • Define the problem statement of the minor project according to the need of industry. • Work as a team member for successful completion of minor project. • Identify various types of faults in power system. • Select suitable switchgears for different applications. • Test the performance of different protective relays. • Apply different protection schemes in power system. • Identify the various resources / sources and / or schemes for starting a new venture.

	• Use tools/instruments for installation and maintenance • Apply electrical safety regulations and rules during maintenance. • Implement energy conservation techniques in electrical machines. • Apply energy conservation techniques in electrical installations. • Apply principles for Combined Controllers Compensation • Differentiate between Conventional Grid and Smart Grid. • Apply the concept of smart grid in various applications.
PO2: Acquire knowledge of facts, principles and processes related to Electrical engineering	• Develop competencies and skills required by relevant industries. • Illustrate the working of various power converters. • Apply knowledge of AC and DC Drive control with thyristor. • Comprehend the basic principle, operation and performance of Electric Vehicle. • Control various drives in Electric Vehicles. • Describe various types of Charging Infrastructure used in EV. • Detail and analyze the battery management system in EV. • Differentiate between Simple EV and Hybrid EVs. • Interpret the operation of Generation, transmission and distribution of electrical system. • Identify various components & know their functions. • Understand Tariff and the various methods to improve power factor. • Detail components used in PV system and their selection and installation.

	• Handle the maintenance and troubleshooting of PV system. • Identify different traction systems. • Differentiate speed time curve of different services of traction system. • Detail the traction system auxiliaries. • Apply various speed control methods applicable to traction motors • Identify various types of faults in power system. • Select suitable switchgears for different applications. • Comprehend the importance of entrepreneurship and its role in nation's development. • Classify the various types of business and business organizations. • Identify the various resources / sources and / or schemes for starting a new venture. • Illustrate various commissioning test on transmission line, underground cable and electrical machines • Prepare the maintenance schedule of transmission line, underground cable and electrical machines. • Compare HVDC and HVAC transmission systems. • Comprehend the principles of dc links, including power control, harmonics, and filters. • Familiarize with FACTS devices, • Differentiate between Conventional Grid and Smart Grid. • Understand the fundamentals of distributed generation and micro gird. • Apply the concept of smart grid in various applications.

PO3: Demonstrate cognitive and practical skills to complete tasks and solve problems of Electrical Engineering applications.	• Develop competencies and skills required by relevant industries. • Apply knowledge of AC and DC Drive control with thyristor. • Apply the appropriate power converters for commercial and industrial applications. • Control various drives in Electric Vehicles. • Interpret the operation of Generation, transmission and distribution of electrical system. • Calculate different parameter of transmission system. • Apply safety measures during installation and maintenance of PV system. • Handle the maintenance and troubleshooting of PV system. • Apply various speed control methods applicable to traction motors • Define the problem statement of the minor project according to the need of industry. • Apply different protection schemes in power system. • Conduct market survey and prepare project report. • Illustrate various commissioning test on transmission line, underground cable and electrical machines • Prepare the maintenance schedule of transmission line, underground cable and electrical machines. • Comprehend the methodologies and techniques involved in conducting energy audits. • Apply principles for Combined Controllers Compensation • Knowledge of communication and measurement and data monitoring technologies in Smart Grid. • Define the problem statement of the Industrial training / Major project according to the need of industry.

PO4: Develop skills to collect, organize and communicate information.	• Work in team for solving industrial problems • Develop writing, speaking and presentations skills. • Understand Tariff and the various methods to improve power factor. • Acquire knowledge of site assessment tools, installation tools and safety tools. • Define the problem statement of the minor project according to the need of industry. • Work as a team member for successful completion of minor project. • Write the minor project report effectively. • Present the minor project report using PPT. • Comprehend the importance of entrepreneurship and its role in nation's development. • Classify the various types of business and business organizations. • Identify the various resources / sources and / or schemes for starting a new venture. • Explain the principles of management including its functions in an organisation. • Conduct market survey and prepare project report. • Prepare the maintenance schedule of transmission line, underground cable and electrical machines. • Knowledge of communication and measurement and data monitoring technologies in Smart Grid. • Define the problem statement of the Industrial training / Major project according to theneed of industry. • Work as a team member for successful completion of Industrial training / Major project. • Write the Major project report effectively. • Present the Major project report using PPT

PO5: Accomplish own work and supervise others work in various Electrical applications	• Comprehend about present and future requirement of industries. • Work in team for solving industrial problems • Develop competencies and skills required by relevant industries. • Apply the appropriate power converters for commercial and industrial applications. • Control various drives in Electric Vehicles. • Detail and analyze the battery management system in EV. • Interpret the operation of Generation, transmission and distribution of electrical system. • Calculate different parameter of transmission system. • Understand Tariff and the various methods to improve power factor. • Acquire knowledge of site assessment tools, installation tools and safety tools. • Handle the maintenance and troubleshooting of PV system. • Define the problem statement of the minor project according to the need of industry. • Identify various types of faults in power system. • Test the performance of different protective relays. • Apply different protection schemes in power system. • Classify the various types of business and business organizations. • Identify the various resources / sources and / or schemes for starting a new venture. • Explain the principles of management including its functions in an organisation. • Conduct market survey and prepare project report. • Prepare the maintenance schedule of transmission line, underground cable and electrical machines. • Comprehend the methodologies and techniques involved in conducting energy audits.

	• Interpret energy conservation policies in India. • Knowledge of communication and measurement and data monitoring technologies in Smart Grid. • Work as a team member for successful completion of Industrial training / Major project.
PO6: Adopt self-study learning by choosing multidisciplinary electives of own interest	• Apply critical thinking in problem solving. • Demonstrate self and time management. • Display analytical and research abilities. • Integrate multiple knowledge domains. • Enhance the scope and depth of learning.

23. SUBJECTS & CONTENTS

(THIRD YEAR)

FIFTH SEMESTER

5.1	Industrial/In-House Training - II	135 -136
5.2	Industrial Electronics and Control of Drives	137-140
5.3	Electric Vehicle Technology	141-143
5.4	Power system	144-147
5.5	Multidisciplinary Elective(MOOCs+/Offline)	148-149
5.6	Programme Elective-I	150-155
5.7	Minor Project	156-157

5.1 INDUSTRIAL / IN – HOUSE TRAINING-II

L	P
-	2

RATIONALE

Industrial training / In – house training will help the students to understand the working environmentof relevant industries. The student will learn to work in team to solve the industrial problems. It willalso give exposure about the present and future requirements of the relevant industries. This trainingis very important for development of required competencies and skills for employment and start– ups.

COURSE OUTCOMES

After undergoing the training, the students will be able to:

CO1: Familiarize with the working environment of industries

CO2: Apply necessary safety precautions and measures.

CO3: Comprehend about present and future requirement of industries.

CO4: Work in team for solving industrial problems

CO5: Develop competencies and skills required by relevant industries.CO6: Develop writing, speaking and presentations skills.

PRACTICAL EXERCISES

1. Report writing based on industrial training.
2. Preparation of Power Point Slides based on industrial training and presentation by the candidate.
3. Internal Evaluation based on quality of Report, PPT preparation, PPT presentation and answerto queries.
4. External Evaluation based on quality of Report, PPT preparation, PPT presentation and answerto queries.

GUIDELINES

Students will be evaluated based on Industrial training / In – house training report and their presentation using Power Point about the knowledge and skills gained during the training. The Headof the Department will depute faculty coordinators by assigning a group of students to each. The coordinators will mentor and guide the students in preparing the PPTs for final presentation. The following performance parameters are to be considered for assessment of the students out of 100 marks:

	Parameter	**Weightage**
i	Industrial / In-house assessment of the candidate by the trainer	40%
ii	Report Writing	20%
iii	Power Point Presentation	20%
iv	Viva-voce	20%

5.2 INDUSTRIAL ELECTRONICS AND CONTROL OF DRIVES

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RATIONALE

Industrial electronics and drives play a very vital role in operation and controlling the modern industries which are more efficient, effective and precise as compare to the conventional methods. The old magnetic and electrical control schemes have all become obsolete. Electrical diploma holder many times has to maintain the panels used in the modern control process. Therefore, the knowledge of components like thyristors and other semiconductor devices used in such control panels is must for them in order to supervise the work efficiently and effectively. Looking in to usefulness and importance of the subject this has been incorporated in the curriculum.

COURSE OUTCOMES

After undergoing the subject, the students will be able to:

CO1: Demonstrate the characteristics of different power electronic switches

CO2: Illustrate the working of various power converters.

CO3: Apply knowledge of AC and DC Drive control with thyristor.

CO4: Apply the appropriate power converters for commercial and industrial applications.

DETAILED CONTENTS

UNIT I
Introduction to Thyristors

1.1. Classification of Thyristors
1.2. Construction, working principle and V-I characteristics of SCR, DIAC, TRIAC
1.3. Two transistor analogy of SCR
1.4. Selection of heat sinks for Thyristors
1.5. Methods of triggering a Thyristor and their types, dv/dt and di/dt protection.
1.6. Commutation of Thyristors.
1.7. UJT: Construction, working principles and V-I characteristics. UJT as a relaxation oscillator
1.8. Applications of SCR, DIACS and TRIACS such as light intensity control, speed control of DC and universal motor, fan regulator ,battery charger etc.

UNIT II

Controlled rectifiers

2.1 Single phase half wave controlled rectifier with resistive load and inductive load, concept of freewheeling diode.

2.2 Single phase half controlled full wave rectifier.

2.3 Single phase full controlled full wave rectifier.

2.4 Single phase full wave centre tapped rectifier.

2.5 Three phase full wave half controlled bridge rectifier.

2.6 Three phase full wave fully controlled bridge rectifier.

UNIT III

Inverters, Choppers, Dual Converters and Cyclo-Convertors

3.1 Inverters: Introduction, working principle, voltage and current driven, series and parallel inverters and applications.

3.2 Choppers: Introduction, types of choppers and their working principle and applications.

3.3 Dual converters: Introduction, working principle and applications.

3.4 Cyclo-converters: Introduction, types, working principle and applications.

UNIT IV

Thyristor Control of Electric Drives

4.1 Concept of electric drive**,** Advantages of Electric drives.

4.2 DC drives control: Half wave drives, Full wave drives, Chopper drives.

4.3 AC drives control: Phase control, Variable frequency a.c. drives, Constant V/f control

4.4 Cyclo convertors controlled AC drives.

4.5 Concept of Electric Braking for AC Drive.

UNIT V

Power Converter Applications

5.1 Uninterrupted Power supply (UPS): Working Principle of Online and off Line UPS.

5.2 Switch mode Power Supply (SMPS): Working Principle and use.

5.3 Power Converter for Electrical Vehicle charging.

5.4 Power Converter for Renewable Energy: solar and wind.

LIST OF PRACTICALS

1. To draw V-I characteristics of an SCR.
2. To draw V-I characteristics of a TRIAC.
3. To draw V-I characteristics of a DIAC.
4. To draw uni-junction transistor characteristics.
5. To observe the output wave shape of an UJT relaxation oscillator.
6. To observe the output waves shape on CRO of Single phase half controlled full wave rectifier.
7. To observe the output wave shape on CRO of Single phase full controlled full wave rectifier.
8. Illumination control circuit using SCR/TRIAC and observe the wave shape across load.
9. Speed-control of a DC shunt motor or universal motor using SCR/TRIAC.
10. Fan speed regulator using TRIAC.
11. To study the Construction of battery charger using Thyristor.
12. Testing and Installation of UPS.

RECOMMENDED BOOKS

1. Industrial Control Electronics. John Webb, Kevin Greshock, Maxwell, Macmillan International editions.
2. Fundamentals of Power Electronics by S Rama Reddi, Narosa Publishing House Pvt. Ltd, New Delhi.
3. Power Electronics, Circuits Devices and Applications by Mohammad H. Rashid.
4. Power Electronics by Dr. P S Bhimbra, Khanna Publishers, New Delhi.
5. Industrial Electronics & Control by S K Bhattacharya & S Chatterji , New Age international Publications (P) Ltd,New Delhi.
6. Power Electronics by S K Sahdev ,Uneek Publication, Jalandhar.
7. Power Electronics and Controls by Samir K Datta, Prentice Hall of India, New Delhi.
8. E-books / e-tools /relevant software to be used as recommended by AICTE /HSBTE / NITTTR.

SUGGESTED WEBSITES

1. http://swayam.gov.in
2. https://nptel.ac.in/

INSTRUCTIONAL STRATEGY

The teachers may encourage students to perform practical simultaneously for better understanding of the subjects and verification of theoretical concepts. The various components must be shown to the students for identification and also tested. Practical applications of the various circuits and devices should be discussed in the class. This subject contains five units each having equal weightage in terms of contact hours and marks distribution.

5.3 ELECTRIC VEHICLE TECHNOLOGY

L	P
2	2

RATIONALE

This subject gives basic knowledge about Electric Vehicle (EV) and Hybrid Electric Vehicles (HEV). The subject provides an overview of Electrical component and technology used in EV and HEV, drives for Electric Vehicles and their control, battery management system and various energy charging infrastructure strategies.

COURSE OUTCOMES

After undergoing the subject, the students will be able to:

CO 1: Comprehend the basic principle, operation and performance of Electric Vehicle.
CO 2: Control various drives in Electric Vehicles.
CO 3: Describe various types of Charging Infrastructure used in EV.
CO 4: Detail and analyze the battery management system in EV.
CO 5: Differentiate between Simple EV and Hybrid EVs.

DETAILED CONTENTS

UNIT I

Introduction to Electric Vehicles (EV)

1.1 History and evolution of Electric Vehicle, Policies and regulations related to EV in India.
1.2 Needs and Importance of Electric Vehicle.
1.3 Advantages and Disadvantages of Electric Vehicles,
1.4 Types of EVs- Battery Electric Vehicle (BEV), PHEV (Plug in Hybrid Electric Vehicle) and Hybrid Electric Vehicle (HEV).
1.5 Mandatory safety precautions while handling Electric Vehicle.

UNIT II

Drives for EVs

2.1 Working principle and Control of various motors used in Electric Vehicles- Brushless DC (BLDC) motor, Switched Reluctance Motor (SRM) and Permanent Magnet Synchronous Motor (PMSM).
2.2 Advantages and disadvantages of above motors.

UNIT III

EV charging system

3.1 Electric Vehicle Charger: Main components of EV Charger, EV Charging Sockets, Charging of Electric Vehicle.

3.2 Safety precautions for EV charging.

3.3 Alternate charging sources – Wireless, Solar, fuel cell, ultra capacitor and flywheel etc.

UNIT IV

Battery management systems of EV

4.1 Types of batteries used in EVs- dry batteries, zinc chloride, lead acid and Lithium Ion batteries, Construction and working of Lithium Ion batteries, Battery capacity in AH & KWH.

4.2 Charging & discharging tests of Li-Ion batteries.

4.3 Regenerative braking in EVs.

4.4 Safety precautions while handling a high voltage battery.

4.5 Battery management system.

4.6 Battery cooling system.

UNIT V

Hybrid Electric Vehicle (HEV)

5.1 Overview of Hybrid Electric Vehicles.

5.2 Types of HEV (overview) like gasoline ICE & battery, diesel &battery, Battery & Fuel cell, battery capacitor, battery & flywheel etc.

5.3 Comparison with EV, advantages and disadvantages of HEV.

PRACTICAL EXERCISES

1. Draw block diagram of Electric Vehicle and identify its various parts.
2. Develop schematic diagram of hybrid electric vehicle and its parts.
3. Prepare a report on batteries used in EV and HEV.
4. Diagnose, repair and maintenance of batteries used in Electric Vehicle.
5. Study of various types of braking system used in EV.

6. Demonstration of wiring layout of Electric Vehicles using model (if available) or watching videos
7. Prepare test procedure for electrical equipment used in Electric vehicle.
8. List safety procedures and schedule for handling HEVs and EVs.
9. Case study of Electric Vehicle available in Indian market and study the technology used in it.
10. Measurement of voltage of battery installed in Electric vehicle.

RECOMMENDED BOOKS

1. A.K. Babu, Electric & Hybrid Vehicles, Khanna Publishing House, New Delhi (Ed. 2018).
2. Fuhs, A. E. Hybrid Vehicles and the Future of Personal Transportation, CRC Press,
3. Gianfranco, Electric and Hybrid Vehicles: Power Sources, Models, Sustainability, Infrastructure and the Market, Pistoia Consultant, Rome, Italy.
4. Ehsani, M. Modern Electric, Hybrid Electric and Fuel Cell Vehicles: Fundamentals, Theory and Design, CRC Press.
5. Iqbal Hussein. Electric and Hybrid Vehicles: Design and fundamentals, CRC Press 2003, second edition.
6. Chan C. C. and K. T. Chau, Modern Electric Vehicle Technology, Oxford Science Publication, .
7. Krishnan, R. Electric motor drives: modelling, analysis, and control, Prentice Hall.

SUGGESTED WEBSITES

1. http://swayam.gov.in
2. https://nptel.ac.in/

INSTRUCTIONAL STRATEGY

The teachers may encourage students to perform practical simultaneously for better understanding of the subjects and verification of theoretical concepts. The various components must be shown to the students for identification and also tested. Practical applications of the various circuits and devices should be discussed in the class. This subject contains five units each having equal weightage in terms of contact hours and marks distribution.

5.4 POWER SYSTEM

L	P
3	4

RATIONALE

The majority of the diploma 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. It is crucial for them to stay updated on the latest developments and practices in the electricity departments, corporations, and boards in order to stay informed about modern techniques and advancements in the transmission and distribution of electrical power.

COURSE OUTCOMES

After undergoing the subject, students will be able to:

CO1: Interpret the operation of Generation, transmission and distribution of electrical system.

CO2: Identify various components & know their functions.

CO3: Calculate different parameter of transmission system.

CO4: Understand Tariff and the various methods to improve power factor.

DETAILED CONTENTS

UNIT I

Power Generation

1.1 Different types of Power Generation: Working operation of thermal power plant, diesel power and nuclear power plant. Comparison of the generating stations on the basis of running cost, site, starting, maintenance etc.

1.2 Economics of Generation: Fixed and running cost, load estimation, load curves, demand factor, load factor, diversity factor, power factor and their effect on cost of generation. Base load and peak load power stations

1.3 Power Grid: Inter-connection of power stations and its advantages, concept of regional and national grid.

UNIT II

Transmission Systems

2.1 Introduction: Classification of transmission lines, selection of voltage for H.T and L.T lines, advantages of high voltage for Transmission AC and DC, Introduction to 765kV and 1200 kV lines (HVAC & HVDC). Comparison of AC versus DC for power transmission.

2.2 Constructional and Mechanical Features: Types of conductors-Copper, Aluminum: Solid, stranded. Bundle conductors and Transposition of conductor. Line supports: Requirements, types of line structures. Line insulators – requirements, types, Failure of insulator. String efficiency, methods of improving string efficiency. Earth wire and their accessories. Importance of sag, calculation of sag, effects of wind and ice. Indian electricity rules pertaining to clearance.

2.3 Electrical Features: Voltage regulation, Concept of corona, effects of corona and remedial measures, Skin effect, proximity effect and Ferranti effect, Transmission line losses.

2.4 Concept of Load dispatch Centre.

UNIT III

Distribution System

3.1 Overhead AC Distribution system: Layout of HT and LT distribution system, constructional feature of distribution lines and their erection. Feeder, distributor and Service mains. Types of different distribution schemes. Advantages, disadvantages and applications of different distribution schemes.

3.2 Underground Distribution system**:** Comparison of underground system with overhead system. Constructional features of LT (400 V), HT (11 kV) underground cables. Faults in Underground Cable, determination of fault location by Blavier Test, Murray Loop Test, Varley Loop Test.

UNIT IV

Sub Stations

4.1 Classification of substation, selection & location of site, Equipment's used in substation, Layout of 33kV/11kV and 11kV/400Vdistribution substation and various auxiliaries and equipment associated with it.

4.2 Brief introduction to Gas Insulated Substation.

UNIT V

Tariff and Power factor

5.1 Tariff: Types of tariff & characteristics, Types of consumers & their tariff.

5.2 Power Factor: Concept of Power factor and its significance. Causes of low power factor, Methods of p.f. improvements, Economics of p.f. improvements.

LIST OF PRACTICALS

1. To measure earth resistance with the help of earth resistance tester.
2. To study different types of line insulators, line support.
3. Visit a power generation plant to study its major parts, working and prepare detail report.
4. Visit a 400kV/220kV/132kV transmission line and make list of all components viz line supports, conductors, insulators and other accessories and prepare detail report.
5. Visit to a 66kV/33kV/11kV/415V/230V distribution line make list of all components viz line supports, conductors, insulators and other accessories and preparing detail report.
6. To determine experimentally flash over voltage of transformer oil and hence determine the dielectric strength.
7. To measure the rating of capacitor bank installed in a sub-station for improving power factor.
8. Study of Indian Electricity rules as per BIS standard related to clearance of overhead transmission and distribution lines.
9. Draw a layout diagram of 11kV/400V substation installed in the campus and make list of all accessories.
10. To find fault in underground cables by Murray Loop Test/ Varley Loop Test.
11. Study of data related to conductors of different sizes/types for overhead lines as per IS 398.
12. Visit to a distribution substation to study layout of major components and types of Feeders, Distributors and Service Mains and prepare detailed report.

RECOMMENDED BOOKS

1. Electrical Power System and Analysis by C L 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–I by S K Sahdev, Uneek Publications, Jalandhar.
4. Electrical Power System by V K Mehta, S Chand and Co., New Delhi.

5. Electrical Power System by J B Gupta, S K Kataria and Sons, New Delhi.
6. Sub-Station Design by Satnam, Dhanpat Rai and Co., New Delhi.
7. Electrical Power Distribution System by AS Pabla, Tata Mc Graw Hill, New Delhi.
8. Electrical Power System by S Channi Singh, Tata Mc Graw Publishing Co. New Delhi.
9. E-books/e-tools/ relevant software to be used as recommended by AICTE/HSBTE/NITTTR.

SUGGESTED WEBSITES

1. http://swayam.gov.in
2. https://nptel.ac.in/

INSTRUCTIONAL STRATEGY

Since this is a descriptive and practice oriented subject, it is suggested that visits to different types of power generating stations and substations including grid stations and load dispatch center be arranged and various equipment, accessories and components explained to the students before the actual class room teaching and make them familiar with the equipment and accessories installed over there and The students may be asked to prepare notes while on visit and submit the report and give seminar. In addition to Show actual insulators/ sample of cables/connectors in the classroom, Show charts/slides/photos/video films depicting different types of transmission lines, substations and their components and Give them some field-based and internet based projects. This subject contains five units each having equal weightage in terms of contact hours and marks distribution.

5.5 MULTI-DISCIPLINARY ELECTIVE

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RATIONALE

Multidisciplinary electives are very important and play major role in implementation of National Education Policy. Multidisciplinary is a subject which is useful for two or more disciplines in whichstudents are asked to understand the concept of multidisciplinary or interdisciplinary. It will help the students to gain an arsenal of skills that are easily transferable across work environments.

COURSE OUTCOMES

At the end of the multidisciplinary elective, the students will be able to:

CO1: Apply critical thinking in problem solving.
CO2: Demonstrate self and time management.
CO3: Display analytical and research abilities.
CO4: Integrate multiple knowledge domains.
CO5: Enhance the scope and depth of learning.

LIST OF MULTIDISCIPLINARY ELECTIVES

(The list is indicative and not exhaustive)

1. Introduction to Internet of Things
2. Introduction to Robotics
3. Introduction to Embedded System Design
4. Fundamentals of Artificial Intelligence
5. Digital Image Processing
6. Introduction to Machine Learning
7. Block Chain
8. The Joy of Computing Using Python
9. Cloud Computing
10. Introduction to Industry 4.0
11. Industrial Internet of Things
12. Object Oriented System Development using UML, Java and Patterns

GUIDELINES

Multidisciplinary Elective shall be offered preferably in online mode. Online mode multidisciplinaryelective shall preferably be through Massive Open Online Courses (MOOCs) from Swayam, NPTEL,Upgrad, Udemy, KhanAcademy or any other online portal to promote self-learning. A flexible basketof large number of multidisciplinary electives is suggested which can be modified depending upon the availability of courses at suggested portals and requirements. For online multidisciplinaryelectives, department coordinators shall be assigned to monitor and guide the group of students for selection of minimum 20 hours duration online course of their choice. For offline multidisciplinary electives, a suitable relevant subject shall be offered by the respective department to the students withminimum 40% of the total class strength as per present and future requirements.

Assessment of MOOCs multidisciplinary elective shall be based on continuous evaluation by the respective coordinator. The coordinator shall consider the submitted assignments by the students fromtime to time during the conduct of MOOCs. The MOOCs assessment shall be conducted by the coordinator along with one external expert by considering submitted assignments out of 100 marks.

In case, no suitable multidisciplinary elective is available online, only then the course may be conducted in offlinemode. The assessment of offline multidisciplinary elective shall be internal and external. The offline multidisciplinary elective internal assessment of 40 marks shall be based on internal sessional tests, assignments etc. and external assessment of 60 marks shall be based on external examination at institute level.

SUGGESTED WEBSITES

1. https://swayam.gov.in/
2. https://www.udemy.com/
3. https://www.upgrad.com/
4. https://www.khanacademy.org/

5.6 PROGRAMME ELECTIVE-I

5.6.1 SOLAR PANEL INSTALLATION AND MAINTENANCE

L	P
3	-

RATIONALE

To train the students of diploma for checking the installation site, understands the layout requirement as per design, assesses precautionary measures to be taken, installs the solar panel as per customer's requirement and ensures effective functioning of the system post installation and Know the safety measures during installation of PV system and also understand the maintenance and troubleshooting of PV system.

COURSE OUTCOMES

After undergoing the subject, students will be able to:

CO1: Acquire knowledge of site assessment tools, installation tools and safety tools.
CO2: Detail components used in PV system and their selection and installation.
CO3: Apply safety measures during installation and maintenance of PV system.
CO4: Handle the maintenance and troubleshooting of PV system.

DETAILED CONTENT

UNIT I
INTRODUCTION TO PHOTOVOLTAIC (PV)

1.1 Basic of PV system: Photo voltaic effect, PV Cell, PV panel, PV module, PV Arrays, Photovoltaic I-V Characteristics Curves, conversion efficiency.
1.2 Selection of Site: Site assessment tools, Site Location, Climate Condition, Solar Irradiance, Solar Insolation, Sun Angle and PV Orientation, Shading analysis.
1.3 Tilt angle and its significance in solar panel orientation.

UNIT II
COMPONENTS OF PV SYSTEM

2.1 PV Module: Series and Parallel connection of PV.
2.2 Charger Controller: Function, type of charge controller.

2.3 Inverter: Function, power ratings.

2.4 Storage Battery: Battery parameters, battery bank, types of batteries used in solar system.

2.5 PV Mounting Structure: Roof mounted and ground mounted Structure.

2.6 Balance of Systems: Disconnecting switches, wires and cables, combiner boxes, net meter, protection devices, earthing and grounding, Solar tracking systems etc.

UNIT III

SOLAR PV SYSTEM INSTALLATION

3.1 Installation Tool: Hand tool ,wire strippers, crimping tools, bolts, nuts, and washers, Leveling tools, ground anchors, multimeter, clamp on meter, non-contact thermometer, angle finder etc.

3.2 Types of Solar PV System: Standalone PV system, On Grid system, Off Grid system and Hybrid PV system, Comparison of Different types of PV system.

3.3 Design Methodology for SPV system: Calculation of load, Size of solar panel, Battery sizing, Selection of inverter, Size of charge controller, Cable sizing etc

3.4 Connection of PV system components.

UNIT IV

SAFETY DURING PV INSTALLATION

4.1 Operating Hazardous Tools and Equipment: Personal protective equipment (PPE), Fall protection equipment/tools, Fire protection equipment.

4.2 Safety of PV system: PV module safety, Electrical Safety, Battery safety.

4.3 Marking and Labeling of PV components.

UNIT V

MAINTENANCE AND TROUBLESHOOTING:

5.1 Maintenance of Solar PV system.

5.2 Maintenance of Battery.

5.3 Installation and Troubleshooting of Solar PV system.

RECOMMENDED BOOKS

1. D. Yogi Goswami, Frank Kreith, Jan. F. Kreider, “Principles of Solar Engineering”, Taylor & Francis, 2000, Indian reprint, 20032.
2. Edward E. Anderson, “Fundamentals for solar energy conversion”, Addison Wesley Publ. Co., 1983.
3. L. Ashok kumar ,K. Mohana Sundaram, ‘‘Solar PV System: Design, Installation, Operation and

Maintenance'', Nova Science publisher.
4. Solanki, Chetan Singh, ''Solar Photovoltaics: Fundamentals, Technologies and Applications'', PHI Learning, New Delhi.
5. Solanki, Chetan Singh, ''Solar Photovoltaic Technology and Systems - A Manual for Technicians, Trainers and Engineers'', PHI Learning, New Delhi.
6. D. Mukherjee, ''Fundamentals of Renewable Energy'', New Age International Publishers.
7. Joe Roberts , ''Solar Panel Installation and Maintenance Guide''.

SUGGESTED WEBSITES

1. http://swayam.gov.in
2. https://nptel.ac.in/

INSTRUCTIONAL STATREGY

Teachers should lay emphasis on concepts and principles while imparting instructions. As far possible, students should be given opportunities to visit PV installation plant and practical understand the concept of PV installation procedure, connection and their maintenance schedule. This subject contains five units each having equal weightage in terms of contact hours and marks distribution.

5.6.2 ELECTRICAL TRACTION SYSTEM

L	P
3	-

RATIONAL

The country is leading towards the railway electrification. It is a need for the diploma student to know about the electric traction scheme as it is an open field of job opportunity. The subject is classified as elective course, with a view to give exhaustive coverage to electric traction along with the environmental impact as well as bulk transportation boost. The content gives the better coverage of subject in traction systems, auxiliary equipment, electric locomotives, control of traction motors and future-trends.

COURSE OUTCOMES

After undergoing the subject, students will be able to:

CO1: Identify different traction systems.

CO2: Differentiate speed time curve of different services of traction system.

CO3: Detail the traction system auxiliaries.

CO4: Apply various speed control methods applicable to traction motors

DETAILED CONTENT

UNIT I

Basics of Traction System

1.1 General description of Traction system in India.

1.2 Electric Traction Systems: Types, Advantages and disadvantages over other traction system.

1.3 Track electrification: DC System, composite system –single phase to three phase system and single phase AC to DC system (Kando system).

1.4 Advantages and disadvantages of single phase 25 KV AC system over DC system.

UNIT II

Mechanics of Traction

2.1 Types of services – urban, sub-urban, and main line.

2.2 Speed-time curves, Average speed and schedule speed of different types of traction service.

2.3 Factors affecting the schedule speed.

UNIT III

Traction Motors and Control

3.1 Desirable characteristics and Special features of traction motors.

3.2 Suitability of DC series motor, three phase Induction motor for traction.

3.3 Traction motor Control of DC locomotives and EMUs: series parallel control combined with rheostatic control, energy efficiency and limitations of series parallel cum rheostatic control, chopper control of motors in DC traction systems.

3.4 Traction control system of AC locomotives: Tap changer, step less voltage control through use of thyristors.

UNIT IV

Braking System

Requirement of a braking system.

4.1 Mechanical braking: vacuum braking, compressed air braking, hand brake for parking.

4.2 Electric braking: Rheostatic braking and regenerative braking.

UNIT V

Electric Traction Auxiliary Equipment

5.1 Overhead catenary wire.

5.2 Conductor rail system.

5.3 Current collector-pentagraph.

5.4 Coach wiring and lighting devices.

RECOMMENDED BOOKS

1. J. Upadhyay S. N. Mahendra Electric Traction Allied Publishers Ltd.
2. G. C. Garg Utilisation of Electric Power & Electric Traction, Khanna Publishers Co., New Delhi.

3. Om Prakash Kesari Vidyut Engine Parichay (In Hindi) S. P. Graphics, Nashik.
4. J. B. Gupta Utilisation of Electric Power & Electric Traction, S. K. Kataria & Sons.
5. Partab H., Dhanpat Rai and Co, Modern Electric Traction.

SUGGESTED WEBSITES

1. http://swayam.gov.in
2. https://nptel.ac.in/

INSTRUCTIONAL STRATEGIES

Teachers should lay emphasis on concepts and principles while imparting instructions. As far possible, students should be given opportunities to visit nearby locomotive, Show video/animation films to explain functioning of traction motor. The teacher should conduct group Discussion on various topics and get updated with latest trends in traction. This subject contains five units each having equal weightage in terms of contact hours and marks distribution.

5.7 MINOR PROJECT

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RATIONALE

Minor project work will help in developing the relevant skills among the students as per National Skill Qualification Framework. It aims at exposing the students to the present and future needs of various relevant industries. It is expected from the students to get familiar with industrial environment. For this purpose, students are required to be involved in Minor Project Work related to different in different establishments.

COURSE OUTCOMES

After undergoing this course, the students will be able to:

CO1: Define the problem statement of the minor project according to the need of industry.
CO2: Work as a team member for successful completion of minor project.
CO3: Write the minor project report effectively.
CO4: Present the minor project report using PPT.

GUIDELINES

Depending upon the interests of the students and location of the organization the student may be asked to visit. Depending upon the interest of the students, they can develop minor projects as per present and future demand of the relevant industry. The supervisors may guide the students to identify their minor project work and chalk out their plan of action well in advance. As a minor project activity each student is supposed to study the operations at site and prepare a detailed project report of the observations/processes/activities. The supervisor may create a group of 4 to 5 students as per their interest to work as a team for successful completion of the minor project.

The supervisor shall evaluate the students along with one external expert by considering the following parameters:

	Parameter	**Weightage**
i	Defining problem statement, focus and approach	20%
ii	Innovation / creativity	20%
iii	Report Writing	20%
iv	Power Point Presentation	20%
v	Viva - voce	20%

SIXTH SEMESTER

6.1	Power System Protection	158-161
6.2	Entrepreneurship Development & Management	162-164
6.3	Installation and Maintenance of Electrical Equipment	165-168
6.4	Energy Conservation and Audit	169-171
6.5	Programme Elective-II	172-177
6.6	Major Project / Industrial Training	178-179

6.1 POWER SYSTEM PROTECTION

L	P
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RATIONALE

In view of the complexities associated with the modern interconnected power stations, the responsibilities and the job requirements of a diploma passout have become more complex than what they used to be earlier. He is required to work with modern electrical equipment and maintain reliability of supply. The course is designed to understand the concepts, principles involved in the construction and working of generating stations and protective switch gear system so that one can handle, install, maintain them and also take decisions at his/her level in different situations. The teaching of this subject requires reinforcement in the form of visits to substations, power stations and well designed laboratory experiences. A practice-oriented approach to the teaching of this subject is suggested.

COURSE OUTCOMES

After undergoing the subject, the student will be able to:

CO1: Identify various types of faults in power system.
CO2: Select suitable switchgears for different applications.
CO3: Test the performance of different protective relays.
CO4: Apply different protection schemes in power system.

DETAILED CONTENTS

UNIT 1

Faults

1.1 Common type of faults in both overhead and underground systems.
1.2 Types of Symmetrical faults: Three phases to ground and Three Phase fault.
1.3 Types of Unsymmetrical faults: Line to line fault, Single line to ground fault, double line to ground fault, Line to line and third line to ground fault.

UNIT II

Switchgears

2.1 Definition of switchgear, Purpose of switchgear. Function of, switch, fuse, isolator and circuit breaker. Difference between fuse and circuit breaker.

2.2 Circuit Breaker: Operating principle of circuit breaker. Arc phenomenon. Methods of Arc extinction. Definition of Arc voltage, Restriking and Recovery voltage, Rate of rise of restriking voltage (RRRV). Rating of Circuit breakers: making capacity, breaking capacity, short time capacity.

2.3 Types of Circuit Breakers: Constructional and working of Oil circuit breakers, Air Blast Circuit Breaker, SF_6 circuit breakers, VCB.

UNIT III

Protection Devices

3.1 Fuses: Properties and Characteristics of fuse, Types of Fuse: HV and LV fuses, rewire-able, cartridge, HRC.

3.2 Earthing: Purpose of earthing, method of earthing, Equipment earthing, Substation earthing, Methods of reducing earth resistance.

3.3 Basic relay terminology- Protective relay, Relay time, Pick up, Reset current, current setting, Plug setting multiplier, Time setting multiplier.

3.4 Protective relays: Classification, principle of working, construction and operation of – Electromagnetic (Attracted armature type, Induction) relay, Thermal relay. Block diagram and working of Static relay.

i. Over-current relay: Principle, operation of instantaneous over current relay, Inverse definite minimum time (IDMT) over current relay.
ii. Directional over-current: operation of Directional over-current.
iii. Differential relay: operation of Differential relay.
iv. Distance relays: Impedance relay, mho relay.

UNIT IV

Protection scheme

4.1 Protection for Alternator: Differential protection over current, Earth fault protection scheme.

4.2 Protection for transformer: Buchholz protection scheme, differential protection scheme.

4.3 Protection for Feeder and transmission line - time graded and over current protection, current graded system, differential protection**.**

UNIT V

Over-Voltage Protection

5.1 Causes of over voltages: Internal and external causes, types of lighting strokes.

5.2 Protection against Overvoltage and Lightning: ground wire, earthing screen, surge diverters or lightning arresters.

5.3 Types of Lightning arresters: rod gap, horn gap, metal oxide type.

PRACTICAL EXERCISES

1. Identify various switchgears installed in the laboratory and write their specifications.
2. Test HRC fuse by performing the load test.
3. Perform the overload and short circuit test of MCB as per IS specifications.
4. Plot the time-current characteristics of Kit-Kat fuse wire.
5. Perform Earthing of different equipment installed in the institute viz Motors, Generators, Energy Meter, Main Distribution Board and Energy Meter Box.
6. Plot the time current characteristics of over current relay.
7. To write down specifications of Lightning arrestors installed in a substation.
8. Power measurement by using CTs and PTs.
9. Measurement of current on any LT line with clip meter.
10. Study of different types of circuit breakers and isolators by visiting power station and to prepare detailed report.
11. Prepare charts on different Generating stations in our state mentioning their locations.
12. Students may be taken to various Sub-stations/Grid Stations for study the differential protection of transformer.

RECOMMENDED BOOKS

1. Testing, Commissioning, Operation and Maintenance of Electrical Equipment by S Rao , Khanna Technical Publication, New Delhi.
2. Electrical Power–II by S K Sahdev ,Uneek Publications, Jalandhar (Pb).
3. Electrical Power Systems by C L Wadhwa ,Wiley Eastern Ltd., New Delhi.
4. Text book of Electrical Technology by B L Theraja ,S Chand and Co., New Delhi.
5. Electrical Power by Dr. S L Uppal ,Khanna Publications , Delhi.

6. A Course in Electrical Power by M L Soni, P V Gupta and Bhatnagar, Dhanpat Rai & Sons, New Delhi.
7. Principles of Power Systems by V K Mehta, S Chand and Co.,New Delhi.
8. Preventive Maintenance of Electrical Apparatus by S K Sharotri, Katson Publishing House, Ludhiana.
9. e-books /e-tools/ relevant software to be used as recommended by AICTE/HSBTE/NITTTR.

SUGGESTED WEBSITES

1. http://swayam.gov.in
2. https://nptel.ac.in/

INSTRUCTIONAL STRATEGY

Since this is a descriptive and practice oriented subject, it is suggested that visits to different types of generating stations and substations be arranged and various equipment, accessories and components explained to the students. The protection schemes should be shown at the site and engineers from field may be invited for delivering expert lectures on these topics. Help of Video Films may be taken to explain the layout; construction and working of different power equipment. This subject contains five units each having equal weightage in terms of contact hours and marks distribution.

6.2ENTREPRENEURSHIP DEVELOPMENT AND MANAGEMENT

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RATIONALE

In the present day scenario, it has become imperative to impart entrepreneurship and management concepts to students so that a significant percentage of them can be directed towards setting up and managing their own small enterprises. This subject focuses on imparting the necessary competencies and skills of enterprise set up and its management.

COURSE OUTCOMES

After undergoing the subject, the students will be able to:

CO1: Comprehend the importance of entrepreneurship and its role in nation's development.

CO2: Classify the various types of business and business organizations.

CO3: Identify the various resources / sources and / or schemes for starting a new venture.

CO4: Explain the principles of management including its functions in an organisation.

CO5: Conduct market survey and prepare project report.

DETAILED CONTENTS

UNIT I

Entrepreneurship: Concept and definitions, classification and types of entrepreneurs, entrepreneurial competencies, Traits / Qualities of entrepreneurs, manager v/s entrepreneur, role of Entrepreneur, barriers in entrepreneurship, Sole proprietorship and partnership forms of business organisations, small business vs startup, critical components for establishing a start-up, Leadership: Definition and Need, Manager Vs leader, Types of leadership

UNIT II

Definition of MSME (micro, small and medium enterprises), significant provisions of MSME Act, importance of feasibility studies, technical, marketing and finance related problems faced bynew enterprises, major labor issues in MSMEs and its related laws, Obtaining financial assistance

through various government schemes like Prime Minister Employment Generation. Program (PMEGP) Pradhan Mantri Mudra Yogna (PMMY) , Make in India, Start up India, Stand up India National Urban Livelihood Mission (NULM); Schemes of assistance by entrepreneurial support agencies at National, State, District level: NSIC, NRDC, DC:MSME, SIDBI, NABARD, Commercial Banks, SFC's TCO, KVIB, DIC, Technology Business Incubator (TBI) and Science and Technology Entrepreneur Parks (STEP).

UNIT III

NATURE AND FUNCTIONS OF MANAGEMENT: Definition, Nature of Management, Management as a Process, Management as Science and Art, Management Functions, Management and Administration, Managerial Skills, Levels of Management; Leadership.

PLANNING AND DECISION MAKING: Planning and Forecasting - Meaning and definition, Features, Steps in Planning Process, Approaches, Principles, Importance, Advantages and Disadvantages of Planning, Types of Plans, Types of Planning, Management by Objective. Decision Making-Meaning, Characteristics.

UNIT IV

ORGANISING AND ORGANISATION STRUCTURE: Organising Process - Meaning and Definition, Characteristics Process, Need and Importance, Principles, Span of Management,Organisational Chart - Types, Contents, Uses, Limitations, Factors Affecting Organisational Chart.

STAFFING: Meaning, Nature, Importance, Staffing process. Manpower Planning, Recruitment, Selection, Orientation and Placement, Training, Remuneration.

CONTROLLING AND CO-ORDINATION Controlling - Meaning, Features, Importance, Control Process, Characteristics of an effective control system, Types of Control. Co-ordination -characteristics, essentials.

UNIT V

Market Survey and Opportunity Identification, Scanning of business environment, Assessment ofdemand and supply in potential areas of growth, Project report Preparation, Detailed project report including technical, economic and market feasibility, Common errors in project report preparations, Exercises on preparation of project report.

RECOMMENDED BOOKS

1. BS Rathore and Dr JS Saini, "A Handbook of Entrepreneurship", Aapga Publications,Panchkula (Haryana).
2. Entrepreneurship Development, Tata McGraw Hill Publishing Company Ltd., New Delhi.
3. CB Gupta and P Srinivasan, "Entrepreneurship Development in India", Sultan Chand andSons, New Delhi.
4. Poornima M Charantimath,"Entrepreneurship Development – Small Business Enterprises", Pearson Education, New Delhi.
5. David H Holt, "Entrepreneurship: New Venture Creation", Prentice Hall of India Pvt.Ltd., New Delhi.
6. PM Bhandari, "Handbook of Small Scale Industry".
7. L M Prasad, "Principles and Practice of Management", Sultan Chand & Sons, NewDelhi.

SUGGESTED WEBSITES

1. https://ipindia.gov.in/

INSTRUCTIONAL STRATEGY

Some of the topics may be taught using question/answer, assignment or seminar method. The teacher will discuss stories and case studies with students, which in turn will develop appropriate managerial and entrepreneurial qualities in the students. In addition, expert lecturers may also be arranged from outside experts and students may be taken to nearby industrial organisations on visit. Approach extracted reading and handouts may be provided. In addition, different activities like conduct of entrepreneurship awareness camp extension lecturers by outside experts, interactions sessions with entrepreneurs and industrial visits may also be organised. This subject contains five units of equal weightage.

6.3 INSTALLATION AND MAINTENANCE OF ELECTRICAL EQUIPMENT

L	P
2	2

RATIONALE

Electrical Power system consists of a number of transformers, circuit breakers and other equipment which require installation, commissioning and regular maintenance to prevent permanent break down. Many times an engineering diploma holder has to carryout/supervises installation, commissioning and maintenance of various electrical equipment in power stations, substations and industry. This course will enable the diploma pass out student to understand the concepts, principles and acquire basic skills of installation, commissioning and maintenance of electrical equipment in power stations, substations and industry.

COURSE OUTCOMES

After undergoing the subject, the students will be able to:

CO1: Use tools/instruments for installation and maintenance
CO2: Apply electrical safety regulations and rules during maintenance.
CO3: Illustrate various commissioning test on transmission line, underground cable and electrical machines
CO4**:** Prepare the maintenance schedule of transmission line, underground cable and electrical machines.

DETAILED CONTENTS

UNIT I

Tools and Accessories for Installation and Maintenance

1.1 Tools: Tools, accessories and instruments required for installation, maintenance and repair work. Workmen's safety devices. Underground cable handling equipment. using fire extinguisher for safety against fire.

1.2 IER rules: Knowledge of Indian Electricity rules, safety codes, causes and prevention of accidents. Meaning of Authorized persons, anti-climbing devices and danger plates, caution notice. Clearances rules for crossing of transmission and distribution line to roads, streets, power/telecommunication lines, river and railway line.

1.3 Necessity of Maintenance, Types of maintenance.

UNIT II

Installation and maintenance of transmission and Distribution lines

2.1 Installation of Line: Method of erection of steel structures and pole support. Connection of jumpers, tee-off points, joints and dead ends. Earthing of transmission lines and guarding. Arrangement for different types of insulators. Installation and use of Bird guards, earth wire and guy wires. Laying of service lines, provision of service fuses, installation of energy meters.

2.2 Maintenance of Line: Patrolling and visual inspection of lines, special inspections and night inspections. Permit to work, arranging of shut downs personally, temporary earthing, cancellation of permit and restoration of supply. Maintenance schedule of busbars, isolating switches, Relays, circuit breakers, LT switches.

UNIT III

Installation and Maintenance of Underground Cables

3.1 Installation of Cable: Inspection, storage, transportation and handling of cables. Clearances from other department such as Municipal, Highway authorities, railway, etc. Different methods of laying cable. Introduction to Cable filling compounds, Epoxy resin and hardeners.

3.2 Maintenance of Cable: Cable jointing and termination.

UNIT IV

Installation and Maintenance of Electrical Machine

4.1 Installation of Machine: Inspection and handling of transformers and motors. Installation of power and distribution transformers. Installation of CT and PT. Dehydration of Transformer.

4.2 Maintenance of Machine: Preventive Maintenance schedule of transformer below and above 1000KVA. Maintenance schedule of CT and PT. Preventive Maintenance schedule of motors, over hauling of motors, trouble shooting of electric motors.

UNIT V

Testing and Commissioning of Electrical Equipment

5.1 Testing of insulator.

5.2 Testing of transmission and distribution line before commissioning.

5.3 Testing of electrical motor.

5.4 Testing of transformers.

PRACTICAL EXERCISES

1. Write IE rules related to safety and demonstrate the steps taken when a person comes in contact with a live wire.
2. Study of tools, accessories and instruments required during installation, maintenance and repair of electrical equipment.
3. Study the steps required for erection of steel structure along with connection of all accessories viz. jumpers, tee points, insulators, joints etc. during installation of a transmission line.
4. Measure insulation resistance of Three-phase PVC cable in a distribution board.
5. Study of steps required for erection of distribution line along with connection of all accessories viz. jumpers, tee points, insulators, joints etc. during installation of a distribution line.
6. Study of tests done at the time of commissioning of transmission and distribution line as per IS standards.
7. Prepare list of all electrical accessories required for installation of Pole mounted substation, Plinth mounted substation.
8. Study of various pre-installation tests as per IS standard done on following electrical equipment viz Electrical motors, Electrical Generators, Transformers and Underground cables.
9. Study of various pre-commissioning tests as per IS standard done on following electrical equipment viz Electrical motors, Electrical Generators, Transformers and Underground cables.
10. Prepare maintenance schedule of Power transformer.
11. Prepare maintenance schedule of Distribution Transformer.
12. Prepare maintenance schedule of Motors.

RECOMMENDED BOOKS

1. Testing, Commissioning, Operation and Maintenance of Electrical Equipment by S Rao, Khanna Technical Publication, New Delhi.
2. Preventive Maintenance of Electrical Apparatus by S K Sharotri ,Katson Publishing House , Ludhiana.
3. Installation and Maintenance of Electrical Equipment by Praveen Kumar, North Publication , Jalandhar.

4. Installation, Maintenance and Repair of Electrical Machines and Equipment by Madhvi Gupta, KATSON Publication.
5. Electrical Workshop Practices by Dr. Umesh Rathore & Naresh K. Sharma, KATSON Publication New-Delhi.
6. A Course in Electrical Installation, Estimating & Costing by J. B. Gupta, KATSON Publication.
7. Electrical Installations work by T.G. Ffancist. E.L.B.S (Vth metric edition) .
8. Preventive maintenance Electrical equipment by Charies J Hurburt. 4. Commission of Electrical plant by RCH Richardson.
9. Electrical Maintenance & Repair by J.I. Watts. Mc Millars London.
10. Troubles in Electrical Equipments by N.E. Stafford. McGraw Hills Pub.
11. A Text Book of Electrical installation work Vol.2. by R.A. Mee., Macdonald London.
12. Electrical Maintenance & Repairs by P.P.Gupta., Dhanpat Rai & Sons Pub.

SUGGESTED WEBSITES

1. http://swayam.gov.in
2. https://nptel.ac.in/

INSTRUCTIONAL STRATEGY

The lectures include interactive discussions, Q&A sessions, casual quizzes, and video sessions to help students clarify their understanding and resolve any doubts. The virtual learning environment also offers e-resources for students to utilize. Additionally, there are practical sessions aimed at developing necessary occupational skills. On occasion, students will participate in flipped classroom exercises to enhance their presentation abilities. This subject contains five units each having equal weightage in terms of contact hours and marks distribution.

6.4 ENERGY CONSERVATION AND AUDIT

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2	2

RATIONALE

The theory and practical experiences associated with energy conservation and audit subject are essential for students to develop the necessary skills and competencies to effectively contribute towards the improvement of energy saving in industries. These courses not only provide students with a deep understanding of energy conservation and auditing but also equip them with practical skills that are vital for a successful career in this field. With the increasing demand for energy and the need for sustainable practices, it is crucial for students to be well-versed in these areas, and this subject play a vital role in achieving that goal.

COURSE OUTCOMES

After undergoing this course, the students will be able to:

CO1: Implement energy conservation techniques in electrical machines.

CO2: Apply energy conservation techniques in electrical installations.

CO3: Comprehend the methodologies and techniques involved in conducting energy audits.

CO4**:** Interpret energy conservation policies in India.

DETAILED CONTENTS

UNIT I

Fundamentals of Energy Conservation

1.1 Energy Scenario: Primary and Secondary Energy, Energy demand and supply.

1.2 Introduction to Energy conservation, energy management , energy efficiency and its need

1.3 Bureau of Energy efficiency (BEE) and its Roles

1.4 Star Labelling: Need and its benefits.

UNIT II

Energy Conservation in Electrical Installation Systems

2.1 General energy saving tips in Lighting system

2.2 Energy efficiency measures in fans , water pumps, Room Air Conditioners, Refrigerators, Heaters, Blowers , Washing Machines etc

2.3 Energy conservation in Electricity Bill: concept of Electricity billing, Maximum Demand Controller kVAR Controller , Maximum demand controllers; Automatic power factor controllers (APFC)

UNIT III

Energy Conservation in Electrical Machines

3.1 General energy saving tips for transformer and AC/DC motor.

3.2 Energy efficient motor; significant features, advantages, applications and limitations

3.3 Energy efficient transformers, amorphous transformers; epoxy Resin cast transformer / Dry type of transformer.

3.4 Energy saving factors for the selection of DG system.

UNIT IV

Energy Audit of Electrical System

4.1 Energy audit : Definition, and Need of energy audit

4.2 Types of Energy audit and Instruments used for energy audit

4.3 Roles and responsibilities of energy Manager and Accountability,

4.4 Energy Audit procedure: Techniques involved in conducting energy audits, including data collection, analysis, and evaluation of energy consumption patterns.

UNIT V

Energy Conservation Act

5.1 Energy conservation Act 2001: Objectives, features and its amendments.

5.2 Salient features of Energy Conservation Building Code (ECBC): Building Envelope, Comfort System and Controls, Lighting & Controls and Electrical & Renewable Energy Systems**.**

5.3 Salient features of Eco Niwas Samhita Code (ENS)

PRACTICAL EXERCISES

1. Identify star labelled electrical apparatus and compare the data for various star ratings.
2. Study of various instrument used for energy audit
3. Use APFC unit for improvement of p. f. of electrical load.
4. Determine the reduction in power consumption by replacement of lighting system in a class room / laboratory.
5. Collect electricity bill of a residential consumer and suggest suitable means for conservation and reduction of the energy bill.

6. Prepare an energy audit report for your Institute.
7. Prepare a technical report on energy conservation act 2003.
8. Prepare a technical report on Energy Conservation Building Code (ECBC).
9. Studying the various energy conservation methods useful in power generation, transmission and distribution.
10. Visit an industry and studying various energy management systems in an industry. Further identify the various energy conservation methods useful in a particular industry.

RECOMMENDED BOOKS

1. Turner, W. C., Energy Management Handbook, Fairmount Press, 2012, ISBN 9781304520708 .
2. Sharma, K. V., Venkata seshaiah; P., Energy Management and Conservation, I K International Publishing House Pvt. Ltd; 2011 ISBN 9789381141298.
3. Singh, Sanjeev; Rathore, Umesh, Energy Management, S K Kataria &Sons, New Delhi
4. Chakrabarti, Aman, Energy Engineering And Management, e-books Kindle Edition.
5. Electric Energy Generation, Utilization and Conservation by Sivaganaraju, S; Pearson, New Delhi.
6. Electrical Power by V. K. Mehta; Khanna and Khanna Publishers, New Delhi.
7. Hand book on Energy Audit & Environmental Management by YPAi & Shashank Jain published by TERI Latest Edition.
8. Guide book on General Aspects of Energy Management and Energy Audit by Bureau of Energy Efficiency, Government of India. Edition 2015.

SUGGESTED WEBSITES

1. http://swayam.gov.in
2. https://nptel.ac.in/

INSTRUCTIONAL STRATEGY

Teachers are expected to lay considerable stress on understanding the basic concepts in energy conservation, principles and their applications. As far as possible, the teaching of the subject must be supplemented by demonstrations and practical work in the laboratory. This subject contains five units each having equal weightage in terms of contact hours and marks distribution.

6.5 PROGRAMME ELECTIVE-II
6.5.1 HVDC & FLEXIBLE AC TRANSMISSION SYSTEMS

L	P
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RATIONALE

It is of utmost importance to study High Voltage Direct Current (HVDC) and Flexible AC Transmission Systems (FACTS) in the realm of electrical engineering. As more and more renewable energy sources like wind and solar power are being incorporated into the grid, HVDC and FACTS become essential in effectively integrating these intermittent energy sources. As a result, it is imperative for diploma holders to be well-versed in HVDC and FACTS in order to overcome the challenges of energy transition and efficiently manage electrical grids.

COURSE OUTCOMES

After successful completion of the course, student will be able to

CO1: Compare HVDC and HVAC transmission systems.

CO2: Comprehend the principles of dc links, including power control, harmonics, and filters.

CO3: Familiarize with FACTS devices, their control techniques and applications.

CO4: Apply principle of Combined Controllers Compensation.

DETAILED CONTENTS

UNIT I

HVDC Transmission

1.1 Introduction to HVDC transmission

1.2 Comparison of AC and DC transmission.

1.3 Application of DC transmission system,

1.4 Equipment of HVDC transmission systems

1.5 Modern trends in D. C. transmission

UNIT II

HVDC System Control

2.1 Principles of dc link control

2.2 Types of dc Link

2.3 Starting and Stopping of dc link,

2.4 Power control

2.5 Harmonics and Filters:, Effects of Harmonics, Sources of harmonic generation, Types of filters

UNIT III

Flexible AC Transmission Systems (FACTS)

3.1 Objective and Concept of FACTS

3.2 Control of power flow in transmission lines,

3.3 Application.

UNIT IV

FACTs Controller

4.1 Need for compensation

4.2 Classification of FACTS controllers

4.3 Shunt Compensation: Objectives of shunt compensation, Methods of controllable VAR generation, Static VAr Compensator (SVC), STATCOM.

4.4 Series Compensation: Objectives of series compensation, GCSC, TSSC, TCSC and SSSC.

UNIT V

Combined Controllers Compensation

5.1 Unified Power Flow Controller: Principles of operation, comparison with other FACTS controller

5.2 Interline Power Flow Controller : Principles of operation, comparison with other FACTS controller

RECOMMENDED BOOKS

1. Narain Hingorani & Lazzlo Gyugi “Understanding FACTS. Concepts & Technology of FACTS”, Standard publishers & distributors, 2001.
2. K. R. Padiyar, “FACTS Controllers in Power Ttransmission and Distribution”, New Age International Publishers, 2007.
3. K.R.Padiyar,"HVDC Power Transmission Systems “ New Academic Science , 2017

4. S. Kamaksahiah & V. Kamaraju, “HVDC Tramission”, T^ata McGraw Hill Education Pvt Ltd. 2011.
5. K.R.Padiyar , ‘‘HVDC Power Transmission Systems –Technology and System Interactions’’, New Age International Publishers, 2017,Third edition.
6. Kimbark , ‘‘Direct Current Transmission’’, Blackwell Publishers, Vol.1, 1971.
7. Narain G. Hingorani, Laszlo Gyugyi, ‘‘Understanding FACTS –Concepts and Technology of Flexible AC Transmission Systems’’, Wiley India Pvt Ltd, 2011.
8. R. Mohan Mathur, Rajiv.K.Varma, “Thyristor Based FACTS Controllers for Electrical Transmission systems” John Wiley and Sons, 2011.
9. Jos Arrillaga, Y. H. Liu, Neville R. Watson " Flexible Power Transmission: The HVDC Options”, Wiley 2007.
10. Jos Arrillaga , ‘‘High Voltage Direct Current Transmission, Institution of Engineering and Technology’’, 1998,2nd edition.
11. Yong Hua Song, Allan T Johns Flexible, ‘‘ AC Transmission Systems’’, Institution of Engineering and Technology, 1999.

SUGGESTED WEBSITES

1. http://swayam.gov.in
2. https://nptel.ac.in/
3. HVDC Transmission: https://nptel.ac.in/courses/108/104/108104013/
4. FACTS: https://nptel.ac.in/courses/108/107/108107114/

INSTRUCTIONAL STRATEGY

Some of the topics may be taught using question/answer, assignment or seminar method /quiz/group discussion. In addition, expert lecturers may also be arranged from outside experts. The students should gather information of HVDC transmission projects in India and prepare a report. This subject contains five units each having equal weightage in terms of contact hours and marks distribution.

6.5.2 SMART GRID AND DISTRIBUTED GENRATION SYSTEM

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RATIONALE

The students will be introduced to the origins of the Indian power grid and the fundamental principles of the present-day electric power system in this course. They will also gain an understanding of the smart grid, including its architectural design, communication technology, system and stability analysis, and integration of renewable energy sources and storage.

COURSE OUTCOMES

After successful completion of the course, student will be able to

CO1: Differentiate between Conventional Grid and Smart Grid.

CO2: Knowledge of communication and measurement and data monitoring technologies in Smart Grid.

CO3: Understand the fundamentals of distributed generation and micro gird.

CO4: Apply the concept of smart grid in various applications.

DETAILED CONTENTS

UNIT 1

Introduction of Smart Grid

1.1 Conventional Grid system: Introduction, Evolution of electric Grid system, Regulatory authority in Indian Power sector.

1.2 Smart Grid system: Introduction, Need of Smart Grid, Benefits of Smart Grid, Challenges of Smart Grid, Difference between Conventional Grid and Smart Grid system, Smart Grid scenario in Indian power sector

UNIT II

Smart Grid Architecture

2.1 Components of smart grid system

2.2 Architecture of Smart Grid

2.3 function of Smart Grid components

UNIT III

Smart Grid Technology

3.1 Introduction to Communication and Measurement Technology

3.2 Smart infrastructure (smart energy system and smart information system), Smart communication, Smart management.

3.3 Smart Meter : Advanced meter Infrastructure (AMI) function and its benefits

UNIT IV

Distributed Generation System

4.1 Distributed generation (DG): Concept of distributed generation's, selection of sources, regulatory standards/ framework, Standards for interconnecting Distributed resources to electric power systems: IEEE 1547.

4.2 Overview of Microgrid : concept and definition of microgrid

4.3 SCADA: Introduction to Supervisory Control and Data Acquisition System (SCADA), Functional block diagram, Architecture of SCADA.

UNIT V

Smart grids application

5.1 Home Energy Management system

5.2 Plug in Hybrid Electric Vehicles (PHEVs)

5.3 Electrical Energy Storage Technologies

5.4 Function of SCADA in smart grid

RECOMMENDED BOOKS

1. Bakre, Dr. Shashikant, "Smart Grid", Nirali Prakashan.
2. Modi, Bharat, Anu Prakash, & Yogesh Kumar, "Fundamentals of Smart Grid Technology", S.K. Kataria & Sons.
3. Shunmugalatha, Dr. A., Dr. T. Chandrasekar, Dr. B. Ashok Kumar, J. Rajeswari, and Dr. S. Senthilrani, "Smart Grid", Technical Publication.
4. Salman, Salman K., "Introduction to the Smart Grid: Concepts, Technologies and Evolution", IET Digital Library.
5. Ekanayake, Janaka, Kithsiri Liyanage, and Jianzhong Wu, "Smart Grid: Technology and Applications", John Wiley & Sons.
6. S. Borlase, ''Smart Grids Infrastructure Technology and Solutions'', CRC Press, 2013, 1st Edition.
7. G. Masters, ''Renewable and Efficient Electric Power System'', Wiley–IEEE Press, 2013, 2nd Edition.

8. J. Momoh , ‘‘Smart Grid: Fundamentals of Design and Analysis’’ , Wiley-IEEE Press, 2012, 1st Edition.
9. S. K. Salman , ‘‘Introduction to the Smart Grid: Concepts, Technologies and Evolution’’, IET Energy Engineering Series, 2017, 1st Edition.
10. Mini S Thomas and J. D MacDonald, ‘‘Power System SCADA and Smart Grid’’ , CRC Press, 2015, 1st Edition.
11. D. Mah, P. Hills, Victor O.K. Li, R. Balme , ‘‘Smart Grid Applications and Developments’’ , Springer-Verlag London, 2014, 1st Edition.
12. Ali Keyhani, ‘‘Design of smart power grid renewable energy systems’’, Wiley IEEE, 2016, 2nd Edition.

SUGGESTED WEBSITES

1. http://swayam.gov.in
2. https://nptel.ac.in/

INSTRUCTIONAL STRATEGY

Some of the topics may be taught using question/answer, assignment or seminar method /quiz/group discussion. In addition, expert lecturers may also be arranged from outside experts. Watch YouTube videos on SMART GRID and MICRO GRID and prepare a summary report
This subject contains five units each having equal weightage in terms of contact hours and marks distribution.

6.6 MAJOR PROJECT / INDUSTRIAL TRAINING

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RATIONALE

Industrial Training/Major project work will help in developing the relevant skills among the students as per National Skill Qualification Framework. It aims at exposing the students to the present and future needs of various relevant industries. It is expected from the students to get acquainted with desired attributes for industrial environment. For this purpose, students are required to be involved in industrial training / Major Project Work in different establishments.

COURSE OUTCOMES

After undergoing this course, the students will be able to:

CO1: Define the problem statement of the Industrial training / Major project according to theneed of industry.
CO2: Work as a team member for successful completion of Industrial training / Major project.
CO3: Write the Training / Major project report effectively.
CO4: Present the Training / Major project report using PPT.

GUIDELINES

Depending upon the interest of the students, they can go for Industrial training / Major project as per present and future demand of the industry. The supervisors may guide the students to identifytheir project work and chalk out their plan of action well in advance. As an Industrial training / Major project activity each student is supposed to study the operations at site and prepare a detailed project report of the observations/processes/activities. The supervisor may create agroup of 4-5 students as per their interest to work as a team for successful completion of the Industrial training / Major Project.

The supervisor shall evaluate the students along with one external industry / academic expert byconsidering the following parameters:

	Parameter	**Weightage**
i	Defining problem statement, focus and approach	20%
ii	Innovation / creativity	20%
iii	Report Writing	20%
iv	Power Point Presentation	20%
v	Viva - voce	20%

24. ASSESMENT TOOLS AND CRITERION

The assessment is carried out by conducting:

1. Formative assessments
2. Summative assessments

1. FORMATIVE ASSESSEMENT

The **formative assessment** will be evaluated on the basis of the internal assessments for theory subjects and practical by the concerned teachers for evaluating the knowledge and skill acquired by students and the behavioral transformation of the students. This **internal assessment** is primarily carried out by collecting evidence of competence gained by the students by evaluating them at work based on assessment criteria, asking questions and initiating formative discussions to assess understanding and by evaluating records and reports, and sessional marks are awarded to them.

2. SUMMATIVE ASSESSMENT

The **summative assessment** will include end semester examination for theory part for each candidate and practical examination with viva voice. Each Performance Criteria will be assigned marks proportional to its importance and proportion of marks for Theory and Skills Practical for each subject should be laid down.

The following assessment tools are used for effective student evaluation:

1. Theory Examinations
2. Practical Work
3. Internships
4. Professional Industrial Training
5. Project Work (Minor & Major)
6. Massive Open Online Courses (MOOCs)
7. Viva Voce
8. Case Studies

1. Theory

Evaluation in theory aims at assessing students' understanding of concepts, principles and procedures related to a course/subject, and their ability to apply learnt principles and solve problems.

The **formative evaluation** for theory subjects may be caused through

i. Sessional /class-tests,
ii. Quizzes,
iii. Assignments,
iv. Seminars/ Presentations
v. Attendance
vi. Case Studies

For **Summative evaluation** of theory, the question paper may comprise of three sections.

i. It should contain objective type question and multiple choice questions. The objective type items should be used to evaluate students' performance in knowledge, comprehension and at the most application domains only.
ii. It should contain short answer questions.
iii. Descriptive type questions , with some internal choice of the questions set may be given in this section

2. Practical Assessment

Evaluation of students performance in practical work (Laboratory experiments, Workshop practical /field exercises) aims at assessing students ability to apply or practice the concepts, principles and procedures, manipulative skills, ability to observe and record, ability to interpret and draw conclusions and work related attitudes. This will comprise of a creation of mock environment, wherever applicable in the skill lab which is equipped with all required equipment for development of desired skills. Candidate's soft skills, communication, aptitude, safety consciousness, quality consciousness etc. will be ascertained by observation and will be marked in observation checklist along with the assessment of Job carried out in labs and maintenance of Lab Record files.

Formative and summative evaluation may comprise of weightages to performance on task, quality of product, general behavior and it should be followed by viva-voce of the relevant subject. The end product will be measured against the specified dimensions and standards to gauge the level of his skill achievements

3. Internship

The two mandatory internships after I Year and II Year of the programme are to be assessed in 3rd and 5th semester subsequently. The internships should be preferably done in the field/ in the industry, can be in house depending upon the stream and availability of resources in and around the institute.

Every faculty should be assigned the students and made responsible for the evaluation and assessment of the internship. Formative assessment should be taken from the industry/institute/ department on the basis of performance, behavior and learning capabilities. Summative evaluation may comprise of weightages on the basis of report submission/ presentation followed by viva-voce of the relevant subject.

4. Professional Industrial Training

Evaluation of professional industrial training report and viva-voce/ presentation aims at assessing students' understanding of industrial processes, practices in the industry/field and their ability to engage in activities related to problem-solving in industrial setting as well as understanding of application of learnt knowledge and skills in real life situation. Formative and summative evaluation may comprise of weightages to performance on task, quality of product, general behavior and it should be followed by viva-voce of the relevant subject.

The formative assessment should include the evaluation from the employer where the student is doing his training or Project work in the ratio of 40:60. The final assessment will be the combination of the employer assessment and evaluation by the faculty of the institute which shall include report submission/ presentation/ seminar followed by viva-voce of the relevant subject.

5. Project Work Assessment

The purpose of evaluation of project work is to assess student's ability to apply, in an integrated manner, knowledge and skills in solving real life problems, manipulative skills, ability to observe, record, creativity and communication skills. The project work assigned should be of

relevance to the core skill, state of the art topics and the project areas that are pertaining to enhance job skill and enhance occupational opportunities. For both, minor and major project, Formative and summative evaluation may comprise of weightages to performance on task, quality of product, nature and relevance of project and general behavior.
The formative assessment should include the continuous assessment based on the work allocated and mid semester viva voice or presentation. The final assessment will be the combination of the project undertaken, report submission and should be followed by viva-voce of the relevant subject.

In case of the assessment of this component, the team of examiners should be constituted on 50 – 50 % basis. i.e. half of the examiners in the team should be invited from outside the institute conducting examination.

6. MOOC COURSES (Open Elective and Multi-Disciplinary Elective)

Massive Open Online Courses (MOOCs) platforms promise open, online courses to massive numbers of students as they are free to join, they provide a wide range of courses, they allow for space and time flexibility and their participants can benefit from various online communication tools and access to quality content.

The coordinating Department/Centre/Office shall monitor every student to adopt the courses online of their choice and preference on Swayam portal. The duration of courses will vary depending on the level and credit points. Courses offered in the duration of 4-10 weeks for 2 to 3 credits at diploma level are to be opted. Students, after they have registered, can get a certificate after attending the classes and submitting the assignments/quizzes and qualifying nationwide exam conducted written exam at the institute close to the one where the student is enrolled.

On successful completion of each course, the institution offering the MOOCs course would issue the certificate, along with the number of credits and grades, through which the student can get credits transferred into his marks certificate issued by his parent institution. Guidelines for credit sharing will be issued by concerned Regulators such as UGC, AICTE, etc. for consideration by various Institutes. There may be standard norms for the host Institution to conduct the course that may include continuous evaluation through assignments, online quizzes, case studies, online writing exercises, term examinations, student feedback, online forum management, etc.

The coordinating Department/Centre/Office of the respective department shall monitor every student and submit to the Office of Examinations, a score sheet (marks card) during the last 10 days prior to the close of the even semester.

7. Viva Voce

This tool will be used to assess the conceptual understanding and the behavioral aspects as regards the job role and the specific task at hand. It will also include questions on safety, quality, environment and equipment's etc. Ask questions on non-prescribed tasks to ensure that the learners have complete knowledge on the assessment

Computation of SGPA and CGPA

The UGC recommends the following procedure to compute the Semester Grade Point Average (SGPA) and Cumulative Grade Point Average (CGPA):

i. The SGPA is the ratio of sum of the product of the number of credits with the marks scored by a student in all the courses taken by a student and the sum of the number of credits of all the courses undergone by a student, i.e

$$SGPA\ (Si) = \sum(Ci \times Gi) / \sum Ci$$

where Ci is the number of credits of the ith course and Gi is the marks scored by the student in the ith course.

ii. The CGPA is also calculated in the same manner taking into account all the courses undergone by a student over all the semesters of a programme, i.e.

$$CGPA = \sum(Ci \times Si) / \sum Ci$$

where Si is the SGPA of the ith semester and Ci is the total number of credits in that semester.

iii. The SGPA and CGPA shall be rounded off to 2 decimal points and reported in the transcripts.

25. TEACHING LEARNING TOOLS FOR EFFECTIVE IMPLEMENTATION

For effective implementation of curriculum, the faculty and staff of institutions have to play a vital role in planning instructional experiences for the courses in four different environments viz. class-room, laboratory, library and field and execute them in right perspective. It is emphasized that only a proper mix of different teaching methods in all these places of instruction can bring the changes in students behavior as stipulated in the curriculum document. It is important to understand curriculum document holistically and further be aware of intricacies of Teaching-Learning Tools for achieving curriculum objectives. Given below are certain recommendations which may help in carrying out teaching-learning effectively:

PROGRAMME LEVEL RECOMMENDATIONS

1. Curriculum implementation takes place at programme, course and class-room level respectively and synchronization among them is required for its success. The first step towards achieving synchronization is to read curriculum document holistically and understand its rationale and philosophy.

2. An academic plan needs to be prepared at institute level. The Head of the institute have a great role to play in its dissemination and percolation up to grass-root level.

3. Head of Department are required to prepare academic plan at department level referring to institutional academic plan.

COURSE LEVEL RECOMMENDATIONS

Teachers are educational managers at class room level and their success in achieving course level objectives lies in using course plan and their judicious execution which is very important for the success of programme by achieving its objectives. Teachers are required to plan various instructional experiences viz. theory lecture, expert lectures, lab/workshop practicals, guided library exercises, field visits, study tours, camps etc. In addition, they have to carry out progressive assessment of theory, assignments, library, practicals and field experiences. Teachers are also required to do all these activities within a stipulated period which is made available to them in the academic plan at Board level. With the amount of time to their credit, it is essential for them to use it judiciously by planning all above activities properly and ensure execution of

the plan effectively. Following is the gist of suggestions for subject teachers for effective utilization of Teaching Learning Tools to achieve the course objectives:

1. Teachers need to ensure attainment of course outcomes so as to help the students achieve program outcomes and also meet the desired learning outcomes in five domains of NSQF i.e. Process, Professional knowledge, Professional skills, Core skills and Responsibility.

2. Teachers are required to prepare a course plan, taking into account number of weeks available and courses to be taught.

3. Teachers are required to prepare lesson plan for every theory class. This plan may comprise of contents to be covered, learning material for execution of a lesson plan.

4. Teachers are required to plan for expert lectures from field/industry. For this, necessary steps need to be taken such as planning in advance, identifying field experts, making correspondence to invite them, taking necessary budgetary approval etc.

5. Teachers are required to plan for guided library exercises by identification of course specific experience requirement, setting time, assessment, etc. The assignments and seminars can be thought of as terminal outcome of library experiences.

6. Concept based industrial/field visits may be planned and executed for such contents of course which are abstract in nature and no other requisite resources are readily available in institute to impart them effectively.

7. Lot of focus needs to be laid on skill development. There is need for planning practical experiences in right perspective. These slots in a course are the avenues to use problem based learning and experiential learning effectively. The development and use of lab manuals will enable the institutes to provide lab experiences effectively.

8. Emphasis should to lay on developing soft skills like communication skills, personality Development, self-learning, inter personal skills, problem solving, and creativity etc.

9. Where ever possible, it is essential to use activity based learning rather than relying on delivery based conventional teaching all the time. While teaching, the teacher should make extensive use of audio visual aids such as video films, power point presentations and IT tools.

10. Teachers may take initiative in establishing liaison with industries and field organizations for imparting field experiences to their students.

11. Students be made aware about issues related to ecology and environment, safety, concern f for wastage of energy and other resources etc.

12. To enhance digital learning, open electives and multi-disciplinary electives have been provided in the curriculum to be taken up in the form of MOOCs. For Open electives, some courses may be identified out of the prescribed list given in the curriculum keeping in mind the interest of students. Similarly, for multi-disciplinary electives, courses to be o offered may be identified by considering their relevance and utility. Every year SWAYAM is notifying the list of courses which are going to be offered in forthcoming even and odd semester. The institute needs to select the courses that are offered on SWAYAM platform or any other online platform.

13. For effective implementation of Massive Open Online Courses (MOOCs), a faculty member in the department may be identified and given the responsibility to coordinate various activities related to MOOCs. The concerned faculty member will facilitate in registration of students for MOOCs. The faculty member will also be responsible for compiling the result of students on the completion of MOOCs and pass on the information to the concerned authority.

14. Flexibility has been provided in the curriculum for the students to choose a course related to the discipline as per their interest. For effective implementation of discipline-specific electives, the institute should identify some courses from the list of courses prescribed in the curriculum. The courses should be selected and offered keeping in mind the interest of students, infrastructure and expertise available in and around the institute related to the courses. Option for discipline-specific elective may be taken from students through a form and a course, with more than 10 students opting for it, may be run.

15. Where ever possible, it is essential to use activity based learning rather than relying on delivery based conventional teaching all the time. While teaching, the teacher should make extensive use of audio visual aids such as video films, power point presentations and IT tools.

16. Teachers may take initiative in establishing liaison with industries and field organizations for imparting field experiences to their students.

17. Students be made aware about issues related to ecology and environment, safety, concern for wastage of energy and other resources etc.

18. To enhance digital learning, open electives and multi-disciplinary electives have been provided in the curriculum to be taken up in the form of MOOCs. For Open electives, some courses may be identified out of the prescribed list given in the curriculum keeping in mind the interest of students. Similarly, for multi-disciplinary electives, courses to be offered may be identified by considering their relevance and utility. Every year SWAYAM is notifying the list of courses which are going to be offered in forthcoming even and odd semester. The institute needs to select the courses that are offered on SWAYAM platform or any other online platform.

26. LIST OF EXPERTS

1. Controller of Examination, Haryana State Board of Technical Education, Panchkula.
2. Controller of Admn. & Finance, Haryana State Board of Technical Education, Panchkula.
3. Joint Secretary, Haryana State Board of Technical Education, Panchkula.
4. Deputy Secretary, Training & Placement, Haryana State Board of Technical Education, Panchkula.
5. Deputy Secretary, Examination, Haryana State Board of Technical Education, Panchkula.
6. Deputy Secretary, Academic, Haryana State Board of Technical Education, Panchkula.
7. Assistant Secretary, Academic, Haryana State Board of Technical Education, Panchkula.
8. Sh. Hitesh Kumar, Deputy Secretary (T & P), Haryana State Board of Technical Education, Panchkula.
9. Sh. Rajiv Sharma, Lecturer, Electrical Engineering Department, Seth Jai Parkash Polytechnic, Damla, Haryana.
10. Sh. Rajesh Kamboj, Lecturer, Electrical Engineering Department, Government Polytechnic, Nilokheri, Haryana.
11. Sh. Rajesh Chopra, Lecturer, Electrical Engineering Department, Government Polytechnic, Nilokheri, Haryana.
12. Sh. Deepak Kumar, Lecturer, Electrical Engineering Department, Seth Jai Parkash Polytechnic, Damla, Haryana.
13. Dr. Neeraj Kumar, Lecturer, Electrical Engineering Department, Government Polytechnic. Nanakpur.
14. Sh. Surender Malik, Lecturer, Electrical Engineering Department, Government Polytechnic, Ambala, Haryana.
15. Jitendra Virmani, Senior Technical Officer, Central Scientific Instruments Organisation, Chandigarh.
16. Mr. Rangachar Bhardwaj, Project Engieer, MV Drives, R&D, ABB India, Bangalore.

17. Smt. Pushpa Rani, Senior Lecturer, Applied Science Department, Government Polytechnic, Sonipat, Haryana.

18. Smt. Krishna Bhoria, Lecturer, Applied Science Department, Government Polytechnic, Ambala, Haryana.

19. Smt. Preetpal Kaur, Guest Faculty, Applied Science Department, Government Polytechnic, Ambala, Haryana.

20. Ms. Monika, Lecturer, Applied Science Department, Seth Jai Parkash Polytechnic, Damla, Haryana.

21. Dr. Neena Sharma, English Department, MCM College, Chandigarh.

22. Dr. Bhajan Lal, Lecturer, Applied Science Department, Government Polytechnic, Sirsa, Haryana.

23. Sh. Anil Nain, Lecturer, Applied Science Department, Government Polytechnic, Hisar, Haryana.

24. Dr. Sarita Mann, Lecturer, Applied Science Department, Government Polytechnic, Ambala, Haryana.

25. Smt. Bindu Verma, Lecturer, Applied Science Department, Seth Jai Parkash Polytechnic, Damla, Haryana.

26. Mr. Satyawan Dhaka, Senior Lecturer, Applied Science Department, Government Polytechnic, Nilokheri.

27. Mrs. Sapna Sang, Lecturer, Applied Science Department, Seth Jai Parkash Polytechnic, Damla.

28. Mr. Ravi Bansal, Lecturer, Applied Science Department, Government Polytechnic, Manesar.

29. Mrs. Kiran, Lecturer, Applied Science Department, Government Polytechnic, Sonepat.

30. Dr. Naveen Jha, Assistant Professor, Department of Mathematics, Government Engineering College, Bharatpur.

31. Dr. Vidhi Grover, Lecturer, Applied Science Department, Seth Jai Parkash Polytechnic, Damla.

32. Mr. Tavinder Singh, Lecturer, Applied Science Department, Government Polytechnic, Sirsa.

33. Ms. Sunita Rani, Lecturer, Applied Science Department, Government Polytechnic, Ambala.

34. Mr. Subhash Chandra Bhoria, Senior Lecturer, Mechanical Engineering Department, Government Polytechnic, Hisar.

35. Mr. Jagjit Singh Narang, Senior Lecturer, Mechanical Engineering Department, Government Polytechnic, Ambala.

36. Mr. Pardeep Kumar, Senior Lecturer, Mechanical Engineering Department, Government Polytechnic, Nilokheri.

37. Dr. Pankaj Sharma, Professor, Applied Science Department, NITTTR, Chandigarh.

38. Dr. Ashok Kumar, Associate Professor, Applied Science Department, NITTTR, Chandigarh.

39. Dr. KG Srinivasa, Professor, Information Management & Emerging Engineering, NITTTR, Chandigarh.

40. Dr. Ritula, Faculty, Associate Professor, Electrical Engineering Department, Chandigarh.

41. Dr. KC Lachhwani, Assistant Professor, Applied Science, NITTTR, Chandigarh.

42. Dr. Rajesh Mehra, Professor and Head, Curriculum Development Centre, NITTTR, Chandigarh.

43. Dr. AB Gupta, Professor and Head, Education & Educational Management Department, NITTTR, Chandigarh.

44. Sh. PK Singla, Associate Professor, Curriculum Development Centre, NITTTR, Chandigarh.

45. Dr. SK Gupta, Associate Professor, Curriculum Development Centre, NITTTR, Chandigarh.

46. Dr. Meenakshi Sood, Associate Professor, Curriculum Development Centre, NITTTR, Chandigarh. Coordinator

27. APPENDIX

Sr. No.	LIST OF EQUIPMENTS
1.	Measuring Instruments: Portable moving coil permanent magnet 150 mm uniform scale with anti parallax mirror, knife edge pointer, housed in teak wood/ebonite case, accuracy 1.5% a) Ammeter 0-5-10 Amp b) Ammeter 50 mA , 100 mA, 1000 mA c) Ammeter 0-10 Amp – 20 A d) Ammeter 0 -2.5- 5 Amp e) Voltmeter 0-30 V f) Voltmeter 0-10-15 V, 0-200 – 300 V, 0-200-500 V
2.	Stabilized DC Power Supply with maximum voltage regulation of 0.01 to 0.05% , input supply 230V AC single phase, 50 Hz and DC output 0-10V,0-1.5A and also with short circuit (0-30 V) and over load protection with measuring devices
3.	Lead Acid Batteries 12 V, 11 plates, 30 amp hour capacity
4.	Battery Charger: SCR based automatic 12 V, AC input voltage 230 V, output dc voltage 0-12 V, 0-2 amp. rating provided with voltmeter, ammeter of suitable range
5.	Breadboards
6.	Standard Resistance: 0.01 ohm,10 amp, Fixed on bakelite base with brass terminals, 4 terminal arrangement, immersed in moisture free oil contained in a vessel sealed from the top
7.	Colour coded resistances of different values viz 5ohm, 10 ohm, 50 ohm 200 ohm, 250 ohm, 500 ohm, 1000 ohm
8.	Tungsten filament lamp, Single phase, 220 volts, 50Hz
9.	Induction coil of 50 turns and 100 turns wound on non-magnetic material cylindrical surface with provision to connect galvanometer.
10.	Solenoid consisting of Induction coil of 100 turns wound on a cylindrical loop made of non-magnetic material with provision to connect galvanometer.
11.	Galvanometer: 220 V, AC mains,
12.	Hydrometer for measuring specific gravity of lead acid battery range 1100 - 1300
13.	Multimeter a) Analog Hand Held Multimeter, suitable to measure DC Voltage : 0 – 2.5V/10V/50V/250V/1000V with Accuracy : ± 3%, AC Voltage : 0 – 10V/50V/250V/1000V, with Accuracy : ± 4%, DC Current : 0 – 2.5mA/25mA/250mA/10A with Accuracy : ± 3%, Resistance : 0 – 2k/20k/2M/20MΩ with Accuracy : ± 3% and having facility for

	Transistor Polarity Test ,diode test, capacitor test b) Digital Multimeter: Three and half digits LCD display, manually operated multimeter with AC/DC, 1A current resistance upto 10 Mohm, complete with leads manual and batteries, accuracy 0.5% for dc and 1% for AC measurement Voltage upto 1000V
14.	Earth tester: 500 volt, 0.10-100 ohms with 3/4 terminals, complete with all accessories (hammers, screw driver, 3 spikes with connecting leads, as per ISS) Accuracy + 1% FSD, housed in teak wood/ebonite case, with leather case
15.	Moving Iron Voltmeter/Ammeter: Portable moving iron measuring Instrument, housed in teak wood/ebonite case, scale 150 mm knife edge pointer, with anti mirror, critically damped, accuracy 1% FSD a) 0-500 mA-1000 mA b) 0-5-10 amp c) 0-2 amp d) 0-125-250 volts e) 0-250-500 volts
16.	Wattmeter: Portable dynamometer type, housed in teak wood/ebonite case, scale 150 mm knife edge pointer with anti parallax, current range 0-5-10 amp Voltage range 0-250-500 volt or 125-250 volt
17.	Rheostats: Sliding Rheostats wound with evenly oxidised iron free nickel copper on vitreous enamelled round steel tube. Contactors should be made of laminated phosphor bronze sheet. Resistance tolerances + 2% a) Single tube 150 ohm – 2 A b) Single tube 300 ohm – 5 A c) Double Tube 500 ohms – 20 A, 30 A d) Double Tube 440 ohms – 3 A e) Double Tube 110 ohms – 10 A
18.	Dimmerstat: Single phase 0-230 V, output 0-270 V, 10A
19.	Inductance: Coil mounted provision for change in value, well polished teak board with terminals fitted with 2.5 Kg variable core
20.	Variable Inductor: Single phase, 250 V, mounted on well polished teak wood frame with terminals, 2.5 kW, continuously variable core type.
21.	Phase Regulator: 10A, 250V,2.5 KVA variable power factor and lagging to leading arrangement indicator
22.	Power Factor Meter:
23.	Load: 3 phase variable resistive load, 415 V, 10 KW, trolley mounted tube type provided with switches to vary the load in twenty steps
24.	Digital LCR/Q Bridge:

25.	Clamp Meter 0-10 A 220 V 50 Hz
26.	Current Transformer 0-10 A 220 V 50 HZ Single Phase
27.	Potential Transformer 0-250V 50 HZ Single Phase
28.	Experimental Kit to measure temperature using N.T.C. Thermistor having arrangement for reading temperature on 3 ½ digit LCD display heating rod, power supply AC 220V, 50Hz, suitable amplifier and protection system
29.	Measurement of temperature using thermocouple Thermocouple trainer kit with arrangements of thermocouple sensor for copper constantan thermocouple, oven for heating, LCD Display, 2 No.s thermometers suitable to measure temperature from 0°C to 200°C.
30.	Experimental Kit to measure temperature using RTD Transducer Kit
31.	Experimental kit for Measurement of pressure by using LVDT
32.	Frequency meter: a) Digital, 4 digit LED display frequency meter suitable for use on 230 V AC main supply range 20-99 Hz b) Vibrating Reed type 230 V, having 21 reed 40-60 Hz. abs Body c) Moving Coil type, portable housed in phenolic moulded body with antiparallax mirror. Scale and knife edge pointer, range 40-60 Hz, 230 V
33.	Phase sequence indicator: Portable, housed in a plastic moulded casing, rotating disc type, supported with one meter long red, yellow and blue leads with clips, rating 30 sec. 500 V, burden 15 VA voltage 50 to 500 V frequency 25 to 50 Hz.
34.	Flux meter: Operated on 230 V ac portable with selector switch, output, 10 mV on all ranges 0-50, 0-100, 0-200, 0-500, 0-1K, 0-2K, 0-10K gauss. Accuracy + 1% with built in calibration
35.	Cathode Ray Oscilloscope 10 MHz Vertical deflection Bandwidth DC-10 MHz(-3db) Rise time 30 ms, Deflection coefficient 12 calibrated steps, 5 mV/cm to 20 V in input impedance 1 M ohm started by 25 p.f input coupling DC-AC-GND Max. input voltage-500 V(DC+ peak AC)
36.	Transformer: Single phase, core type, natural air cooled, 230/110 V, 1 KVA, 50Hz
37.	Static Converter: 3-Phase, 415 V, 50 Hz, output 230 V dc 15 KW, regulation + 1%, servo controlled, thyristorised
38.	Separately excited DC Generator, 230 Volt, 5 H.P , 1440 rpm complete with appropriate panel board with voltmeters, ammeters, switches, indicators, starter and field regulator
39.	DC Shunt Motor - Shunt Gen. Set: DC shunt motor 230 V, 3 kW, 1440 rpm coupled with DC shunt generator, 230 V, 3kW, complete with appropriate panel board with meters, switches, indicators starter and field regulator

40.	DC shunt motor 230 V, 3 HP, 1440 rpm complete with appropriate panel board, starter and loading arrangements (Belt assembly)
41.	DC Series motor: DC series motor, 230 V, 3 HP , 1440 rpm with breaking (eddy current or drum pulley) arrangement and appropriate panel board and over speed safety precautions e.g. light shunt winding etc.
42.	Synchronous Generator, 3 phase, 415 Volt, 5 H.P., with Prime mover, Excitor, Starter, output terminals brought out to connect load.
43.	Squirrel Cage Induction Motor: 3-phase squirrel cage induction motor 3 Kw, 415 V, 50 Hz, 1440 rpm all six terminals brought out, complete with appropriate panel board, starter etc
44.	Slip ring Induction motor: Three-phase, wound rotor induction motor, 3Kw, 415 V. 50 Hz, 1440 rpm with stator and rotor terminals brought out coupled with a dc shunt generator, 230V, 3 KW with appropriate panel board and starter
45.	Single phase Induction Motor Capacitor start with centrifugal switch 0.5 KW with suitable loading arrangement and appropriate panel board.
46.	1-phase transformer: Single phase transformer, 230/115 V, 50 Hz, 3 KVA housed in a metal tank
47.	3-Phase transformer: Three phase transformer, 415/230V,50 Hz, 5 KVA all terminals brought out, housed in a metal tank
48.	Variacs: a) One phase, 230 V, 50 Hz, 8-A auto transformer continuously valuable, housed in a metal body, portable b) One phase, 230 V, 50 Hz, 15-A transformer continuously valuable, housed in a metal body, portable c) Three phase, 230 V, 50 Hz, 30 A, 415-V transformer continuously valuable housed in a metal body, portable phase
49.	Loading Rheostats: a) Resistance type, single phase, 230V, 15A, each natural air cooled, housed in metal body fitted with switches and mounted on trolleys b) Resistance type, three phase 440V, 15A, natural air cooled, housed in metal body, switches and base wheels, six terminals brought out c) Continuously variable choke type loading coil, coil upto 15A, three phase, 440V, 50Hz, housed in a metal case on wheels (Trolley Aid) d) Capacitor bank, variable in steps through switches, 440V, 3 phase, 15A max. housed in a portable metal case
50.	Rheostats: Wire wound Rheostats (Approx. of following rating) 440 Ohm, 3A 110 Ohm 8A
51.	Tachometer: Digital non-contact type tachometers 0-10,000 rpm, 3 1/2 digit
52.	Stroboscope: with calibrated dial for frequency/rpm measurement

53.	DC Ammeters: Portable moving coil permanent magnet 150 mm uniform scale with anti parallax mirror, knife edge, pointer, housed in a teak wood/ebonite case, accuracy + 1-5% a) Ammeter 0-3 amp b) Ammeter 0-25 amp c) Ammeter 0-50A
54.	DC Voltmeters Portable moving coil permanent magnet 150 mm uniform scale with anti parallax mirror, knife edge pointer, housed in a teak wood/ebonite case, accuracy + 1-5% a) 0-15 b) 0-50 c) 0-150 d) 0-300 e) 0-600
55.	AC Ammeters Portable moving iron, 150 mm uniform scale with anti parallax mirror, knife edge pointer, housed in a teak wood/ebonite case, accuracy +1.5% a) 0-1A b) 0-3A c) 0-10A d) 0-20A
56.	AC Voltmeters Portable moving iron 150 mm uniform scale with anti parallax mirror, knife edge pointer, housed in a teak wood/ebonite case, accuracy +1.5% a) 0-1V b) 0-15V c) 0-30/60 V d) 0-150/300 V
57.	Wattmeters: Portable dynamometer type: Portable dynamometer measuring instrument housed in a teak wood/ebonite case scale 150 mm, knife edge pointer with antiparallax mirror, critically damped, accuracy + 1% a) 75/300/600 V and 1.5/3A (LPF) b) 75/300/600 V and 1.5/20A (UPF) c) 75/150/300 V and 15/30A d) 110/220/440 V and 15/30A
58.	Portable Power factor meters: Dynamometer type, eddy current type, damping, frequency cycle 50 Hz , scale length 150 mm, current rated upto 20A, Volt-300V. p.f. range 0.5 lag-unity 0.5 lead, housed in teak wood/ebonite case with antiparallex mirror with knife edge pointer a) Portable type single phase single element type 110 V/240 V or 1 A or 5 A

	b) Portable type 3-phase single element type 110 V/ 240 V, 1 A or 5 A
59.	Synchroscope: Suitable for 110V AC, 1-phase, 50 Hz alongwith potential transformer, 230V and 415V on primary and 110V on secondary side
60.	Phase Shifting Indicator: Suitable for 50 V to 500 AC from 25 Hz to 55 Hz
61.	Tong Testing Ammeter: 0-15 A/50A/100A Clip-on type
62.	Current Transformer: 100-50-25-10/5A
63.	Potential Transformer: a) 10 VA, 440/110 V b) 10 VA, 220/110 V
64.	DC Regulated Power Supplies: 0-30V, 5A, DC and also with short circuit and over lead protection with measuring devices
65.	Earth tester: 500 volt, 0.10-100 ohms with 3/4 terminals, complete with all accessories (hammers, screw driver, 3 spikes with connecting leads, as per ISS) Accuracy + 1% FSD, housed in teak wood/ebonite case, with leather case
66.	Static Converter: 3-Phase, 415 V, 50 Hz, output 230 V dc 15 KW, regulation + 1%, servo controlled, thyristorised
67.	Coil Winding Machine:
68.	Bench Drilling Machine:
69.	Portable Drilling Machine:
70.	Multi meter: Laboratory service type with large and easy to read mirror scale with over head protection high accuracy, voltage range a.c/ d.c 0-600 V Current Ranges - AC 50 mA - 10 amp. DC 10 mA - 10 amp Ohmmeter 2 Ohm to 20 K Ohm Accuracy DC voltage and current + 1% AC voltage and current + 2%, Ohmmeter + 3% with test leads and carrying case
71.	Meggar: Insulation tester having hand driven generator to generate 500 volts DC having effective range of measuring insulation resistance from 0 to 100 M ohm. Confirming to IS 2992/1965
72.	Fans of various type with one having solid State speed regulator: a) Ceiling fan: 1200 mm, 1500 mm sweep operating at 230V, 50Hz, b) Table fan: 400 mm sweep operating at 230 V, 50 Hz, supply AC c) Exhaust fan: 375 mm sweep operating at 230 V, 50 Hz, supply AC main 0.25 HP d) Desert cooler, complete with 375 mm sweep, 1400 rpm, 1/4 HP motor operating at 230 V, 50 Hz, AC, complete supporting frame fan, water circulating pump, float and control switches etc
73.	Electrical Appliances: 1. Electric Kettle: 750 watts, 230V single phase AC, 50Hz, capacity 1 lit. a) Filament type

	b) Rod type rated 1000 watt. 2. a) Electric Iron, 500 watt, 230 V, Ordinary, 50 Hz, 1 Kg weight b) Electric Iron, 500 watt, 230 V, Automatic, 50 Hz, 1/2 Kg 3. Electric Toaster: 500 watt 4. Geyser 15 lit capacity, 2 Kw, 230 Volts 50 Hz, AC 5. Immersion rod: 1000 watt, 230 Volts 50Hz, AC supply operated 6. Room Heater 1000 watt, 230 V, 50 Hz, AC supply a) Parabolic type b) Rod type (single rod/double rod) 7. Air convector: 1000 watts, 230 V, 50 Hz, with 2 temperature settings 8. Mixer cum grinder: 250 watts, 230 volts, 50 Hz, 1 1/2 lit. capacity with various attachments (food processor) 9. Heater: Wire wound type, 1000 watts, 230 V, 50 Hz supply 10. Hot plate: Single/double filament 1500/2000 watts, with control knobs operating at 230 V, 50 Hz, AC supply 11. Electrical Oven: 2 KW, with temperature control devices and temperature indicating meters operating at 230 volts, 50 Hz AC supply 12. Electric Shaver: 40-60 watts, to be operated at 230 V, 50 HP supply 13. Electric Lighter: to be operated at 230 v, 50 Hz Electric/Electronic
74.	Miniature Circuit Breakers(MCBs)RCCB/ELCB
75.	Electric Lamps: a) Mercury vapour lamp 120 watt, 230v, 50 Hz AC supply complete with choke, lamp holder and power factor capacitor b) Mercury vapour lamp ML type 120/125 watt, 230 v, 50 Hz supply c) Sodium vapour lamp 120 watt/250 watt, 230 volts, 50 Hz with choke d) Flourescent tube: 20/40 watt, 230 V,50 Hz, single phase with choke, starter and fittings various sizes and types i.e. round etc. e) Halogen lamps: 1000 watts/1500 watt, 230 v, 50 Hz complete with fittings(Fluorescent tube light) f) Filament Lamps - 60 W lamp, 230 V - 60 W lamp, 100 V - 60 W lamp, 230 V - 200 W lamp - 500 W lamp - 100 W – 110 V lamp - 100 W - 150 V lamp g) CFL LAMP

76.	
77.	Automobile Electrical Wiring Demonstration working model for automobile Electric wiring
78.	Screw Driver Set: Electrician type round nickel plated steel blade, flat tip with plastic insulated handle
79.	Combination Pliers: 205 mm length with thick plastic insulated handle Insulated for 500 V (Taparia, PYE make)
80.	Long Nose Pliers: 150 mm insulated for 500 volts
81.	Diagonal Pliers: 150 mm insulated for 500 volts suitable for cutting hard wires
82.	Adjustable Wrench Chromium plated adjustable wrench lengths 255 mm max. opening 30 mm
83.	a) Flat nose pliers: Rectangular section jaw and smooth gripping surface plastic insulated handles length 130 mm b) Slip Nose Pliers with slim long grains of half round section and smooth gripping surfaces plastic insulated handle length 130 mm c) Round Nose Pliers: With slim long round grains and plastic insulated handles lengths 130 mm
84.	Ball Pien Hammer: Ball pein hammer with polished fall and pein wooden handle having wts i) 250 gms ii) 500 gms iii) 800 gms
85.	Screw Holding Screw Driver Set: Screw driver set fitted with spring each clips to secure screw head round or hexagonal chromium plated blade with plastic handle set of three screw driver blade size i) 4 x 50 mm ii) 4 x 75 mm iii) 4 x 100 mm
86.	Instrument Makers Screw Driver Set: Set of screw drivers with chrome vanedium set steel shaft and fluted nickel plated steel handle with hexagonal end shaft width 0.8 to 3.8 mm complete with plastic case
87.	Tweezers a) With blunt serrated Jaws stainless steel nickel plated length 160 mm b) Pointed ends serrated jaws stain less steel nickel plated length 130 mm
88.	Work shop Scissors Stainless steel, scissors suitable for cutting insulation, paper, plastic etc. length approx. 150 mm
89.	Adjustable Hacksaw Frame: Extra robust tubular steel frame cast handle adjustable for hacksaw blade from 250 - 300 mm with set of 10 spare blades

90.	Hand Drill Machine: Two speed hand drill machine with enclosed gear adjustable crank, supporting handle, self centering chuck for straight shank drills upto 10 mm
91.	Bench Vice: Drop forged steel bench vice with jaw width 100 mm, Jaw opening 120 mm, Jaw depth 75 mm, quick release complete with i) One pair of detachable aluminium protective jaw plates ii) One pair of detachable fibre protective jaw plates
92.	Bearing Puller Three legs heavy duty bearing puller of size 100 mm/200 mm
93.	Automatic Centre Punch: Spring loaded action knurled shank centre punch length 115 mm and dia at point 2mm
94.	Wire Gauge: Suitable upto 0-76 SWG
95.	Try Square: Engineers try square from stainless steel with stock 90 degrees all sides accurately finished legs 150 x 100 mm
96.	Measuring tape: Pocket measuring tape of steel spring return device, flexible, clearly graduated in metric readings 2 mts long
97.	Files Set: Hand files with plastic handles for each general metal treatment double cut 200/350 mm long consisting of i) Flat smooth cut ii) Flat second cut iii) Half round second cut iv) Half round smooth cut v) Round second cut vi) Round smooth cut vii) Square second cut viii) Square smooth cut ix) This single cut smooth 20 x 3.3mm x) Triangular file 200 mm
98.	Wire Stripper: Stripper with side mounted spring return and adjustable jaws via look screws for cable insulation maximum 4 mm dia length 150 mm.
99.	Screw Driver Mains Voltage Tester: Flat tip screw driver with built in new test lamp transparent plastic handle insulated block, metal pocket clip suitable upto 400 v. AC blade 4 x 100 mm Overall length 180 mm
100.	Cable Knife: Electrician knife blade made from stainless steel with length 50 mm plastic moulded handle overall length 180 mm
101.	Soldering Gun Kit: Instant action soldering device trigger controlled with built in illumination of soldering butt bakelite housing, normal power 45 watts, with approx. 2 mts supply cord suitable for electric supply of 230 volt AC, single phase 50 Hz. Accessories: (i) Fine bit

	(ii) Bit for plastics
102.	Rubber Mallet: Soft Rubber with wooden handle approx. 200 gms
103.	Screw Extractor Set: Left hand thread for easy removal of broken right hand threaded screw and bolts. Set of three extractors for screws with die from 3 to 11 mm Figure Stamp Set for marking made from high grade stainless steel figure height 4mm complete with plastic box
104.	Soldering Iron: Soldering iron 35 watts, 65 W, 100 Watts operating at 230 V, 50 Hz supply
105.	Oil Can: 0.75 lit capacity
106.	Blow Lamp: 1 Pint kerosene oil capacity blow lamp
107.	Hand Saw: Hand saw 10" (254) size 10 teeth per inch teak wood handle
108.	DC regulated low voltage variable power supply
109.	DC regulated multiple output power supply
110.	Audio oscillator
111.	Wide band RC Oscillator
112.	RF Signal Generator
113.	Pulse Generator
114.	Function Generator
115.	Digital Storage Oscillos.
116.	Digital Panel meters
117.	Digital thermometer
118.	Digital Lux meter
119.	CROs 20 MHz (Scientific Make)
120.	Function Generators Audio Frequency
121.	Rectifier Kits
122.	Filter Circuit Kit
123.	Bread Boards
124.	Transistor Kits (a) CB (b) CE
125.	FETs
126.	Operational Amplifier Kits
127.	Raw Materials
128.	Breadboards
129.	Various IC of AND, NOT, OR, XOR, NAND, NOR gates
130.	Trainer Board to Study flip flops

131.	Trainer Board to Study encoder/ decoder
132.	Trainer Board to Study multiplexer/ demultiplexer
133.	Trainer Board to Study Shift Registers SIPO, SISO
134.	Trainer Board to Study Shift Registers PISO, PIPO
135.	Interfacing Cards with 8051 -Sensors cards -Wifi cards -bluetooth cards -DC motor interface with motor -LCD interface
136.	Micro-controller Kit 8051 based
137.	Digital IC Tester Model - Nikki
138.	Universal Programmer
139.	Morgan Chopper Kit
140.	Joner Chopper
141.	Kit for Ni-Cd battery charging
142.	iKWP solar PV system for I-V characteristics
143.	Speed Control of dc motor (Thyristorized)
144.	Single Phase Cyclo Convertor with Thyristors
145.	SCR Characteristics
146.	Cycloconvertor for changing speed of 3 phase induction motor
147.	UJT Characteristics and its Application as Relaxation Oscillator
148.	Thyristor control experimental kits Instrumentation/Transducer experimental kit. Basic electronic experiment kit
149.	Trainer Kit to study characteristics of DIAC
150.	Trainer Kit to study characteristics of TRIAC
151.	Trainer Board to Study Half Wave Controlled Rectifier
152.	Trainer Board to Study Full Wave Controlled Rectifier
153.	Trainer Board for SCR based Lamp intensity control
154.	Trainer Board for SCR fan speed control
155.	PLC Trainer Kits
156.	Seven segment display
157.	PLC Simulator Software
158.	PLC interface cards
159.	Desktop Computers Core i5 (11^{th} 12^{th} or 13^{th} -gen) 8 GB/16GB of RAM 512GB or larger Hard Disk, SSD drive, USB Port, TFT Screen 19”,


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