Curriculum for

Diploma Programme in
- *RENEWABLE ENERGY*

For the State of Uttar Pradesh

Compiled by:

IRDT, Kanpur

APPROVED AND IMPLEMENTED BY:
BOARD OF TECHNICAL EDUCATION,UTTAR PRADESH,LUCKNOW

APPROVED IN CDC COMMITTEE MEETING OF BTE,UP,LUCKNOW DATED:26-09-2021

CONTENTS

Sr. No	Particulars	Page No.
1.	Salient Features of the Diploma Programme	7
2.	Employment Opportunities	9
3.	Learning Outcomes of Diploma Programme in Mechanical Engineering	10
4.	Deriving Curriculum Areas from Learning Outcomes of the Programme	12
5.	Abstract of Curriculum Areas	15
6.	Horizontal and Vertical Organization of the Subjects	17
7.	Study and Evaluation Scheme	19
8.	Guidelines (for Assessment of Student Centered Activities and Internal Assessment)	25
9.	Detailed Contents of various Subjects	26-195

FIRST SEMESTER

1.1	Communication Skills-I	26
1.2	Applied Mathematics - I	30
1.3	Applied Physics – I	34
1.4	Applied Chemistry	41
1.5	Engineering Drawing-I	47
1.6	Basics of Information Technology	51
1.7	General Workshop Practice-I	56

SECOND SEMESTER

2.1	Applied Mathematics - II	61
2.2	Applied Physics -II	65
2.3	Basic Electrical Engineering	70
2.4	Basics of Mechanical and Civil Engineering	75
2.5	Analog Electronics	80
2.6	General Workshop Practice-II	84

THIRD SEMESTER

3.1	Fundamentals of Renewable energy Resources	88
3.2	Solar Photovoltaic	92
3.3	Renewable Energy Instrumentation Applications	97
3.4	Fundamental of Thermodynamics and Heat Transfer	100
3.5	Renewable Energy Instrumentation Applications Laboratory	104
3.6	*Communication Skill II	107

FOURTH SEMESTER

4.1	Solar Energy	110
4.2	Hydraulics and Pneumatics	114
4.3	Wind Energy	119
4.4	Bio-Energy	125
4.5	Environmental studies	128
4.6	Energy conservation	132

APPROVED IN CDC COMMITTEE MEETING OF BTE,UP,LUCKNOW DATED:26-09-2021

4.7	Constitution of India	136
-	Industrial Training	139

FIFTH SEMESTER

5.1	Energy Efficiency, Economics and Audit	140
5.2	Marine and Geothermal Energy	144
5.3	Electric and Hybrid Vehicle	148
5.4	Distributed Generation Systems	151
5.5	Installation , Maintenance & Monitoring of Renewable Energy Power Plant	155
5.6	Fuel cell & Hydrogen Energy	159

SIXTH SEMESTER

6.1	Renewable Energy Power Plant	163
6.2	Entrepreneurship & Start - ups	168
6.3	Electrical Machine and Measurement	171
6.4	Internet of Things	177
	Operations Research	181
	Engineering Economics and Accountancy	184
	Heat Transfer	187
6.5	Project Work	191

10.	Resource Requirement	196
11.	Evaluation Strategy	224
12.	Recommendations for Effective Implementation of Curriculum	227
13.	List of Participants	229

PREFACE

An important issue generally debated amongst the planners and academician's world over is how technical education can contribute to sustainable development of the societies struggling hard to come in the same bracket as that of the developed nations. The rapid industrialization and globalization have created an environment for free flow of information and technology through fast and efficient means. This has led to shrinking of the world, bringing people from different culture and environment together and giving rise to the concept of world turning into a global village. In India, a shift has taken place from the forgettable years of closed economy to knowledge based and opens economy in the last few decades. In order to cope with the challenges of handling new technologies, materials and methods, we have to develop human resources having appropriate professional knowledge, skills and attitude. Technical education system is one of the significant components of the human resource development and has grown phenomenally during all these years. Now it is time to consolidate and infuse quality aspect through developing human resources, in the delivery system. Polytechnics play an important role in meeting the requirements of trained technical manpower for industries and field organizations. The initiatives being taken by the State Board of Technical Education, UP to revise the existing curricula of diploma programmes as per the needs of the industry and making them NSQF compliant, are laudable.

In order to meet the requirements of future technical manpower, we will have to revamp our existing technical education system and one of the most important requirements is to develop outcome-based curricula of diploma programmes. The curricula for diploma programmes have been revised by adopting time-tested and nationally acclaimed scientific method, laying emphasis on the identification of learning outcomes of diploma programme.

The real success of the diploma programme depends upon its effective implementation. However best the curriculum document is designed, if that is not implemented properly, the output will not be as expected. In addition to acquisition of appropriate physical resources, the availability of motivated, competent and qualified faculty is essential for effective implementation of the curricula.

It is expected from the polytechnics to carry out job market research on a continuous basis to identify the new skill requirements, reduce or remove outdated and redundant courses, develop innovative methods of course offering and thereby infuse the much-needed dynamism in the system.

Manoj Kumar
Director

APPROVED IN CDC COMMITTEE MEETING OF BTE,UP,LUCKNOW DATED:26-09-2021

Institute of Research Development & Training
Kanpur, U.P.

ACKNOWLEDGEMENTS

We gratefully acknowledge the guidance and contribution received from the following persons:

1. Sh. Alok Kumar-III, IAS, Secretary, Technical Education Department, U.P. Govt.

2. Sh. Sunil Kumar Chaudhary, Special Secretary, Technical Education Department, U.P. Govt.

3. Sh. Manoj Kumar, Director, Technical Education, UP & I.R.D.T., Kanpur, for taking keen interest in the review of this curriculum.

4. Secretary, Board of Technical Education, UP for initiating this project of review of curriculum.

5. All the participants from industry/field organizations, engineering colleges, polytechnics and other technical institutions for their professional inputs during curriculum workshops.

6. Faculty/Subject Experts from U.P. Government polytechnics and BBDEC, Lucknow.

1. SALIENT FEATURES OF DIPLOMA PROGRAMME IN RENEWABLE ENERGY

1)	Name of the Programme	:	Diploma Programme in Renewable Energy
2)	Duration of the Programme	:	Three years (Six Semesters)
3)	Entry Qualification	:	Matriculation or equivalent NSQF Level as Prescribed by State Board of Technical Education, UP
4)	Intake	:	60 (or as prescribed by the Board)
5)	Pattern of the Programme	:	Semester Pattern
6)	NSQF Level	:	Level - 5
7)	Ratio between theory and Practice	:	45 : 55 (Approx.)

8) Industrial Training:
Four weeks of industrial training is included after IV semester during summer vacation. Total marks allotted to industrial training will be 50.

9) Ecology and Environment :

As per Govt. of India directives, a subject on Environmental Studies has been incorporated in the curriculum.

10) Energy Conservation:

A subject on Energy Conservation has been incorporated in the curriculum.

11) Entrepreneurship Development:

A full subject on Industrial Management and Entrepreneurship Development has been incorporated in the curriculum.

12) Student Centred Activities:

A provision of 3-6 periods per week has been made for organizing Student Centred Activities for overall personality development of students. Such activities will comprise of co–curricular activities such as expert lectures, self study, games, hobby classes like photography, painting, singing etc. seminars, declamation contests, educational field visits, NCC, NSS and other cultural activities, disaster management and safety etc.

13) Project work

A project work has been included in the curriculum to enable the student get familiarize with the practices and procedures being followed in the industries and provide an opportunity to work on some live projects in the industry.

2. EMPLOYMENT OPPORTUNITIES FOR DIPLOMA HOLDERS IN RENEWABLE ENERGY

The following are the major employment opportunities for diploma holders in Renewable Energy:

- In manufacturing industry primarily in private sector and to some extent in public sector
- In service sector like Railways, Hospitals, Military Engineering Services, Boards and Corporations, Construction Companies, Transportation Departments, New and Renewable Energy Development Agency .
- In marketing sector for sales and after- sales services
- As an entrepreneur

  Though the diploma holders in Renewable Engineering find placement in all functional areas like R&D, planning, shop floor production, quality control, inventory management but majority of them find employment in shop floor management.

3. LEARNING OUTCOMES OF DIPLOMA PROGRAMME IN RENEWABLE ENERGY

After undergoing this programme, students will be able to:

1.	Prepare and interpret drawings of engineering components.
2.	Prepare simple jobs as per specifications.
3.	Identify and able to take readings on various electrical equipment's (voltmeter, ammeter, CRO, wattmeter, multi-meter)
4.	Apply Thermodynamics Laws. • Use of various energy sources.
5.	Use P.N. junction as rectifier • Use Zener diode as voltage stabilizer
6.	Use cutting tools for machines and machine tools.
7.	Basic Knowledge about various type of renewable energy
8.	Identify different types of solar cell, its components & materials.
9.	To learn efficient operation of various types of instruments utilized for renewable power applications.
10.	Apply fundamental concepts of thermodynamics to thermodynamic systems
11.	Know the characteristics and specification of different instruments.
12.	Get concept on amount of solar radiation on earth & its measurement technique
13.	Explain fluid properties, their units and conversion.
14.	Know about the components of a wind turbine and their functions.
15.	Know various sources of biomass, their fuel value & applications in biomass energy conversion.
16.	Comprehend the importance of ecosystem and sustainable understand various forms & elements of energy
17.	To select appropriate tariff system and methods for reducing electricity consumption and energy saving
18.	To understand the warmest temperature in the oceans now a days
19.	Introduction to Hybrid Electric Vehicles: History of hybrid and electric vehicles
20.	Understanding modern power system components and transformation
21.	Prepare profile with an appropriate accuracy as per drawing following safety precaution

22.	The students will have the general knowledge of Fuel Cells as a promising technology in the context of clean power sustainability and alternative fuels for shipping.
23.	Understand solar radiation, solar power plant
24.	Have the ability to discern distinct entrepreneurial traits
25.	To introduce the concepts of ideal synchronous machines and poly-phase induction machines
26.	Able to understand the application areas of IOT
27.	Methodology of Operations Research.
28.	Describe the factors that shape the economic environment of engineering companies
29.	Understand basic concept of heat transfer

4. DERIVING CURRICULUM AREAS FROM LEARNING OUTCOMES OF THE PROGRAMME

The following curriculum areas/subjects have been derived from learning outcomes:

Sr. No.	Learning Outcomes	Curriculum Areas/Subjects
1.	Prepare and interpret drawings of engineering components.	– Engineering Drawing
2.	Prepare simple jobs as per specifications.	– General Workshop Practice
3.	Identify and able to take readings on various electrical equipment's (voltmeter, ammeter, CRO, wattmeter, multi-meter)	– Basics of Electrical Engineering
4.	Apply Thermodynamics Laws. • Use of various energy sources.	– Basics of Mechanical and civil Engineering
5.	Use P.N. junction as rectifier • Use Zener diode as voltage stabilizer	– Analog Electronics
6.	Use cutting tools for machines and machine tools.	– General Workshop Practice
7.	Basic Knowledge about various type of renewable energy	-Fundamentals Of Renewable Energy Resources
8.	Identify different types of solar cell, its components & materials.	-Solar Photovoltaic
9.	To learn efficient operation of various types of instruments utilized for renewable power applications.	-Renewable Energy Instrumentation Applications
10.	Apply fundamental concepts of thermodynamics to thermodynamic systems.	-Fundamentals Of Thermodynamics And Heat Transfer
11.	Know the characteristics and specification of different instruments.	-Renewable Energy Instrumentation Applications Laboratory
12.	Get concept on amount of solar radiation on earth & its	-Solar Energy

	measurement technique	
13.	Explain fluid properties, their units and conversion.	-Hydraulics And Pneumatics
14.	Know about the components of a wind turbine and their functions.	– Wind Energy
15.	Know various sources of biomass, their fuel value & applications in biomass energy conversion.	– Bio Energy
16.	Comprehend the importance of ecosystem and sustainable	– Environmental studies
	understand various forms & elements of energy	– Energy Conservation
17.	To select appropriate tariff system and methods for reducing electricity consumption and energy saving	– Energy Efficiency, Economics and Audit
18.	To understand the warmest temperature in the oceans now a days	– Marine And Geothermal Energy
19.	Introduction to Hybrid Electric Vehicles: History of hybrid and electric vehicles	– Electric And Hybrid Vehicle
20.	Understanding modern power system components and transformation	– Distributed Generation Systems
21.	Prepare profile with an appropriate accuracy as per drawing following safety precaution	– Installation, Maintenance & Monitoring Of Renewable Energy Power Plant
22.	The students will have the general knowledge of Fuel Cells as a promising technology in the context of clean power sustainability and alternative fuels for shipping.	– Fuel Cell & Hydrogen Energy

23.	Understand solar radiation, solar power plant	– Renewable Energy Power Plant
24.	Have the ability to discern distinct entrepreneurial traits	– Entrepreneurship & Start – Ups
25.	To introduce the concepts of ideal synchronous machines and poly-phase induction machines	– Electrical Machine And Measurement
26.	Able to understand the application areas of IOT	– Internet Of Things
27.	Methodology of Operations Research.	– Operations Research
28.	Describe the factors that shape the economic environment of engineering companies	– Engineering Economics And Accountancy
29.	Understand basic concept of heat transfer	– Heat Transfer

5. ABSTRACT OF CURRICULUM AREAS

a) General Studies

1. Communication Skills
2. Environmental Studies
3. Energy Conservation

b) Applied Sciences

4. Applied Mathematics
5. Applied Physics
6. Applied Chemistry

c) Basic Courses in Engineering/Technology

7. Engineering Drawing
8. General Workshop Practice
9. General Engineering
10. Basics of Information Technology

d) Applied Courses in Engineering/Technology

11. Fundamentals of Renewable energy Resources
12. Solar Photovoltaic
13. Renewable Energy Instrumentation Applications
14. Fundamental of Thermodynamics and Heat Transfer
15. Solar Energy
16. Hydraulics and Pneumatics
17. Wind Energy

18. Bio-Energy
19. Environmental studies
20. Energy conservation
21. Fundamentals of Renewable energy Resources
22. Solar Photovoltaic
23. Renewable Energy Instrumentation Applications
24. Fundamental of Thermodynamics and Heat Transfer
25. Renewable Energy Instrumentation Applications Laboratory
26. Fundamentals of Renewable energy Resources

e) Industrial Training

27. Project Work

f) Specialized Subjects

28. Automobile Engineering (for Automobile, Production and CAD)
29. Air Conditioning (for RAC)
30. Repair and Maintenance (for Repair & Maintenance)
31. Automobile Maintenance, Servicing & Repair (for Automobile)
32. Computer Aided Design (for CAD)
33. Tool Engineering (for Production)
34. Refrigeration Plant, Erection and Servicing (for RAC)

6. HORIZONTAL AND VERTICAL ORGANISATION OF THE SUBJECTS

Sr. No.	Subjects	Distribution in Periods per week in Various Semesters					
		I	II	III	IV	V	VI
1.	Communication Skills	6	-	6	-	-	-
2.	Applied Mathematics	5	5	-	-	-	-
3.	Applied Physics	7	7	-	-	-	-
4.	Applied Chemistry	7	-	-	-	-	-
5.	Engineering Drawing	8	-	-	-	-	-
6.	Basics of Information Technology	6	-	-	-	-	-
7.	General Workshop Practice	8	8	-	-	-	-
8.	Basic Electrical Engineering	-	9	-	-	-	-
9.	Basics of Mechanical and Civil Engineering	-	7	-	-	-	-
10.	Analog Electronics	-	8	-	-	-	-
11.	Fundamentals of Renewable Energy Resources	-	-	5	-	-	-
12.	Solar Photovoltaic	-	-	8	-	-	-
13.	Renewable Energy Instrumentation Applications	-	-	9	-	-	-
14.	Fundamental of Thermodynamics and Heat Transfer	-	-	9	-	-	-
15.	Renewable Energy Instrumentation Applications Laboratory	-	-	8	-	-	-
16.	Solar Energy	-	-	-	6	-	-
17.	Hydraulics and Pneumatics	-	-	-	8	-	-

18.	Wind Energy	-	-	-	8	-	-
19.	Bio-Energy				10		-
20.	Environmental studies				5		-
21.	Energy conservation				5		-
22.	Constitution of India				2		-
23.	Energy Efficiency, Economics and Audit					5	-
24.	Marine and Geothermal Energy					5	-
25.	Electric and Hybrid Vehicle					7	-
26.	Distributed Generation Systems					15	-
27.	Installation , Maintenance & Monitoring of Renewable Energy Power Plant					6	-
28.	Fuel cell & Hydrogen Energy					8	-
29.	Renewable Energy Power Plant						8
30.	Entrepreneurship & Start - ups						9
31.	Electrical Machine and Measurement						8
32.	Internet of Things						5
	Operations Research						
	Engineering Economics and Accountancy						
	Heat Transfer						
33.	Project Work	-	-	-	-	-	12
34.	Student Centered Activities	1	4	3	4	2	6
Total		**48**	**48**	**48**	**48**	**48**	**48**

7. STUDY AND EVALUATION SCHEME FOR DIPLOMA PROGRAMME IN RENEWABLE ENERGY
FIRST SEMESTER

Sr. No.	SUBJECTS	STUDY SCHEME Periods/Week			Credits	MARKS IN EVALUATION SCHEME								Total Marks of Internal & External
						INTERNAL ASSESSMENT			EXTERNAL ASSESSMENT					
		L	T	P		Th	Pr	Tot	Th	Hrs	Pr	Hrs	Tot	
1.1	*Communication Skill-I	4	-	2	4	20	10	30	50	2 ½	20	3	70	100
1.2	*Applied Mathematics-I	5	-	-	4	20	-	20	50	2 ½	-	-	50	70
1.3	*Applied Physics-I	5	-	2	5	20	10	30	50	2 ½	20	3	70	100
1.4	*Applied Chemistry	5	-	2	5	20	10	30	50	2 ½	20	3	70	100
1.5	Engineering Drawing -I	-	-	8	2	-	40	40	60	3	-	-	60	100
1.6	Basics of Information Technology	-	-	6	2	-	40	40	-	-	60	3	60	100
1.7	General Workshop Practice-I	-	-	8	2	-	40	40	-	-	60	4	60	100
#Student Centred Activities		-	-	1	1	-	30	30	-	-	-	-	-	30
Total		**19**	**-**	**29**	**25**	**80**	**180**	**260**	**260**	**-**	**180**	**-**	**440**	**700**

* Common with other diploma programmes

APPROVED IN CDC COMMITTEE MEETING OF BTE,UP,LUCKNOW DATED:26-09-2021

Student Centred Activities will comprise of co-curricular activities like extension lectures, games, hobby clubs e.g. photography etc., seminars, declamation contests, educational field visits, N.C.C., NSS, Cultural Activities and self study etc.

STUDY AND EVALUATION SCHEME FOR DIPLOMA PROGRAMME IN RENEWABLE ENERGY
SECOND SEMESTER

Sr. No.	SUBJECTS	STUDY SCHEME Periods/Week			Credits	MARKS IN EVALUATION SCHEME								Total Marks of Internal & External
						INTERNAL ASSESSMENT			EXTERNAL ASSESSMENT					
		L	T	P		Th	Pr	Tot	Th	Hrs	Pr	Hrs	Tot	
2.1	*Applied Mathematics-II	5	-	-	4	20	-	20	50	2 ½	-	-	50	70
2.2	*Applied Physics-II	5	-	2	5	20	10	30	50	2 ½	20	3	70	100
2.3	Basic Electrical Engineering	5	-	2	5	20	10	30	50	2 ½	20	3	70	100
2.4	Basics of Mechanical and Civil Engineering	6	-	2	5	20	10	30	50	2 ½	20	3	70	100
2.5	*Analog Electronics	4	-	4	5	20	10	30	50	2 ½	20	3	70	100
2.6	General Workshop Practice-II	-	-	8	2	-	40	40	-	-	60	4	60	100
#Student Centred Activities		-	-	5	1	-	30	30	-	-	-	-	-	30
Total		**25**	**-**	**23**	**27**	**100**	**110**	**210**	**250**	**-**	**140**	**-**	**390**	**600**

* Common with other diploma programmes

Student Centred Activities will comprise of co-curricular activities like extension lectures, games, hobby clubs e.g. photography etc.,

APPROVED IN CDC COMMITTEE MEETING OF BTE,UP,LUCKNOW DATED:26-09-2021

seminars, declamation contests, educational field visits, N.C.C., NSS, Cultural Activities and self-study etc.

STUDY AND EVALUATION SCHEME FOR DIPLOMA PROGRAMME IN RENEWABLE ENERGY

THIRD SEMESTER

Sr. No.	SUBJECTS	STUDY SCHEME Periods/Week			Credits	MARKS IN EVALUATION SCHEME								**Total Marks of Internal & External**
						INTERNAL ASSESSMENT			EXTERNAL ASSESSMENT					
		L	T	P		Th	Pr	Tot	Th	Hrs	Pr	Hrs	Tot	
3.1	Fundamentals of Renewable energy Resources	5	-	-	4	20	-	20	50	2 ½	-	-	50	70
3.2	Solar Photovoltaic	4	-	4	4	20	10	30	50	2 ½	20	3	70	100
3.3	Renewable Energy Instrumentation Applications	4	1	4	5	20	10	30	50	2 ½	20	3	70	100
3.4	Fundamental of Thermodynamics and Heat Transfer	5	1	3	6	20	10	30	50	2 ½	20	3	70	100
3.5	Renewable Energy Instrumentation Applications Laboratory	-	-	8	2	-	20	20	-	-	50	3	50	70
3.6	*Communication Skill II	4	-	2	4	20	10	30	50	2 ½	20	3	70	100
#Student Centred Activities (SCA)		-	-	3	1	-	30	30	-	-	-	-	-	30
Total		22	2	24	27	100	90	190	250	-	130	-	380	570

APPROVED IN CDC COMMITTEE MEETING OF BTE,UP,LUCKNOW DATED:26-09-2021

* Common with other diploma programmes

Student Centred Activities will comprise of co-curricular activities like extension lectures, self-study, games, hobby clubs e.g. photography etc., seminars, declamation contests, educational field visits, N.C.C., NSS, Cultural Activities, disaster management and safety etc.

STUDY AND EVALUATION SCHEME FOR DIPLOMA PROGRAMME IN RENEWABLE ENERGY

FOURTH SEMESTER

Sr.No.	SUBJECTS	STUDY SCHEME Periods/Week			Credits	MARKSINEVALUATIONSCHEME								**Total Marks of Internal & External**
						INTERNAL ASSESSMENT			EXTERNAL ASSESSMENT					
		L	T	P		Th	Pr	Tot	Th	Hrs	Pr	Hrs	Tot	
4.1	Solar Energy	4	-	2	4	20	10	30	50	2½	20	3	70	100
4.2	Hydraulics and Pneumatics	5	1	2	6	20	10	30	50	2½	20	3	70	100
4.3	Wind Energy	5	1	2	6	20	10	30	50	2½	20	3	70	100
4.4	Bio-Energy	4	-	6	6	20	10	30	50	2½	20	3	70	100
4.5	Environmental studies	3	-	2	3	20	10	30	50	2½	20	3	70	100
4.6	Energy conservation	3	-	2	3	20	10	30	50	2½	20	3	70	100
4.7	Constitution of India	2	-	-	1	-	20	20	-	-	30	3	30	50
#Student Centred Activities (SCA)		-	-	3	1	-	30	30	-	-	-	-	-	30
Total		26	2	20	30	120	110	230	300	-	150	-	450	680

* Common with other diploma programmes

APPROVED IN CDC COMMITTEE MEETING OF BTE,UP,LUCKNOW DATED:26-09-2021

Student Centred Activities will comprise of co-curricular activities like extension lectures, self-study, games, hobby clubs e.g. photography etc., seminars, declamation contests, educational field visits, N.C.C., NSS, Cultural Activities, disaster management and safety etc.

STUDY AND EVALUATION SCHEME FOR DIPLOMA PROGRAMME IN RENEWABLE ENERGY
FIFTH SEMESTER

Sr. No.	SUBJECTS	STUDY SCHEME Periods/Week			Credits	MARKS IN EVALUATION SCHEME								**Total Marks of Internal & External**
						INTERNAL ASSESSMENT			EXTERNAL ASSESSMENT					
		L	T	P		Th	Pr	Tot	Th	Hrs	Pr	Hrs	Tot	
	Industrial Training (4 Weeks)	-	-	-							50		50	50
5.1	Energy Efficiency, Economics and Audit	5	-		4	20	-	20	50	2 ½	-	-	50	70
5.2	Marine and Geothermal Energy	5	-	-	6	20	-	20	50	2 ½	-	-	50	70
5.3	Electric and Hybrid Vehicle	5	2	-	6	20	-	20	50	2 ½	-	-	50	70
5.4	Distributed Generation Systems	6	-	8	7	20	20	40	50	2 ½	50	4	100	140
5.5	Installation , Maintenance & Monitoring of Renewable Energy Power Plant	4	-	2	4	20	10	30	50	2 ½	20	3	70	100
5.6	Fuel cell & Hydrogen Energy	4	-	4	4	20	10	30	50	2 ½	20	3	70	100

#Student Centred Activities (SCA)	-	-	3	1	-	30	30	-	-	-	-	-	30
Total	29	2	17	27	100	90	190	250	-	130	-	380	630

* Common with other diploma programmes

Student Centred Activities will comprise of co-curricular activities like extension lectures, self-study, games, hobby clubs e.g. photography etc., seminars, declamation contests, educational field visits, N.C.C., NSS, Cultural Activities, disaster management and safety etc.

STUDY AND EVALUATION SCHEME FOR DIPLOMA PROGRAMME IN RENEWABLE ENERGY

SIXTH SEMESTER

Sr.No.	SUBJECTS	STUDY SCHEME Periods/Week			Credits	MARKSINEVALUATIONSCHEME								Total Marks of Internal &External
						INTERNALASSESSMENT			EXTERNALASSESSMENT					
		L	T	P		Th	Pr	Tot	Th	Hrs	Pr	Hrs	Tot	
6.1	Renewable Energy Power Plant	6	-	2	6	20	10	30	50	2½	20	3	70	100
6.2	Entrepreneurship & Startups	5	-	4	7	20	10	30	50	2½	20	3	70	100
6.3	Electrical Machine and Measurement	4	-	4	5	20	10	30	50	2½	20	3	70	100
6.4	(Elective) Internet of Things Operations Research Engineering Economics and Accountancy Heat Transfer	5	-	-	6	20	-	20	50	2½	-	-	50	70
6.5	Project Work	-	-	12	4	-	40	40	-	-	60	3	60	100

#StudentCentred Activities(SCA)	-	-	6	1	-	30	30	-	-	-	-	-	30
Total	20		28	29	80	100	180	200	-	120	-	320	500

* Common with other diploma programmes

#Student Centred Activities will comprise of co-curricular activities like extension lectures, self-study, games, hobby clubs e.g. photography etc., seminars, declamation contests, educational field visits, N.C.C.,NSS, Cultural Activities ,disaster management and safety etc

8. GUIDELINES FOR ASSESSMENT OF STUDENT CENTRED ACTIVITIES (SCA)

It was discussed and decided that the maximum marks for SCA should be 30 as itinvolves a lot of subjectivity in the evaluation. The marks may be distributed as follows:

i. 10 Marks for general behaviour and discipline
(by HODs in consultation with all the teachers of the department)

ii. 5 Marks for attendance as per following:
(by HODs in consultation with all the teachers of the department)

a) 75 - 80% 2 Marks
b) 80 - 85% 4 Marks
c) Above 85% 5 Marks

iii. 15 Marks maximum for Sports/NCC/Cultural/Co-curricular/ NSSactivities as per following:
(by In-charge Sports/NCC/Cultural/Co-curricular/NSS)

a) 15 - State/National Level participation
b) 10 - Participation in two of above activities
c) 5 - Inter-Polytechnic level participation

Note: There should be no marks for attendance in the internal sessional of different subjects.

1.1 COMMUNICATION SKILLS – I

L	T	P
4	-	2

RATIONALE

Knowledge of English Language plays an important role in career development. This subject aims at introducing basic concepts of communication besides laying emphasis on developing listening, speaking, reading and writing skills as parts of Communication Skill.

LEARNING OUTCOMES

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

.

- Understand the importance of effective communication
- Describe the process of communication
- Communicate effectively in different contexts
- Identify parts of speech
- Write correct sentences using appropriate vocabulary
- Reproduce and match words and sentences in a paragraph
- Write various types of paragraphs, notices for different purposes and composition on picture with appropriate format
- Read unseen texts with comprehension

.

DETAILED CONTENTS

1 Basics of Communication (13 periods)

1.1 Definition and process of communication
1.2 Types of communication - formal and informal, oral and written, verbal and non-verbal
1.3 Communications barriers and how to overcome them
1.4 Barriers to Communication, Tools of Communication

2 Application of Grammer (18 periods)

2.1 Parts of Speech (Noun, verb, adjective, adverb) and modals
2.2 Sentences and its types
2.3 Tenses
2.4 Active and Passive Voice
2.5 Punctuation
2.6 Direct and Indirect Speech

3 Reading Skill (10 periods)

Unseen passage for comprehension (one word substitution, prefixes, suffixes, antonyms, synonyms etc. based upon the passage to be covered under this topic)

4 Writing Skill (15 periods)

4.1 Picture composition
4.2 Writing paragraph
4.3 Notice writing

LIST OF PRACTICALS

Note: Teaching Learning Process should be focused on the use of the language in writing reports and making presentations.

Topics such as Effective listening, effective note taking, group discussions and regular presentations by the students need to be taught in a

project oriented manner where the learning happens as a byproduct.

Listening and Speaking Exercises

1. Self and peer introduction
2. Newspaper reading
3. Just a minute session-Extempore
4. Greeting and starting a conversation
5. Leave taking
6. Thanking
7. Wishing well
8. Talking about likes and dislikes
9. Group Discussion
10. Listening Exercises.

INSTRUCTIONAL STRATEGY

Student should be encouraged to participate in role play and other student centred activities in class room and actively participate in listening exercises

MEANS OF ASSESSMENT

- Assignments and quiz/class tests, mid-semester and end-semester written tests
- Actual practical work, exercises and viva-voce
- Presentation and viva-voce

RECOMMENDED BOOKS

1. Communicating Effectively in English, Book-I by Revathi Srinivas; Abhishek Publications, Chandigarh.
2. Communication Techniques and Skills by R. K. Chadha; DhanpatRai Publications, New Delhi.

3. High School English Grammar and Composition by Wren & Martin; S. Chand & Company Ltd., Delhi.
4. Excellent General English-R.B.Varshnay, R.K. Bansal, Mittal Book Depot, Malhotra
5. The Functional aspects of Communication Skills – Dr. P. Prsad, S.K. Katria & Sons, New Delhi
6. Q. Skills for success – Level & Margaret Books, Oxford University Press.
7. e-books/e-tools/relevant software to be used as recommended by AICTE/BTE/NITTTR.

Websites for Reference:

1. http://www.mindtools.com/ page 8.html – 99k

SUGGESTED DISTRIBUTION OF MARKS

Topic No.	Time Allotted (Periods)	Marks Allotted (%)
1	13	24
2	18	32
3	10	16
4	15	28
Total	**56**	**100**

1.2 APPLIED MATHEMATICS - I

L	T	P
5	-	-

RATIONALE

Contents of this course provide fundamental base for understanding elementary mathematics and their uses in solving engineering problems. Contents of this course will enable students to use basic mathematical function like logarithms, partial fractions, matrices and basic 2D, curves in solving various engineering problems of all fields.

LEARNING OUTCOMES

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

- Apply Binomial theorem to solve engineering problems
- Apply determinants properties and Crammer's rule to solve engineering problems
- Apply dot & cross product of vectors to find the solution of engineering problems
- Use complex numbers in various engineering problems
- Apply differential calculus and higher order to solve engineering problems
- Find velocity, acceleration, errors and approximation in engineering problems with application of derivatives.

DETAILED CONTENTS

1. Algebra -I (12 Periods)

   1.1 Series : AP and GP; Sum, nth term, Mean
   1.2 Binomial theorem for positive, negative and fractional index (without proof). Application of Binomial theorem.
   1.3 Determinants : Elementary properties of determinant of order 2 and 3, Multiplication system of algebraic equation, Consistency of equation, Crammer's rule

2. Algebra- II (12 Periods)

2.1 Vector algebra : Dot and Cross product, Scaler and vector triple product.

2.2 Complex number.

Complex numbers, Representation, Modulus and amplitude Demoivre theorem, its application in solving algebraic equations, Mod. function and its properties..

3. Trigonometry (10 Periods)

3.1 Relation between sides and angles of a triangle : Statement of various formulae showing relationship between sides and angle of a triangle.

3.2 Inverse circular functions : Simple case only

4. Differential Calculus - I (18 Periods)

4.1 Functions, limits, continuity, - functions and their graphs, range and domain, elementary methods of finding limits (right and left), elementary test for continuity and differentiability.

4.2 Methods of finding derivative, Trigonometric functions, exponential function, Function of a function, Logaritimic differentiation, Differentiation of Inverse trigonometric function, Differentiation of implicit functions.

5. Differential Calculus - II (18 Periods)

5.1 Higher order derivatives, Leibnitz theorem (without proof). Simple applications.

5.2 Application - Finding Tangents, Normal, Points of Maxima/Minima, Increasing/Decreasing functions, Rate, Measure, velocity, Acceleration, Errors and approximation.

INSTRUCTONAL STRATEGY

The basic instructional strategy to teach basic mathematics, Binomial theorem, trigonometry, differential equations etc. should be conceptual with real world applications of relevant branch. More numerical and theory examples can be used for clear understanding of the content**.**

MEANS OF ASSESSMENT

- Assignments and Quiz/Class Tests
- Mid-term and End-term Written Tests
- Model/Prototype Making

RECOMMENDED BOOKS

1. Elementary Engineering Mathematics by BS Grewal, Khanna Publishers, New Delhi
2. Engineering Mathematics, Vol I & II by SS Sastry, Prentice Hall of India Pvt. Ltd.,
3 Applied Mathematics-I by Chauhan and Chauhan, Krishna Publications, Meerut**.**
4. Applied Mathematics-I (A) by Kailash Sinha and Varun Kumar; Aarti Publication, Meerut

SUGGESTED DISTRIBUTION OF MARKS

Topic	Time Allotted (Periods)	Marks Allotted (%)
1.	12	20
2.	12	20
3.	10	12
4	18	24
5	18	24
Total	**70**	**100**

1.3 APPLIED PHYSICS – I

L	T	P
5	-	2

RATIONALE

Applied physics includes the study of a diversified topics related to 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 behave. Concrete knowledge of physical laws, analysis and applications in various fields of engineering and technology are given prominence in this course content.

Note: Teachers should give examples of engineering/technology applications of various concepts and principles in each topic so that students are able to learn and appreciate these concepts and principles. In all contents, SI units should be followed.

LEARNING OUTCOMES

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

- Identify the use of S.I. system of measurement with accuracy and how it is used in engineering
- Represent physical quantities as scalars and vectors, applying the physical laws and concepts of linear and circular motion in everyday life.
- Solve difficult problems (walking of man, horse and cart problem, flying of bird/ aircraft, etc.)
- Analyse and design banking of roads/railway tracks and apply conservation of momentum principle to Explain rocket propulsion, recoil of gun etc.
- Derive work, power and energy relationship and solve problems about work and power.
- Define work, energy and power and their units.
- Describe conservation of energy and its applications
- Understand the concept of rotational motion of a rigid body and its applications
- Apply the physical laws and concepts of gravity, its variation with longitude and latitude and its uses in space satellite etc. .
- Understand the concept of elasticity, surface tension, pressure and the laws governing movement of fluids.
- Express physical work in term of heat and temperature; Measure temperature in various processes on different scales (Celsius, Kelvin, Fahrenheit etc.)

- Distinguish between conduction, convection and radiation, identify the different methods for reducing heat losses
- Understand the laws of thermodynamics, Carnot cycle and their applications.

DETAILED CONTENTS

1. Units and Dimensions (10 Periods)

1.1 Need of Measurement in engineering and science, unit of a physical quantities - fundamental and derived units, systems of units (FPS, CGS and SI units)

1.2 Dimensions and dimensional formulae of physical quantities.

1.3 Principle of homogeneity of dimensions

1.4 Dimensional equations and their applications, conversion of numerical values of physical quantities from one system of units into another, checking the correctness of physical equations and deriving relations among various physical quantities

1.5 Limitations of dimensional analysis

1.6 Error in measurement, accuracy and precision of instruments, random and systematic errors, absolute error, relative error, and percentage error, Estimation of probable errors in the results of measurement (combination of errors in addition, subtraction, multiplication, division and powers), rules for representing significant figures in calculation.

1.7 Application of units and dimensions in measuring length, diameter, circumference, volume, surface area etc. of metallic and non metallic blocks, wires, pipes etc (at least two each).

2. Force and Motion (10 periods)

2.1 Scalar and vector quantities – examples, representation of vector, types of vectors

2.2 Addition and Subtraction of Vectors, Triangle and Parallelogram law (Statement only), Scalar and Vector Product.

2.3 Resolution of Vectors and its application to lawn roller.

2.4 Force, Momentum, Statement and Derivation of Conservation of linear momentum, its applications such as recoil of gun.

2.5 Impulse and its Applications

2.6 Circular motion (Uniform and Non-uniform), definition of angular displacement, angular velocity, angular acceleration, frequency, time period.

2.7 Relation between linear and angular velocity, linear acceleration and angular acceleration (related numerical)

2.8 Central force, Expression and Applications of Centripetal and centrifugal forces with examples such as banking of roads and bending of cyclist, Principle of centrifuge.

2.9 Application of various forces in lifts, cranes, large steam engines and turbines

3. Work, Power and Energy (10 periods)

3.1 Work: and its units, examples of zero work, positive work and negative work, conservative and non-conservative force,
3.2 Friction: modern concept, types, laws of limiting friction, Coefficient of friction and its Engineering Applications.
3.3 Work done in moving an object on horizontal and inclined plane for rough and plane surfaces with its applications
3.4 Energy and its units: Kinetic energy and potential energy with examples and their derivation, work energy theorem.
3.5 Principle of conservation of mechanical energy for freely falling bodies, examples of transformation of energy.
3.6 Power and its units, calculation of power in numerical problems
3.7 Application of Friction in brake system of moving vehicles, bicycle, scooter, car trains etc.

4 Rotational Motion (10 periods)

4.1 Concept of translatory and rotatory motions with examples
4.2 Definition of torque with examples
4.3 Angular momentum, Conservation of angular momentum (quantitative) and its examples
4.4 Moment of inertia and its physical significance, radius of gyration for rigid body, Theorems of parallel and perpendicular axes (statements only), Moment of inertia of rod, disc, ring and sphere (hollow and solid) (Formulae only). Concept of Fly wheel.
4.5 Rotational kinetic energy, Rolling of sphere on the slant plane,
4.6 Comparison of linear motion and rotational motion.
4.7 Application of rotational motions in transport vehicles, and machines.

5 Motion of planets and satellites (08 periods)

5.1 Gravitational force, Kepler's law of planetary motion,
5.2 Acceleration due gravity and its variation,

5.3 Gravitational Potential and Gravitational potential energy,
5.4 Motion of satellite, orbital velocity and time period of satellite, Total energy and Binding energy of a satellite, Escape energy and escape velocity,
5.5 Types of satellites, Geo-stationary satellite, semi-synchronous, polar satellite (concept only) and their uses in science and technology,
5.6 Concept of Black Holes

6. Properties of Matter (12 periods)

6.1 Elasticity: definition of stress and strain, different types of modulii of elasticity, Hooke's law, significance of stress strain curve
6.2 Pressure: definition, its units, atmospheric pressure, gauge pressure, absolute pressure, Fortin's Barometer and its applications
6.3 Surface tension: concept, its units, angle of contact, Capillary action and determination of surface tension from capillary rise method, applications of surface tension, effect of temperature and impurity on surface tension
6.4 Viscosity and coefficient of viscosity: Terminal velocity, Stoke's law and effect of temperature on viscosity, application in hydraulic systems.
6.5 Concept of fluid motion, stream line and turbulent flow, Reynold's number Equation of continuity, Bernoulli's Theorem and their applications.

7. Heat and Thermodynamics (10 periods)

7.1 Difference between heat and temperature
7.2 Modes of transfer of heat (Conduction, convection and radiation with examples)
7.3 Different scales of temperature and their relationship
7.4 Expansion of solids, liquids and gases, coefficient of linear, surface and cubical expansions and relation amongst them
7.5 Heat conduction in a metal rod, Temperature gradient, Concept of Co-efficient of thermal conductivity, Uses and effects of Heat conduction in Daily life.
7.6 Isothermal and Adibatic process
7.7 Zeroth, First and second law of thermodynamics, Heat engine (concept Only), Carnot cycle.
7.8 Application of various systems of thermometry in refrigeration and air-conditioning etc.

LIST OF PRACTICALS (to perform minimum six experiments)

1. To find radius of wire and its volume and the maximum permissible error in these quantities by using both vernier calipers and screw gauge.
2. To find the value of acceleration due to gravity on the surface of earth by using a simple pendulum.
3. To determine the Radius of curvature of (i) convex mirror, (ii) concave mirror by spherometer
4. To verify parallelogram law of forces
5. To study conservation of energy of a ball or cylinder rolling down an inclined plane.
6. To find the Moment of Inertia of a flywheel about its axis of rotation
7. To determine the atmospheric pressure at a place using Fortin's Barometer
8. To determine the viscosity of glycerin by Stoke's method
9. To determine the coefficient of linear expansion of a metal rod
10. To determine force constant of spring using Hooks law

INSTRUCTIONAL STATREGY

Teacher may use various teaching aids like live models, charts, graphs and experimental kits etc. for imparting effective instructions in the subject. The teacher should explain about field applications before teaching the basics to develop proper understanding of the physical phenomenon. Use of demonstration and animations can make the subject interesting and may develop scientific temper in the students. Teacher must plan a tour of Science Park/planetarium available in nearby areas in order to enhance the interest in this course.

MEANS OF ASSEMENTS

- Assignment & Quiz,
- Mid-Term and End-Term written test,
- Model Making,
- Actual Lab & Practical Work,
- Viva Voce

RECOMMENDED BOOKS

1 Text Book of Physics for Class XI (Part-I, Part-II); N.C.E.R.T., Delhi
2 Concepts in Physics by HC Verma, Vol. I & II, Bharti Bhawan Ltd. New Delhi
3 Comprehensive Practical Physics, Vol, I & II, JN Jaiswal, Laxmi Publications (P) Ltd., New Delhi
4 B.Sc.Practical Physics by C L Arora, S. Chand Publication..
5 Engineering Physics by PV Naik, Pearson Education Pvt. Ltd, New Delhi
6 Engineering Physics by DK Bhhatacharya & Poonam Tandan; Oxford University Press, New Delhi
7 Modern Engineering Physics by SL Gupta, Sanjeev Gupta, Dhanpat Rai Publications
8 V. Rajendran,physics-I, Tata McGraw-Hill raw Hill publication, New Delhi
9 Arthur Beiser, Applied Physics, Tata McGraw-Hill raw Hill publication, New Delhi
10 Physics Volume 1, 5^{th} edition, Haliday Resnick and Krane, Wiley publication

TOPIC WISE DISTRIBUTION OF PERIODS AND MARKS

Topic No.	Time Allotted (Periods)	Marks Allotted (%)
1	10	15
2	10	15
3	10	15
4	10	15
5	08	10
6	12	16
7	10	14
Total	**70**	**100**

1.4 APPLIED CHEMISTRY

L	T	P
5	-	2

RATIONALE

The use of various chemicals and chemical products in diverse technical and engineering fields have repeatedly proved the importance of Applied Chemistry, which enhances its role to a new peak. On the other hand, ever increasing use of such materials will compel engineers, technocrats to acquire essential applied chemistry knowledge in order to select engineering materials, which not only suit them but also provide more environmental compatibility. This situation demands principles of Applied Chemistry in diploma-engineering courses. Principles of Applied Chemistry will enable budding engineers and technocrats to develop scientific temper and appreciate physical, chemical and engineering properties of materials. Hence the subject of Applied Chemistry.

LEARNING OUTCOMES

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

- Classify various substances based on state of aggregation
- Substantiate the laws and principles on which structure of atom is established.
- Explain and predict properties of substances.
- Explain sources of water and various characteristics of water (quantitatively).
- Explain cause and factors which can adversely affecting natural water quality and remedial measures available for water purification
- Think critically, develop and adapt water conservation techniques.
- Explain corrosion of metal and their preventive measures.
- explain chemical nature and causes of corrosion
- apply correct and efficient methods of corrosion prevention.
- explain chemistry of fuels and their relative advantages.
- select most efficient fuel for the engine and engineering applications.
- suggest how to subside air pollution caused by the use of fossil fuels
- explain the chemistry of various polymers and plastics

- verify suitability and select polymer/rubber/plastic materials for engineering applications.

DETAILED CONTENTS

1. Atomic Structure, Periodic Table and Chemical Bonding (14 periods)

    1.1 Fundamental particles- mass and charges of electrons, protons and neutrons with names of the scientists who discovered these fundamental particles.
    1.2 Bohr's model of atom and successes and limitations of atomic theory (qualitative treatment only).
    1.3 Atomic number, atomic mass number isotopes and isobars.
    1.4 Definition of orbit and orbitals, shapes of s and p orbitals only, quantum numbers and their significance,
    1.5 Aufbau's principle, Pauli's exclusion principle and Hund's rule electronic configuration of elements with atomic number (Z) = 30 only. (Electronic configurations of elements with atomic number greater than 30 are excluded).
    1.6 Modern periodic law and periodic table, groups and periods, classification of elements into s, p, d and f blocks (periodicity in properties - excluded)
    1.7 Chemical bonding and cause of bonding and types such as ionic bond in NaCl sigma (σ) and pi (π) covalent bonds in H_2, HCl, Cl_2, elementary idea of hybridization in $BeCl_2$, BF_3, CH_4, NH_3 and H_2O, VSEPR, Molecular orbital Theory
    1.8 States of Matter: Solid, Liquid & Gas, Metallic bonding- explanation with the help of electron gas (sea) model.

2. Fuels and Lubricants (18 periods)

    2.1 Definition of fuel, classification of fuels, characteristics of good fuel, relative merits of gaseous, liquid and solid fuels
    2.2 Calorific value-higher calorific value, lower calorific value, determination of calorific value of solid or liquid fuel using Bomb calorimeter and numerical examples.
    2.3 Coal - types of coal and proximate analysis of coal
    2.4 Fuel rating – Octane number and Cetane number, fuel-structural influence on Octane and Cetane numbers
    2.5 Gaseous fuels – chemical composition, calorific value and applications of natural gas (CNG), LPG, producer gas, water gas and biogas.
    2.6 Elementary ideal on – hydrogen as future fuels, nuclear fuels.
    2.7 Lubricants: Definition and properties, mechanism, industrial application and its function in bearings.
    2.8 Synthetic lubricants and cutting fluids.

3. Water (14 periods)

3.1 Demonstration of water resources on Earth using pie chart.

3.2 Classification of water – soft water and hard water, action of soap on hard water, types of hardness, causes of hardness, units of hardness – mg per liter (mgL^{-1}) and part per million (ppm) and simple numerical, pH and buffer solutions and their applications.

3.3 Disadvantages caused by the use of hard water in domestic and boiler feed water. Primming and foaming and caustic embrittlement in boilers.

3.4 Removal of hardness -Permutit process and Ion-exchange process.

3.5 Physico-Chemical methods for Water Quality Testing

a) Determination of pH using pH meter, total dissolved solids (TDS)

b) Testing and Estimation of- alkalinity, indicator their types and application total hardness by EDTA method and O'Hener's Method. (chemical reaction of EDTA method are excluded).

c) Understanding of Indian Water Quality standards as per WHO

3.6 Natural water sterilization by chlorine and UV radiation and reverse osmosis.

3.7 Municipality waste water treatment. Definition of B.O.D and C.O.D.

4. Electrochemistry (4 periods)

Redox Reaction, Electrode Potential, Nernst equation, Electrochemical cell (Galvanic and Electrobytes); Nernst equation.

5. Corrosion and its Control (10 periods)

5.1 Definition of corrosion and factors affecting corrosion rate.

5.2 Theories of

a) Dry (chemical) corrosion- Pilling Bedworth rule

b) Wet corrosion in acidic atmosphere by hydrogen evolution mechanism

5.3 Definition of passivity and galvanic series

5.4 Corrosion control:

a) Metal coatings – Cathodic protection, Cementation on Base Metal Steel –Application of Metal Zn (Sheradizing),Cr (Chromozing) and Al (Calorizing), Sacrificial protection and impressed current voltage

b) Inorganic coatings – Anodizing and phosphating,

c) Organic coatings - use of paints varnishes and enamels

d) Internal corrosion preventive measures- alloying (with reference to passivating, neutralizing and inhibition) and heat treatment (quenching, annealing)

6. Organic compounds, Polymers and Plastics (10 periods)

6.1 Classification of organic compounds and IUPAC Nomenclature
6.2 Definition of polymer, monomer and degree of polymerization
6.3 Brief introduction to addition and condensation polymers with suitable examples (PE, PS, PVC, Teflon, Nylon -66 and Bakelite)
6.4 Definition of plastics, thermo plastics and thermo setting plastics with suitable examples, distinctions between thermo and thermo setting plastics
6.5 Applications of polymers in industry and daily life

LIST OF PRACTICALS

1. Estimation of total hardness of water using standard EDTA solution
2. Estimation of total alkalinity of given water sample by titrating it against standard sulfuric acid solution
3. Proximate analysis of solid fuel)
4. Estimation of temporary hardness of water sample by O' Hener's Method.
5. Determination of flash and fire point of given lubricating oil using Able's flash point apparatus

INSTRUCTIONAL STRATEGY

Teachers may take help of various models and charts while imparting instructions to make the concept clear. More emphasis should be laid on discussing and explaining practical applications of various chemical process and reactions. In addition, students should be encouraged or motivated to study those processes in more details, which may find practical application in their future professional career.

MEANS OF ASSEMENTS

- Assignment & Quiz,
- Mid-Term and End-Term written test,

- Model Making,
- Actual Lab & Practical Work,
- Viva Voce

RECOMMENDED BOOKS

1. Chemistry in Engineering by J.C. Kuricose & J. Rajaram, Tata McGraw Hill, Publishing Company Limited, New Delhi.
2. Engineering Chemistry by P.C. Jain & Monika Jain, Dhanapat Rai Publishing Company, New Delhi.
3. Eagle's Applied Chemistry - I by S. C. Ahuja & G. H. Hugar, Eagle Prakashan, Jalandhar.
4. Engineering Chemistry – A Text Book by H. K. Chopra & A. Parmar, Narosa Publishing House, New Delhi.
5. Applied Chemistry - I by Dr. P. K Vij & Shiksha Vij, Lords Publications, Jalandhar.
6. Engineering Chemistry by Dr. Himanshu Pandey, Goel Publishing House, Meerut, India

SUGGESTED DISTRIBUTION OF MARKS

Topics	Time Allotted (hrs)	Marks Allotted (%)
1.	14	20
2.	18	24
3.	14	20
4.	4	6
5.	10	15
6.	10	15
Total	**70**	**100**

1.5 ENGINEERING DRAWING - I

L	T	P
-	-	8

RATIONALE

Drawing is the language of engineers and technicians. Reading and interpreting engineering drawing 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.

Note:

i) First angle projection is to be followed
ii) Minimum of 18 sheets to be prepared and atleast 2 sheets on AutoCAD
iii) Instructions relevant to various drawings may be given along with appropriate demonstrations, before assigning drawing practice to students

LEARNING OUTCOMES

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

- Identify and use of different grades of pencils and other drafting instruments which are used in engineering field
- Draw free hand sketches of various kinds of objects.
- Utilize various types of lines used in engineering drawing.
- Read and apply different dimensioning methods on drawing of objects.
- Use different types of scales and their utilization in reading and reproducing drawings of objects and maps.
- Draw 2 - dimensional view of different objects viewed from different angles (orthographic views)
- Draw and interpret complete inner hidden details of an object which are otherwise not visible in normal view
- To make projections of Solid
- Generate isometric (3D) drawing from different 2D (orthographic) views/sketches
- Identify conventions for different engineering materials, symbols, sections of regular objects and general fittings used in Civil and Electrical household appliances

- Use basic commands of AutoCAD.

DETAILED CONTENTS

1. Introduction to Engineering Drawing (03 sheets)

   1.1 Introduction to drawing instruments, materials, layout and sizes of drawing sheets and drawing boards.
   1.2 Different types of lines in Engineering drawing as per BIS specifications
   1.3 Practice of vertical, horizontal and inclined lines, geometrical figures such as triangles, rectangles, circles, ellipses and curves, hexagonal, pentagon with the help of drawing instruments.
   1.4 Free hand and instrumental lettering (Alphabet and numerals) – upper case (Capital Letter), single stroke, vertical and inclined at 75 degree, series of 5,8,12 mm of free hand and instrumental lettering of height 25 to 35 mm in the ratio of 7:4

2. Dimensioning Technique (01 sheet)

   2.1 Necessity of dimensioning, method and principles of dimensioning (mainly theoretical instructions)
   2.2 Dimensioning of overall sizes, circles, threaded holes, chamfered surfaces, angles, tapered surfaces, holes, equally spaced on P.C.D., counter sunk holes, counter bored holes, cylindrical parts, narrow spaces and gaps, radii, curves and arches

3. Scales (02 sheets)

   3.1 Scales –their needs and importance (theoretical instructions), type of scales, definition of R.F. and length of scale
   3.2 Drawing of plain and diagonal scales

4. Orthographic Projections (06 sheets)

   4.1 Theory of orthographic projections (Elaborate theoretical instructions)
   4.2 Projection of Points in different quadrant
   4.3 Projection of Straight Line (1^{st} and 3^{rd} angle)
      4.3.1. Line parallel to both the planes
      4.3.2. Line perpendicular to any one of the reference plane
      4.3.3. Line inclined to any one of the reference plane.

4.4 Projection of Plane – Different lamina like square, rectangular, triangular and circle inclined to one plane, parallel and perpendicular to another plane in 1st angle only

4.5 Three views of orthographic projection of different objects. (At least one sheet in 3rd angle)

4.6 Identification of surfaces

5 Projection of Solid (02 sheets)

5.1. Definition and salient features of Solid

5.2. Types of Solid (Polyhedron and Solid of revolution)

5.3 To make projections, sources, Top view, Front view and Side view of various types of Solid.

6. Sections (02 sheets)

6.1 Importance and salient features

6.2 Drawing of full section, half section, partial or broken out sections, Offset sections, revolved sections and removed sections.

6.3 Convention sectional representation of various materials, conventional breaks for shafts, pipes, rectangular, square, angle, channel, rolled sections

6.4 Orthographic sectional views of different objects.

7. Isometric Views (02 sheets)

7.1 Fundamentals of isometric projections and isometric scale.

7.2 Isometric views of combination of regular solids like cylinder, cone, cube and prism.

8. Common Symbols and Conventions used in Engineering (02 sheets)

8.1 Civil Engineering sanitary fitting symbols

8.2 Electrical fitting symbols for domestic interior installations

*9. Introduction to AutoCAD (02 sheets)

Basic introduction and operational instructions of various commands in AutoCAD. At least two sheets on AutoCAD of cube, cuboid, cone, pyramid, truncated cone and pyramid, sphere and combination of above solids.

* **Auto CAD drawing will be evaluated internally by sessional marks and not by final theory paper.**

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. The institute should procure AutoCAD or other engineering graphics software for practice in engineering drawings. Teachers should undergo training in AutoCAD/Engineering Graphic. Separate labs for practice on AutoCAD should be established.

MEANS OF ASSESSMENT

- Sketches
- Drawing
- Use of software

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, New Delhi
3. Elementary Engineering Drawing in First Angle Projection by ND Bhatt; Charotar Publishing House Pvt. Ltd., Anand
4. Engineering Drawing I & II by JS Layall; Eagle Parkashan, Jalandhar
5. Engineering Drawing I by DK Goel, GBD Publication.

1.6 BASICS OF INFORMATION TECHNOLOGY

L	T	P
-	-	6

RATIONALE

Information technology has great influence on all aspects of life. Primary purpose of using computer is to make the life easier. Almost all work places and living environment are being computerized. The subject introduces the fundamentals of computer system for using various hardware and software components. 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 concept of information technology and its scope; operating a computer; use of various tools using MS Office/Open Office/Libre Office using internet etc., form the broad competency profile of diploma holders. This exposure will enable the students to enter their professions with confidence, live in a harmonious way and contribute to the productivity.

Note:

Explanation of Introductory part should be demonstrated with practical work. Following topics may be explained in the laboratory along with the practical exercises. There will not be any theory examination.

LEARNING OUTCOMES

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

Identify Computer Hardware Components, Network Components and Peripherals.
Explain the role of an Operating System.
Install System and Application Software.
Explain the function of the system components including Processor, Motherboard and Input-output devices.
Use Word Processing Software to prepare document.
Use Spreadsheet Software to create workbooks and automate calculation.
Use Presentation Software to create interactive presentation.
Perform fundamental tasks common to most application software including print, scan, save, edit, cut, copy, paste, format, spell and grammar check.
Find and evaluate information on the Web.
Install Antivirus.
Safeguard against Online Frauds, threats and crimes.
Use online office tools(Google suits)

TOPICS TO BE EXPLAINED THROUGH DEMONSTRATION

1. Introduction to Computers and Peripherals.

Components of Computer, Types of Computer, CPU, RAM, ROM, Hard disk, USB, Flash drive, CD, DVD,Blue ray, Keyboard, Mouse, Monitor, LCD, Printer, Plotter, Scanner, Modem, Sound Cards, Speakers, CMOS battery, Sharing of Printers.

2. Operation System and Application Software

System Software, Application Software, Virtualization Software, Utility Software, MS Office/Open Office/Libreoffice, Working with window, Desktop components, Menu bars, creating shortcut of program. Installation of Application softwares, Antivirus and Drivers.

3. Word Processing, Spreadsheet and Presentation

Usage and creation of word document, spreadsheets and presentation, Google Suits (Google drive, google sheet, google doc. Google presentation)

.

4. Internet

Basics of Networking – LAN, WAN, Wi-Fi technologies, Concept of IP Addrsses, DNS, Search Engines, e-mail, Browsing and cyber laws.

LIST OF PRACTICAL EXERCISES

Identify various components, peripherals of computer and list their functions.
Installation of various application software and peripheral drivers
Installation of operating system (windows/linux/others)
Creation and Management (Rename, delete, search of file and folders)
Installation of Antivirus and remove viruses
Scanning and printing documents
Browsing, Downloading, Information using Internet
E-Mail ID creation, comparing, sending and receiving e-mail. Attaching a file with e-mail message.

9. Word Processing (MS Office/Open Office)

a) File Management

Opening, creating and saving a document, locating files, copying contents in some different file(s), protecting files, giving password protection for a file

Page set up

Setting margins, tab setting, ruler, indenting

Editing a document

Entering text, cut, copy, paste using tool- bars

d) Formatting a document

Using different fonts, changing font size and colour, changing the appearance through bold/italic/underlined, highlighting a text, changing case, using subscript and superscript, using different underline methods

Aligning of text in a document, justification of document, inserting bullets and numbering

Formatting paragraph, inserting page breaks and column breaks, line spacing

Use of headers, footers: Inserting footnote, end note, use of comments, autotext

Inserting date, time, special symbols, importing graphic images, drawing tools

e) Tables and Borders

Creating a table, formatting cells, use of different border styles, shading in tables, merging of cells, partition of cells, inserting and deleting a row in a table

Print preview, zoom, page set up, printing options

Using find, replace options

Using Tools like

Spell checker, help, use of macros, mail merge, thesaurus word content and statistics, printing envelops and lables

Using shapes and drawing toolbar,

Working with more than one window .

10. Spread Sheet Processing (MS Office/Open Office/Libre Office)

Starting excel, open worksheet, enter, edit, data, formulae to calculate values, format data, save worksheet, switching between different spread sheets

Menu commands:

Create, format charts, organise, manage data, solving problem by analyzing data. Programming with Excel Work Sheet, getting information while working

Work books:

Managing workbooks (create, open, close, save), working in work books, selecting the cells, choosing commands, data entry techniques, formula

creation and links, controlling calculations
Editing a worksheet, copying, moving cells, pasting, inserting, deletion cells, rows, columns, find and replace text, numbers of cells, formatting worksheet, conditional formatting
Creating a chart:
Working with chart types, changing data in chart, formatting a chart, use chart to analyze data
Using a list to organize data, sorting and filtering data in list
Retrieve data with query:
Create a pivot table, customizing a pivot table. Statistical analysis of data
Exchange data with other application:
Embedding objects, linking to other applications, import, export document.

11. PowerPoint Presentation (MS Office/Open Office/Libre office)

a) Introduction to PowerPoint
- How to start PowerPoint
- Working environment: concept of toolbars, slide layout & templates.
- Opening a new/existing presentation
- Different views for viewing slides in a presentation: normal, slide sorter.

b) Addition, deletion and saving of slides

c) Insertion of multimedia elements
- Adding text boxes
- Adding/importing pictures
- Adding movies and sound
- Adding tables and charts etc.
- Adding organizational chart
- Editing objects
- Working with Clip Art

d) Formatting slides
- Using slide master
- Text formatting
- Changing slide layout
- Changing slide colour scheme
- Changing background
- Applying design template

12. Google Suits
Using Google drive, Google shut, Google docs, Google slides.

INSTRUCTIONAL STRATEGY

Since this subject is practice oriented, the teacher should demonstrate the capabilities of computers to students while doing practical exercises. The students should be made familiar with computer parts, peripherals, connections and proficient in making use of MS Office/Open Office/Libre office/Google Suit in addition to working on internet. The student should be made capable of working on computers independently.

MEANS OF ASSESSMENT

Class Tests/Quiz
Software Installation and Use
Viva-Voce
Presentation

RECOMMENDED BOOKS

Fundamentals of Computer by V Rajaraman; Prentice Hall of India Pvt. Ltd., New Delhi
Information Technology for Management by Henery Lucas, Tata McGraw Hills, New Delhi
Computers Fundamentals Architecture and Organisation by B Ram, revised Edition, New Age International Publishers, New Delhi
Computers Today by SK Basandara, Galgotia publication Pvt Ltd. Daryaganj, New Delhi.
Internet for Every One by Alexis Leon and Mathews Leon; Vikas Publishing House Pvt. Ltd., Jungpura, New Delhi
A First Course in Computer by Sanjay Saxena; Vikas Publishing House Pvt. Ltd., Jungpura, New Delhi
Computer Fundamentals by PK Sinha; BPB Publication, New Delhi
Fundamentals of Information Technology by Leon and Leon; Vikas Publishing House Pvt. Ltd., Jungpura, New Delhi
On Your Marks - Net…Set…Go… Surviving in an e-world by Anushka Wirasinha, Prentice Hall of India Pvt. Ltd., New Delhi
Fundamentals of Information Technology by Vipin Arora, Eagle Parkashan, Jalandhar

Reference websites
www. tutorialspoint..com

www.sf.net
Gsuite.google.com
Spoken-tutorial.org
Swayam.gov.in

1.7 GENERAL WORKSHOP PRACTICE – I

(Common for Civil Engineering, Electrical Engineering and Chemical Engineering)

L	T	P
-	-	8

RATIONALE

In order to have a balanced overall development of diploma engineers, it is necessary to integrate theory with practice. General workshop practices are included in the curriculum in order to provide hands-on experience about use of different tools and basic manufacturing practices. This subject aims at developing general manual and machining skills in the students. In addition, the development of dignity of labour, safety at work place, team working and development of right attitude are the other objectives.

LEARNING OUTCOMES

After completing the course, the students will be able to:

- Identify tools and equipment used and their respective functions.
- Identify different types of materials and their basic properties.
- Use and take measurements with the help of basic measuring tools/equipment.
- Select proper tools for a particular operation.
- Select materials, tools, and sequence of operations to make a job as per given specification/drawing.
- Prepare simple jobs independently and inspect the same.
- Follow safety procedures and precautionary measures.
- Use safety equipment and Personal Protection Equipment.

DETAILED CONTENTS (PRACTICAL EXERCISES)

Note: The students are supposed to come in proper workshop dress prescribed by the institute. Wearing shoes in the workshop(s) is compulsory. Importance of safety and cleanliness, safety measures and upkeep of tools, equipment and environment in each of the following shops should be explained and practiced. The students should prepare sketches of various tools/jobs in their practical Notebook.

The following shops are included in the syllabus:

1. Carpentry Shop
2. Painting and Polishing Shop
3. Electrical Shop
4. Welding Shop
5. Plumbing Shop

1. CARPENTRY SHOP

1.1 General Shop Talk

- 1.1.1 Name and use of raw materials used in carpentry shop : wood & alternative materials
- 1.1.2 Names, uses, care and maintenance of hand tools such as different types of Saws, C-Clamp, Chisels, Mallets, Carpenter's vices, Marking gauges, Try-squares, Rulers and other commonly used tools and materials used in carpentry shop by segregating as cutting tools, supporting tools, holding tools , measuring tools etc.
- 1.1.3 Specification of tools used in carpentry shop.
- 1.1.4 Different types of Timbers, their properties, uses & defects.
- 1.1.5 Seasoning of wood.

1.2. Practice

- 1.2.1 Practices for Basic Carpentry Work
- 1.2.2 Sawing practice using different types of saws
- 1.2.3 Assembling jack plane — Planning practice including sharpening of jack plane cutter
- 1.2.4 Chiselling practice using different types of chisels including sharpening of chisel
- 1.2.5 Making of different types of wooden pin and fixing methods. Marking measuring and inspection of jobs.

1.3 Job Practice

Job 1	Marking, sawing, planning and chiselling and their practice
Job II	Half Lap Joint (cross, L or T – any one)
Job III	Mortise and Tenon joint (T-Joint)
Job IV	Dove tail Joint (Lap or Bridle Joint)

1.4. Demonstration of job showing use of Rip Saw, Bow saw and Tenon saw, method of sharpening various saws.

2. PAINTING AND POLISHING SHOP

2.1. Introduction of paints, varnishes, Reason for surface preparation, Advantages of Painting, other method of surface coating ie. Electroplating etc.

2.2. Job Practice

Job 1: To prepare a wooden surface for painting apply primer on one side and to paint the same side. To prepare french polish for wooden surface and polish the other side.

Job II: To prepare metal surface for painting, apply primer and paint the same.

Job III: To prepare a metal surface for spray painting, first spray primer and paint the same by spray painting gun and compressor system.

The sequence of polishing will be as follows:

i) Abrasive cutting by leather wheel

ii) Polishing with hard cotton wheel and with polishing material

iii) Buffing with cotton wheel or buff wheel.

3. ELECTRICAL SHOP

3.1 Study, demonstration and identification of common electrical materials with standard ratings and specifications such as wires, cables, switches, fuses, cleats, clamps and allied items, tools and accessories.

3.2 Study of electrical safety measures and protective devices.

Job I Identification of phase, Neutral and Earth wires for connection to domestic electrical appliances and their connections to three pin plugs.

Job II Carrying out house wiring circuits using fuse, switches, sockets, ceiling rose etc. in batten or P.V.C. casing-caping.

3.3 Study of common electrical appliances such as auto electric iron, electric kettle, ceiling/table fan, desert cooler etc.

3.4 Introduction to the construction of lead acid battery and its working.

Job III Installation of battery and connecting two or three batteries in series and parallel.

3.5 Introduction to battery charger and its functioning.

Job IV Charging a battery and testing with hydrometer and cell tester

4. WELDING SHOP

4.1 Introduction and importance of welding as compared to other material joining processes. Specifications and type of welding machines, classification and coding of electrodes, welding parameters, welding joints and welding positions. Materials to be welded, safety precautions.

4.2 Job Practice

Job I Practice of striking arc (Minimum 4 beads on 100 mm long M.S. flat).

Job II Practice of depositing beads on plate at different current levels. (Minimum 4 beads on M.S. plate at four setting of current level).

Job III Preparation of lap joint using arc welding process.

Job IV Preparation of T-joint using gas welding or arc welding on 100 mm x 6 mm MS Flat

5. PLUMBING SHOP

5.1. Use of personal protective equipments, safety precautions while working and cleaning of shop.

5.2. Introduction and demonstration of tools, equipment and machines used in plumbing shop.

5.3. Introduction of various pipes and pipe fittings of elbow, nipple, socket, union etc.

5.4. Job Practice

Job 1 : Preparation of job using elbow, bend and nipple

Job II: Preparation of job using Union, Tap, Plug and Socket.

Job III: Threading practice on pipe with die

MEANS OF ASSESSMENT

- Workshop jobs
- Report writing, presentation and viva voce

RECOMMENDED BOOKS

1. Workshop Technology I,II,III, by SK Hajra, Choudhary and AK Choudhary; Media Promoters and Publishers Pvt. Ltd. Mumbai.
2. Workshop Technology Vol. I, II, III by Manchanda; India Publishing House, Jalandhar.
3. Workshop Training Manual Vol. I, II by S.S. Ubhi; Katson Publishers, Ludhiana.
4. Manual on Workshop Practice by K Venkata Reddy; MacMillan India Ltd., New Delhi
5. Basic Workshop Practice Manual by T Jeyapoovan; Vikas Publishing House (P) Ltd., New Delhi
6. Workshop Technology by B.S. Raghuwanshi; Dhanpat Rai and Co., New Delhi
7. Workshop Technology by HS Bawa; Tata McGraw Hill Publishers, New Delhi.

2.1 APPLIED MATHEMATICS - II

L	T	P
5	-	-

RATIONALE

Basic elements of integral calculus, differential calculus, numerical methods, differential m equations included in this course will play a vital role in understanding engineering problem mathematically. This will also develop analytical as well as conceptual abilities among students.

LEARNING OUTCOMES

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

- Calculate simple integration by methods of integration
- Evaluate the area under curves, surface by using definite integrals.
- Calculate the area and volume under a curve along areas
- Solve the engineering problems with numerical methods.
- Understand the geometric shapes used in engineering problems by co-ordinate geometry.

DETAILED CONTENTS

1. Integral Calculus - I (20 Periods)

Methods of Indefinite Integration :-

1.1 Integration by substitution.
1.2 Integration by rational function.
1.3 Integration by partial fraction.
1.4 Integration by parts.
1.5 Integration of special function

2. Integral Calculus - II: (20 Periods)

2.1 Meaning and properties of definite integrals, Evaluation of definite integrals..

2.2 Application : Length of simple curves, Finding areas bounded by simple curves Volume of solids of revolution, centre of mean of plane areas.

2.3 Simposns 1/3rd and Simposns3/8th rule and Trapezoidal Rule : their application in simple cases. Numerical solutions of algebraic equations; Bisections method, Regula-Falsi method, Newton-Raphson's method(without proof), Numerical solutions of simultaneous equations; Gauss elimination method(without proof)

3. Co-ordinate Geometry (2 Dimension) (18 Periods)

3.1 Circle

Equation of circle in standard form. Centre - Radius form, Diameter form, Two intercept form.

4. Co-ordinate Geometry (3 Dimension) (12 Periods)

4.1 Straight lines and planes in space

Distance between two points in space, direction cosine and direction ratios, Finding equation of a straight line (without proof)

INSTRUCTONAL STRATEGY

Basic elements of Differential Calculus, Integral Calculus and differential equations can be taught conceptually along with real engineering applications in which particular algorithm and theory can be applied. Numerical examples will be helpful in understanding the content of the subject.

MEANS OF ASSESSMENT

- Assignments and Quiz/Class Tests
- Mid-term and End-term Written Tests
- Model/Prototype Making

RECOMMENDED BOOKS

1. Elementary Engineering Mathematics by BS Grewal, Khanna Publishers, New Delhi
2. Engineering Mathematics, Vol I & II by SS Sastry, Prentice Hall of India Pvt. Ltd.,
3 Applied Mathematics-II by Chauhan and Chauhan, Krishna Publications, Meerut**.**
4. Applied Mathematics-I (B) by Kailash Sinha and Varun Kumar; Aarti Publication, Meerut

SUGGESTED DISTRIBUTION OF MARKS

Topic	Time Allotted (Periods)	Marks Allotted (%)
1.	20	28
2.	20	28
3.	18	24
4	12	20
Total	**70**	**100**

2.2 APPLIED PHYSICS – II

L	T	P
5	-	2

RATIONALE

Applied physics includes the study of a diversified topics related to 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 behave. Concrete knowledge of physical laws, analysis and applications in various fields of engineering and technology are given prominence in this course content.
Note: Teachers should give examples of engineering/technology applications of various concepts and principles in each topic so that students are able to learn and appreciate these concepts and principles. In all contents, SI units should be followed**.**

LEARNING OUTCOMES

After undergoing this subject, the student will be able to

• Define wave motion its types (Transverse and Longitudinal), Periodic and Simple Harmonic Motion, solve simple problems.
• Define the terms: frequency, amplitude, wavelength, velocity of a wave.
• Explain various Engineering, Medical and Industrial applications of Ultrasonics.
• Apply acoustics principles to various types of buildings to get best sound effect
• Explain diffraction, interference, polarization.
• Define capacitance and its unit. They will be able to explain the function of capacitors in simple circuits, solve simple problems using C=Q/V
• Explain the role of free electrons in insulators, conductors and semiconductors, qualitatively the terms: potential, potential difference, electromotive force.
• Explain the concept of electric current, resistance and itsmeasurement.
• List the effects of an electric current and their common applications, State and apply Ohm's law, calculate the equivalent resistance of a variety of resistor combinations, determine the energy consumed by an appliance, distinguish between AC and DC electricity
• Explain Biot-Savart Law, Ampere's law, Lorenz Force.
• State the laws of electromagnetic induction, describe the effect on a current-carrying conductor when placed in a magnetic field
• Explain operation of moving coil galvanometer, simple DC motor
• Apply the knowledge of diodes in rectifiers, adapters IC's and various electronic circuits. Apply the concept of light amplification in designing of various LASER based instruments and optical sources.
• Explain total internal reflection and apply this concept for optical fibre and its uses in
Medical field and Communication.

DETAILED CONTENTS

1. Wave motion and its applications (10 periods)

1.1 Wave motion, transverse and longitudinal wave motion with examples, sound and light waves, relationship among wave velocity, frequency and wave length and its application

1.2 Wave equation y = r sin wt, phase, phase difference, principle of superposition of waves

1.3 Simple Harmonic Motion (SHM): definition and characteristic, expression for displacement, velocity, acceleration, time period, frequency in S.H.M., Energy of a body executing S. H. M., simple pendulum, concept of simple harmonic progressive wave,

1.4 Free, Damped and forced oscillations, Resonance with examples, Q-factor

1.5 Definition of pitch, loudness, quality and intensity of sound waves, intensity level, Echo and reverberation, Sabine formula for reverberation time (without derivation), coefficient of absorption of sound, methods to control reverberation time and their applications, Accoustics of building defects and remedy.

1.6 Ultrasonics –production, detection, properties and applications in engineering and medical applications.

2. Wave Optics (10 periods)

2.1 Dual nature of light, wave theory of light, laws of reflection and refraction, Snell's law, Power of lens, magnification.

2.2 Two-Source Interference, Double-Slit interference, Interference due to thin films, Fresnel's biprism.

2.3 use of interference making highly efficient solar panel.

2.4 diffraction, Single Slit diffraction, Intensity calculation etc

2.5 Polarization of electromagnetic waves, polarizing sheets, polarizing by Reflection (Brewser's law), Malus law, use of polariods.

3. Electrostatics (10 periods)

3.1 Concept of charge, Coulombs law, Electric field of point charges, Electric lines of force and their properties, Electric flux, Electric potential and potential difference.

3.2 Gauss law of electrostatics: Application of Gauss law to find electric field intensity of straight charged conductor, plane charged sheet and charged sphere.

3.3 Capacitor and its working principle, Capacitance and its units. Capacitance of parallel plate capacitor. Series and parallel combination of capacitors (numericals), charging and discharging of a capacitor.

3.4 Dielectric and its effect on capacitance, dielectric break down.

3.5 Application of electrostatics in electrostatic precipitation of microbes and moisture separation from air and gases in industry for pollution control (Brief explanation only)

4. Current Electricity (10 periods)

4.1 Electric Current, Resistance, Specific Resistance, Conductance, Specific Conductance, Series and Parallel combination of Resistances. Factors affecting Resistance, Colour coding of carbon Resistances, Ohm's law. Superconductivity.
4.2 Kirchhoff's laws, Wheatstone bridge and its applications (meter bridge and slide wire bridge)
4.3 Concept of terminal potential difference and Electro motive force (EMF), potentiometer.
4.4 Heating effect of current, Electric power, Electric energy and its units (related numerical problems), Advantages of Electric Energy over other forms of energy
4.5 Examples of application of DC circuits in various electrical and electronics equipment such as C.R.O, T.V., Audio-Video System, Computers etc.

5. Magneto Statics and Electromagnetism (08 periods)

5.1 Magnetic poles, force on a moving charge, circulating charges, force on a current carrying wire, Hall effect, torque on a current loop.
5.2 Magnetic field due to moving charge(Biot-Savart Law), due to current (Biot-Savart Law), parallel currents, field of a solenoid, Ampere's law.
5.3 Faraday's law, Lenz' law, motional emf, induced electric fields.
5.4 Magnetic dipole and force on a magnetic dipole in a non-uniform field, Magnetization, Gauss' law for magnetism.
5.5 Types of magnetic materials. Dia, para and ferromagnetic materials with their properties,
5.6 Application of electromagnetism in ac/dc motors and generators.

6. Semiconductor physics (12 periods)

6.1 Types of materials (insulator, semi conductor, conductor), intrinsic and extrinsic semiconductors, p-n junction diode and its V-I characteristics
6.2 Diode as rectifier – half wave and full wave rectifier (centre taped),
6.3 Semiconductor transistor, pnp and npn (concepts only)
6.4 Application of semiconductor diodes (Zener, LED) and that of transistor as amplifier and oscillator.

7. Modern Physics (10 Periods)

7.1 Lasers: concept of energy levels, ionizations and excitation potentials; spontaneous and stimulated emission; laser and its characteristics, population inversion, Types of lasers; Ruby and He-Ne lasers, engineering and medical applications of lasers.
7.2 Fibre optics: Total internal reflection and its applications, Critical angle and conditions for total internal reflection, introduction to optical fibers, light propagation, types, acceptance angle and numerical aperture, types and applications of optical fibre in communication.
7.3 Introduction to nanotechnology, nanoparticles and nano materials,

LIST OF PRACTICALS (To perform minimum six experiments)

1. To determine the velocity of sound with the help of resonance tube.
2. To find the focal length of convex lens by displacement method.

3. To find the refractive index of the material of given prism using spectrometer.
4. To find the wavelength of sodium light using Fresnel's biprism.
5. To verify laws of resistances in series and parallel combination
6. To verify ohm's laws by drawing a graph between voltage and current.
7. To measure very low resistance and very high resistances using Slide Wire bridge
8. Conversion of Galvanometer into an Ammeter and Voltmeter of given range.
9. To draw hysteresis curve of a ferromagnetic material.
10. To draw characteristics of a pn junction diode and determine knee and break down voltages.
11. To find wave length of the laser beam.
12. To find numerical aperture of an optical fiber.

INSTRUCTIONAL STATREGY

Teacher may use various teaching aids like live models, charts, graphs and experimental kits etc. for imparting effective instructions in the subject. The teacher should explain about field applications before teaching the basics to develop proper understanding of the physical phenomenon. Use of demonstration and animations can make the subject interesting and may develop scientific temper in the students. Teacher must plan a tour of Science Park/planetarium available in nearby areas in order to enhance the interest in this course.

MEANS OF ASSESSMENT

Assignment & Quiz,
Mid-Term and End-Term written test,
Model Making,
Actual Lab & Practical Work,
Viva-Voice

RECOMMENDED BOOKS

1. Text Book of Physics (Part-I, Part-II); N.C.E.R.T., Delhi
2. Concepts in Physics by HC Verma, Vol. I & II, Bharti Bhawan Ltd. New Delhi
3. A Text Book of Optics, Subramanian and Brij Lal, S Chand & Co., New Delhi
4. Practical Physics, by C. L. Arora, S Chand publications
5. Engineering Physics by PV Naik, Pearson Education Pvt. Ltd, New Delhi
6. Modern Engineering Physics by SL Gupta, Sanjeev Gupta, Dhanpat Rai Publications.
7. Physics Volume 2, 5th edition, Haliday Resnick and Krane, Wiley publication
8. Fundamentals of Physics by Haliday, Resnick & Walker 7th edition, Wiley

TOPIC WISE DISTRIBUTION OF PERIODS AND MARKS

Topic No.	Time Allotted (Periods)	Marks Allotted (%)
1	10	15
2	10	15
3	10	15
4	10	15
5	08	10
6	12	16
7	10	14
Total	**70**	**100**

2.3 Basic Electrical Engineering

L T P
5 - 4

RATIONALE

A diploma holder may be involved in various jobs ranging from preventive maintenance of electrical installation to fault location. In addition, he/she may be working in testing laboratories where he/she uses measuring instruments. To carry out these and similar jobs effectively, knowledge of basic concepts, principles and their applications is very essential. This course will enable the students to understand the basic concepts and principles of DC and AC fundamental, ac circuits, batteries, electromagnetic induction, voltage and current sources etc

LEARNING OUTCOMES :

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

• Identify and able to take readings on various electrical equipment's (voltmeter, ammeter, CRO, wattmeter, multi-meter)
• Determination of voltage-current relationship in a DC circuit under specific physical conditions
• Measure resistance of an ammeter and a voltmeter
• Verify DC circuits (Thevenin, Nortons, Superposition theorem, Maximum Power Transfer Theorem)
• Verify Kirchhoff's Current and Voltage Laws in a dc circuit
• 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
• Test a lead - acid storage battery
• Measure power and power factor in a single phase R-.L-.C. Circuit and calculation of active and reactive powers in the circuit.
• Measure voltages and currents in polyphase a.c. circuits for star ard delta connections.

DETAILED CONTENTS

1. Overview of DC Circuits (08 periods)

1.1 Definition of basic terms, such as current, EMF, Potential Difference (PD); Ohm's Law and its limitations; Factors affecting resistors and capacitors; simple problems on series and parallel combinations of resistors with their wattage considerations
1.2 Application of Kirchhoff's current law and Kirchhoff's voltage law to simple circuits. Star – Delta connections and their conversion.

2. DC Circuit Theorem (06 periods)

Superposition principle, Maximum Power Transfer Theorem, Thevenin's theorem, Norton's theorem, application of network theorems in solving D.C. circuit problems.

3. Voltage and Current Sources (04 periods)

3.1 Concept of voltage source, symbol and graphical representation characteristics of ideal and practical sources.
3.2 Concept of current sources, symbol, characteristics and graphical representation of ideal and practical current sources.
3.3 Inter Conversion of Voltage-Source and Current Source.

4. Electro Magnetic Induction (10 periods)

4.1 Concept of electro-magnetic field produced by flow of electric current, magnetic circuit, concept of magneto-motive force (MMF), flux, reluctance, permeability, analogy between electric and magnetic circuit.
4.2 Faraday's laws of electro-magnetic induction, principles of self and mutual induction, self and mutually induced e.m.f, simple numerical problems.
4.3 Concept of current growth, decay and time constant in an inductive (RL) circuit.
4.4 Energy stored in an inductor, series and parallel combination of inductors.

5. Batteries (08 periods)

5.1 Basic idea of primary and secondary cells
5.2 Construction, working principle and applications of Lead-Acid, NickelCadmium and Silver-Oxide batteries
5.3 Charging methods used for lead-acid battery (accumulator)
5.4 Care and maintenance of lead-acid battery 5.5 Series and parallel connections of batteries
5.6 General idea of solar cells, solar panels and their applications
5.7 Introduction to maintenance free batteries

6. AC Fundamentals (10 periods)

6.1 Concept of alternating quantities
6.2 Difference between ac and dc
6.3 Concepts of: cycle, frequency, time period, amplitude, instantaneous value, average value, r.m.s. value, maximum value, form factor and peak factor.
6.4 Representation of sinusoidal quantities by phasor diagrams.
6.5 Equation of sinusoidal wave form for an alternating quantity and its derivation

6.6 Effect of alternating voltage applied to a pure resistance, pure inductance and pure capacitance

7. AC Circuits (18 periods)

7.1 Concept of inductive and capacitive reactance
7.2 Alternating voltage applied to resistance and inductance in series.
7.3 Alternating voltage applied to resistance and capacitance in series.
7.4 Introduction to series and parallel resonance and its conditions
7.5 Power in pure resistance, inductance and capacitance, power in combined RLC circuits. Power factor, active and reactive power and their significance, definition and significance of power factor.
7.6 Definition of conductance, susceptance, admittance, impedance and their units
7.7 Introduction to polyphase a.c. systems, advantages of polyphase system over single phase system. Relations between line and phase value of voltages and currents for star and delta connections and their phasor diagram, power in polyphase circuits.

8. Various Types of Power Plants (06 periods)

8.1 Brief explanation of principle of power generation practices in thermal, hydro and nuclear power stations and their comparative study. A Visit to a nearby Power Station(s) may be organized for better understanding and exposure.
8.2 Elementary block diagram of above mentioned power stations

LIST OF PRACTICALS

1. Operation and use of measuring instruments viz voltmeter, ammeter, CRO, Wattmeter, multi-meter and other accessories
2. Determination of voltage-current relationship in a dc circuit under specific physical conditions and to draw conclusions.
3. Measurement of resistance of an ammeter and a voltmeter
4. Verification of dc circuits: a. Thevenin's theorem, b. Norton's theorem,
5. Observation of change in resistance of a bulb in hot and cold conditions, using voltmeter and ammeter.
6. Verification of Kirchhoff's Current and Voltage Laws in a dc circuit
7. 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
8. Charging and testing of a lead - acid storage battery.
9. Measurement of power and power factor in a single phase R-.L-.C. circuit and calculation of active and reactive powers in the circuit.

10 Verification of line to line and line to neutral voltages and current in star and delta connections. Note: Visit to a nearby Power Station(s) may be arranged to

demonstrate various aspects of subject

INSTRUCTIONAL STRATEGY

Basic electrical engineering being a fundamental subject, it needs to be handled very carefully and in a manner such that students develop clear understanding of the related concepts and principles. The teacher may lay more emphasis on laboratory work and give home assignments to students to inculcate self-study and problem solving abilities amongst them.

MEANS OF ASSESSMENT

–Assignments and quiz/class tests
- Mid-term and end-term written tests - Presentation
- Model Making

RECOMMENDED BOOKS

1. Basic Electrical Engineering by PS Dhogal, Tata Mc Graw-Hill Education Pvt Ltd., New Delhi.
2. Experiments in Basic Electrical Engineering by SK Bhattacharya, KM Rastogi; New Age International (P) Ltd.; Publishers New Delhi.
3. Electrical Technology by BL Theraja, S Chand and Co, New Delhi.
4. Basic Electrical Engineering by JB Gupta; SK Kataria and Sons, New Delhi. 5. Basic Electrical Engineering by Asfaque Husain, Jain Book Depot, New Delhi

SUGGESTED DISTRIBUTION OF MARKS

Topic No.	Time Allotted (Periods)	Marks Allotted (%)
1	08	11
2	06	09
3	04	06
4	10	16
5	08	11
6	10	14
7	18	26
8	06	09
Total	**70**	**100**

2.4 Basics of Mechanical and Civil Engineering

L T P
5 - 2

RATIONALE

Apart from the common core subjects, some engineering subjects are included in the diploma course of electrical engineering. One of these subjects is Elementry Mech. Engg. to impart some necessary knowledge and skill about mechanical nature. Inclusion of the subject is further justified by the fact that in practical field, any job of electrical and civil technician is intermingled with either civil or mechanical engineering. As such the relevant basic topics of these disciplines are included in the content of the subject. Some study exercises along with some field work have been suggested to give feel of jobs and equipments involved.

LEARNING OUTCOMES

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

- Apply Thermodynamics Laws. • Use of various energy sources.
- Solve basics problems related to fuel and combustion.
- Have an idea of loading on machine components.
- Explain the application of different types of bearings.
- Explain the uses of different types of gears and springs.
- Explain the working principle of different lubrication systems.

SECTION A - MECHANICAL ENGINEERING DETAILED CONTENTS

1. Thermal Engineering (14 periods)

1.1 Sources of Energy Definition, Concept of thermodynamic system and surroundings, Closed system, Open system, Isolated system, Thermodynamics definition of work.Zeroth law of thermodynamics Basic ideas, conventional and nonconventional forms- Thermal, Hydel, Tidal, wind, Solar, Biomass and Nuclear and their uses.

1.2 Fuels & Combustion: Combustion of fuels- their higher and lower calorific values. Combustion equations for carbon, sulphur, hydrogen and their simple compounds. Calculation of minimum amount of air required for complete combustion. Combustion analysis n mass basis and on volume basis. Concept of excess air in a boiler furnace combustion. Heat carried away by flue gases. Analysis of flue gases by Orsat apparatus. Simple numerical problems Idea of specific properties of liquid fuels such as detonation, knock resistance (cetane and octane numbers), viscosity, solidification point, flash point and flame point.

2. Machine Components (20 periods)

Brief idea of loading on machine components.

(i) Pins, Cottor and Knuckle Joints.
(ii) Keys, Key ways and spline on the shaft.
(iii)Shafts, Collars, Cranks, Eccentrics.
(iv) Couplings and Clutches.
(v) Bearings-Plane, Bushed, Split-step, ball, Roller bearing, Journal bearing, Foot step bearing, thrust bearing, collar bearing and Special type bearings and their applications.
(vi) Gears Different types of gears, gear trains and their use for transmission of motion. Determination of velocity ratio for spur gear trains; spur gear, single and double helical gears, Bevel gears, Mitre wheel, worms, Rack and Pinion. Simple and compound and epicyclic gear trains and their use. Definition of pitch and pitch circle & module.
(vii) Springs Compression, Tension, Helical springs,Torsion springs, Leaf and Laminated springs. Their use and material.

3. Lubrication (08 periods)

Different lubrication system for lubricating the components of machines. Principle of working of wet sump and dry sump system of lubrication. (Explain with simple line diagram). Selection of lubricant based on different application (Requirement with the help of manufacturer catalogue)

SECTION B : CIVIL ENGINEERING

4. Construction Materials (06 periods)

Properties and uses of various construction materials such as stones, bricks, lime, content and timber with their properties, physical/field testing, elements of brick masonry.

5. Foundations (08 periods)

5.1 Bearing capacity of soil and its imporance

5.2 Types of various foundations and their salient features, suitability of various foundations for heavy, light and vibrating machines.

6. Concrete (08 periods)

Various ingredients of concrete, different grades of concrete, water cement ratio, workability, physical/field testing of concrete, mixing of concrete, placing and curing of concrete.

7. RCC (06 periods)

Basics of reinforced cement concrete and its use (elementary knowledge), introduction to various structural elements of a building. Note: While imparting instructions, teachers are expected to lay more emphasis on concepts and principles. It will be better if the classes for general engineering are conducted by organized demonstrations for explaining various concepts and principles.

LIST OF PRACTICALS

1. Study and Sketch of Pins and Cottor
2. Study and Sketch of Keys and Key ways
3. Study and sketch of Couplings andClutches
4. Study and Sketch of Bearings
5. Study and Sketch of Springs
6. Study of green energy

7 Testing of bricks

a) Shape and size
b) Soundness test
c) Water absorption
d) Crushing strength

8 Testing of concrete

a) Slump test
b) Compressive Strength of concrete cube

9 The students should be taken to different construction sites to show them various construction materials, concreting process and construction of RCC structural elements, foundations and other civil works.

INSTRUCTIONAL STRATEGY

Teachers should lay emphasis on basic principles and use charts in class, visits to labs and industry may be arranged to demonstrate certain materials and practices.

MEANS OF ASSESSMENT

- Sessional Tests
- End term Tests
- Practicals
- Viva-Voce

RECOMMENDED BOOKS

1. Textbook of Concrete Technology 2nd Edition, by Kulkarni, PD Ghosh TK and Phull, YR; New Age International(P) Ltd, Publishers, New Delhi
2. Materials of Construction by Ghosh; Tata McGraw Hill Publishing Co. Ltd., New Delhi
3. Civil Engineering Materials by TTTI, Chandigarh; Tata McGraw Hill Publishing Co. Ltd., New Delhi
4. Concrete Technology by J.Jha and Sinha; Khanna Publishers, Delhi
5. Building Construction by Jha and Sinha; Khanna Publishers, Delhi
6. Building Construction by Vairani and Chandola; Khanna Publishers, Delhi
7. Civil Engineering Materials by SV Deodhar and Singhai; Khanna Publishers, New Delhi 8. Soil Mechanics and Foundation Engineering by SK Garg; Khanna Publishers, New

SUGGESTED DISTRIBUTION OF MARKS

Topic Time	Allotted (Periods)	Marks Allotted (%)
1	14	20
2	20	28
3	08	12
4	06	08
5	08	12
6	08	12
7	06	08
Total	**70**	**100**

2.5 ANALOG ELECTRONICS

L	T	P
4	-	4

RATIONALE

At present, electronic gadgets are being extensively used in various manufacturing processes in industries, power system operations, communication systems, computers etc. Even for an electrical diploma holder, it is absolutely necessary to have a basic understanding of electronic components, their function and applications. This understanding should facilitate in operation and maintenance equipment, which are electronically controlled.

In this course, topics like semi-conductor Diodes, Bipolar transistors, rectifiers, single stage and multistage amplifiers and field effect transistors have been included.

LEARNING OUTCOMES

After undergoing the subject, students will be able to:

- Use P.N. junction as rectifier
- Use Zener diode as voltage stabilizer
- Use bi-polar transistors and its application as an amplifier and as a switch
- Analyse amplifier and enhance the gain of amplifier
- Use unipolar transistors as amplifier
- Identify and testing of various active and passive components such as resistor, inductor, capacitor, diode and transistor

DETAILED CONTENTS

1. Semiconductor Diodes (12 periods)

1.1 PN Junction, mechanism of current flow in PN junction, drift and diffusion currents, depletion layer, potential barrier, effect of forward and reverse biasing in a PN junction. Concept of junction capacitance in forward and reverse biased conditions. Breakdown mechanism

1.2 Ideal diode, Semiconductor diode characteristics, static and dynamic resistance

1.3 Use of diode as half wave and full wave rectifiers (centre tapped and bridge type), relation between DC output and AC input voltage, efficiency of rectifier

1.4 Concept of ripples, filter circuits – shunt capacitor, series inductor, and pie (π) filters and their applications

1.5 Diode ratings/specifications

1.6 Various types of diodes such as zener diode, varactor diode, schottky diode, light emitting diode, tunnel diode, photo diode; their working characteristics and applications

1.7 Zener diode and its characteristics

1.8 Use of zener diode for voltage stabilization

2 Bi-polar Transistors (06 periods)

2.1 Concept of junction transistor, PNP and NPN transistors, their symbols and mechanism of current flow

2.2 Transistor configurations: common base (CB), common emitter (CE) and common collector (CC), current relation and their input/output characteristics; comparison of the three configurations

3. Transistor Biasing and Stabilization (10 periods)

3.1 Transistor biasing, its need, operating point, effect of temperature on the operating point of a transistor and need of stabilization of operating point.

3.2 Different biasing circuits, limitations, simple problems to calculate operating point in different biasing circuits. Use of Thevenin's theorem to determine operating point

3.3 Concept of h-parameters of a transistor

3.4 Use of data book to know the parameters of a given transistor

4. Single-Stage Transistor Amplifiers (10 periods)

4.1 Single stage transistor amplifier circuit in CE configuration, function of each component
4.2 Working of single stage transistor amplifier, physical and graphical explanation, phase reversal
4.3 Concept of DC and AC load line
4.4 Voltage gain of single stage transistor amplifier using characteristics of the device
4.5 Concept of input and output impedance
4.6 AC equivalent circuit of single stage transistor amplifiers
4.7 Calculation of voltage gain using AC equivalent circuit
4.8 Frequency response of a single stage transistor amplifier

5. Multi-Stage Transistor Amplifiers (10 periods)

5.1 Need of multi-stage transistor amplifiers – different types of couplings, their purpose and applications.
5.2 Knowledge of various terms such as voltage gain, current gain, power gain, frequency response, decibel gain and band width
5.3 RC coupled two-stage amplifiers, circuit details, working, frequency response, applications
5.4 Loading effect in multistage amplifiers
5.5 Elementary idea about direct coupled amplifier, its limitations and applications
5.6 Transformer coupled amplifiers, its frequency response. Effect of co-efficient of coupling on frequency response. Applications of transformer coupled amplifiers

6. Field Effect Transistor (FET) (08 periods)

6.1 Construction, operation, characteristics and applications of a N channel JFET and P channel JFET
6.2 JFET as an amplifier
6.3 Types, construction, operation, characteristics and applications of a MOSFET
6.4 Comparison between BJT, JFET and MOSFET

LIST OF PRACTICALS

1. a) Identification and testing of electronic components such as resistor, inductor, capacitor, diode, transistor and different types of switches used in Electronic circuits
   b) Measurement of resistances using multimeter and their comparison with colour code values
2. To plot V-I characteristics of a Semiconductor diode and to calculate its static and dynamic resistance
3. a) To plot V-I characteristics of a zenor diode and finding its reverse breakdown voltage
   b) Fabrication of a zenor diode voltage stabilizer circuit using PCB
4. Observation of input and output wave shapes of a half-wave rectifier and verification of relationship between dc output and ac input voltage
5. Observation of input and output wave shapes of a full wave rectifier and verification of relationship between dc and ac input voltage
6. Observation of input and output wave shapes of a full wave rectifier with (i) shunt capacitor) (ii) series inductor (iii) Π filter circuits
7. Plotting input and output characteristics of a transistor in CB configuration
8. Plotting input and output characteristics of a transistor in CE configuration
9. Measurement of operating point in case of (i) fixed biased circuit (ii) potential divider biasing circuit and to observe the effect of temperature variation on the operating point.

INSTRUCTIONAL STRATEGY

This subject gives the knowledge of fundamental concepts of basic electronics. The teacher should give emphasis on understanding of concepts and various term used in the subject. The students be made familiar with diodes, transistors, resistors, capacitors, inductors etc. and electrical measuring instruments etc. Practical exercises will reinforce various concepts. Application of Semiconductor Diodes, Transistors, Field Effect Transistors etc must be told to students.

MEANS OF ASSESSMENT

- Assignments and quiz/class Tests
- Midterm and End-term tests
- Laboratory and Practical work
- Presentations
- Viva-Voce

RECOMMENDED BOOKS

1. Basic Electronics and Linear Circuit by NN Bhargava, Kulshreshta and SC Gupta, Tata McGraw Hill Education Pvt Ltd, New Delhi.
2. Principles of Electrical and Electronics Engineering by VK Mehta; S Chand and Co., New Delhi
3. Electronics Devices and Circuits by Millman and Halkias; McGraw Hill.
4. Electronic Devices and Circuits by Dharma Raj Cheruku and Battula Tirumala Krishna: Pearson Education (Singapore) Pvt Ltd., Indian Branch, 482 F.I.E Patparganj, Delhi- 92
5. Basic Electronics by JB Gupta, SK Kataria and Sons, New Delhi
6. Electronics Devices and circuit by Boylested, Tata McGraw Hill, New Delhi

SUGGESTED DISTRIBUTION OF MARKS

Topic No.	Time Allotted (Periods)	Marks Allocation (%)
1	12	21
2	06	11
3	10	18
4	10	18
5	10	18
6	08	14
Total	**56**	**100**

2.6 GENERAL WORKSHOP PRACTICE –II

(Common for Civil Engineering, Electrical Engineering and Chemical Engineering)

L	T	P
-	-	8

RATIONALE

In order to have a balanced overall development of diploma engineers, it is necessary to integrate theory with practice. General workshop practices are included in the curriculum in order to provide hands-on experience about use of different tools and basic manufacturing practices. This subject aims at developing general manual and machining skills in the students. In addition, the development of dignity of labour, safety at work place, team working and development of right attitude are the other objectives.

LEARNING OUTCOMES

After completing the course, the students will be able to:

- Identify tools and equipment used and their respective functions.
- Identify different types of materials and their basic properties.
- Use and take measurements with the help of basic measuring tools/equipment.
- Select proper tools for a particular operation.
- Select materials, tools, and sequence of operations to make a job as per given specification/drawing.
- Prepare simple jobs independently and inspect the same.
- Follow safety procedures and precautionary measures.
- Use safety equipment and Personal Protection Equipment.

DETAILED CONTENTS (PRACTICAL EXERCISES)

Note: The students are supposed to come in proper workshop dress prescribed by the institute. Wearing shoes in the workshop(s) is compulsory.

Importance of safety and cleanliness, safety measures and upkeep of tools, equipment and environment in each of the following shops should be explained and practiced. The students should prepare sketches of various tools/jobs in their practical Notebook.

The following shops are included in the syllabus:

1 Fitting Shop
2 Sheet Metal Shop
3 Mason Shop
4 Machine Shop

1. FITTING SHOP

1.1 Use of personal protective equipment and safety precautions while working.
1.2 Basic deburring processes.
1.3 Introduction to fitting shop tools, marking and measuring devices/equipment.
1.4 Identification of materials. (Iron, Copper, Stainless Steel, Aluminium etc.)
1.5 Identification of various steel sections (flat, angle, channel, bar etc.).
1.6 Introduction to various fitting shop operations/processes (Hacksawing, Drilling, Chipping and Filing).

1.7 Job Practice

Job I Marking of job, use of marking tools, filing and use of measuring instruments. (Vernier caliper, Micrometer and Vernier height gauge).
Job II Filing a rectangular/square piece to maintain dimensions within an accuracy of ±.25 mm.
Job III Making a cut-out from a square piece of MS flat using hand hacksaw and chipping
Job IV Drilling and tapping practice on MS Flat.

2. SHEET METAL SHOP

2.1. Introduction to sheet metal shop, use of hand tools and accessories e.g. different types of hammers, hard and soft mallet, sheet and wire gauge, necessary allowance required during job fabrication, selection of material.
2.2 Introduction and demonstration of hand tools used in sheet metal shop.

2.3 Introduction and demonstration of various machines and equipment used in sheet metal shop e.g. Shearing Machine, Bar Folder, Burring Machine,

2.4 Introduction and demonstration of various raw materials used in sheet metal shop e.g. black-plain sheet, galvanized-iron plain sheet, galvanised corrugated sheet, aluminium sheet etc.

2.5 Study of various types of nuts, bolts, rivets, screws etc.

2.6 Job Practice

Job I: Shearing practice on a sheet using hand shears.

Job II: Practice on making Single riveted lap joint/Double riveted lap Joint.

Job III: Practice on making Single cover plate chain type, zig-zag type and single rivetted Butt Joint.

3 MASON SHOP

3.1. Introduction and importance of Mason shop

3.2. Introduction of tools, equipment and machines used in Mason shop

3.3. Job Practice

Job I : Preparation of simple bond

Job II : Preparation of Arched bond

Job III: Preparation of RCC structure (column and beam)

4 MACHINE SHOP

4.1 Study and sketch of lathe machine

4.2 Study and Sketch of grinders, milling machine, drilling machine and CNC machine.

4.3 Plain and step turning and knurling practice.

4.4 Study and sketch of planning/shaping machine and to plane a rectangle of cast iron.

MEANS OF ASSESSMENT

- Workshop jobs
- Report writing, presentation and viva voce

RECOMMENDED BOOKS

1. Workshop Technology I,II,III, by SK Hajra, Choudhary and AK Choudhary; Media Promoters and Publishers Pvt. Ltd. Mumbai.
2. Workshop Technology Vol. I, II, III by Manchanda; India Publishing House, Jalandhar.
3. Workshop Training Manual Vol. I, II by S.S. Ubhi; Katson Publishers, Ludhiana.
4. Manual on Workshop Practice by K Venkata Reddy; MacMillan India Ltd., New Delhi
5. Basic Workshop Practice Manual by T Jeyapoovan; Vikas Publishing House (P) Ltd., New Delhi
6. Workshop Technology by B.S. Raghuwanshi; Dhanpat Rai and Co., New Delhi
7. Workshop Technology by HS Bawa; Tata McGraw Hill Publishers, New Delhi.

3.1 Fundamentals of Renewable energy Resources

L	T	P
5	-	-

RATIONALE

Environmental and economic benefits of using renewable energy include: Generating energy that produces no greenhouse gas emissions from fossil fuels and reduces some types of air pollution. Diversifying energy supply and reducing dependence on imported fuels.

LEARNING OUTCOMES

After undergoing the subject, the students will be able to:
1. .Basic Knowledge about various type of renewable energy Use solar cell in PV system applications.
2. Test solar cell characteristic parameters.
3. Fabricate photovoltaic array, module, and panel components.

DETAILED CONTENTS

(12 periods)

1. Solar cell fundamentals:

1.1 Current conduction in semiconductor.
1.2 Atomic structure of silicon, Energy band formation in semiconductor, P-Type and N-type material with silicon, Formation of P-N junction of semiconductor.
1.3 Principles for Electron-Hole Pair generation by Photon absorption, Photo- electric effect, Photo-conductive effect and Photovoltaic effect.
1.4 Materials for Opto-Electronic applications.
1.5 Concept of solar cell, Main elements of silicon solar cell.

2. Solar cell characteristics:
(12 periods)
2.1 Current-Voltage (I-V) characteristics of a Photovoltaic cell.
2.2 Power-Voltage (P-V) characteristics of a Photovoltaic cell.

2.3 Equivalent circuit of a solar cell, Maximum power point (MPP).
2.4 Design considerations of Solar cells – Short circuit current (Isc), Open circuit voltage (Voc), Fill factor (FF), Energy losses & factors for loss, Efficiency.
Factors limiting the efficiency of solar cell.
2.5 Impact of external parameters on solar cell performances – (i)Radiation, (ii)Temperature, (iii) Wind velocity.

3. Materials for Photovoltaic Cells:
(10 periods)
3.1 Classification of solar cell, Cell size.
3.2 Single crystalline silicon cell, Polycrystalline silicon cell.
3.3 Thin film solar cell – Amorphous Silicon, Gallium Arsenide, Cadmium Telluride, Copper Indium Gallium Diselenide.
3.4 Multijunction solar cell.
3.5 Other non-silicon materials for photovoltaic cell fabrications.
3.6 Production technology of Gallium Arsenide and Amorphous Solar Cell.
3.7 Materials required for solar panel and formation of solar panel.

4. Technologies for Photovoltaic Cells Fabrication:
(18 periods)
4.1 Dye-sensitized Solar Cell (DSSC) technology, Organic solar cell technology, Quantum Dot Solar cell technology.
4.2 Concept of PV module, PV panel, PV array and its formation.
4.3 Silicon Group and non-Silicon Group, PV cell, PV module, PV panel and PV array fabrication.
4.4 Application of Nano-Technology in Solar Cell.
4.5 Technical data sheet of solar PV panel.
4.6 Basic control diagram of PV system and its components.
4.7 Power distribution layout of PV system.

5. Testing and Evaluation of Photovoltaic Cells:
(18 periods)
5.1 Solar Simulator and its application.
5.2 Current-voltage analysis of solar cell, Power analysis.
5.3 Light soaking and temperature cycling analysis.

INSTRUCTONAL STRATEGY

The basic instructional strategy to teach Fundamentals of Renewable energy Resources, various type of energy resources viz solar energy , wind energy, bio energy, geothermal energy , tidal energy and their application.

MEANS OF ASSESSMENT

- Assignments and Quiz/Class Tests
- Mid-term and End-term Written Tests
- Model/Prototype Making

RECOMMENDED BOOKS

1. Fundamentals of Renewable Energy Sources by N.S. Rathore (Author), Khobragade Chetan (Author), Asnani Bhawana (Author)
2. Fundamentals and Applications of Renewable Energy Mehmet Kanoğlu Yunus A. Çengel John M. Cimbal
3. Fundamentals of Renewable Energy Sources by G.N. Tiwari
4. Fundamentals of Renewable Energy Processes By Aldo Vieira da Rosa

SUGGESTED DISTRIBUTION OF MARKS

Topic	Time Allotted (Periods)	Marks Allotted (%)
1	12	20
2	12	20
3	10	12
4	18	24
5	18	24
Total	**Total 70**	**Total 100**

3.2 Solar Photovoltaic

L	T	P
4	-	2

RATIONALE

Solar cells, also called photovoltaic cells, convert sunlight directly into electricity. Photovoltaic (often shortened as PV) gets its name from the process of converting light (photons) to electricity (voltage), which is called the photovoltaic effect.

LEARNING OUTCOMES

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

1. Identify different types of solar cell, its components & materials.
2. Use solar cell in PV system applications.
3. Test solar cell characteristic parameters.
4. Fabricate photovoltaic array, module, and panel components.

DETAILED CONTENTS

1. Solar Photovoltaic Systems: (12 Periods)

1.1 Components of PV Systems.

1.2 Maximum power condition of PV system.

1.3 Formation of PV Panel, Cell, Module, Array.

1.4 Balance of System (BOS).

1.5 Mounting structures and installation of PV system.

1.6 Solar tracking systems.

1.7 Power conditioning and control of PV system – Inverters, DC-DC Converters.

1.8 Operations of Charge controllers – ON/OFF type, PWM type, MPPT type.

1.9 Battery Storage systems – Lead Acid, Nickel Cadmium, Li-ion, Zinc Manganese dioxide.

2. Classification of PV system: (12 Periods)

2.1 Stand-Alone Solar PV System.

2.2 Grid Interactive Solar PV System.

2.3 Hybrid Solar PV System.

2.4 Centralized and De-Centralized Systems.

3. Evolution on Electric Grid: (10 Periods)

3.1 Concept of Smart Grid.

3.1.1 Definition of Smart Grid.

3.1.2 Need of Smart Grid.

3.1.3 Functions Smart Grid.

3.1.4 Opportunities and barriers of Smart Grid.

3.2 Difference between Conventional Grid and Smart Grid.

3.3 Concept of Resilient Grid and Smart Grid.

3.4 Role of Smart Meter in Smart Grid.

4. Real Time Prising: (18 Periods)

4.1 Smart Appliances.

4.2 Automatic Meter Reading (AMR).

4.3 Smart Sensors.

4.4 Smart Grid Life Cycle, Regulatory & Cost Recovery, Strategy & Planning.

4.5 Technology Integration.

4.6 Business process readiness, Compliance & Risk Management.

5. Solar PV Applications: (18 Periods)

5.1 Grid Interactive Solar PV Power Generation,

5.2 Principles & components of Solar Water Pumping system,

5.3 Principles & components of street Lighting,

5.4 Principles & components of Medical Refrigeration,

5.5 Village Power using solar PV system,

5.6 Telecommunication and signaling using PV system,

5.7 Numerical based on Water Pumping & Street lighting using PV system.

PRACTICAL EXERCISES

1. Troubleshoot solar PV panel and arrays and identify its remedy.
2. Study of different components of a solar inverter system and its troubleshooting.
3. Performance analysis of single phase bridge inverter for R-L load and voltage control by single pulse width modulation.
4. Study of solar smart metering system and its troubleshooting.
5. Experiment to run water pumping system using solar power.
6. Identify different components of solar street lighting system for DC supply.
7. Identify different components of solar street lighting system for AC supply.
8. Assemble the components of solar home lighting system & study the system.
9. Calculate power flow of a stand-alone PV system with DC load and battery.

INSTRUCTONAL STRATEGY

The basic instructional strategy to teach Solar Photovoltaic, Solar Photovoltaic Systems, Classification of PV system, Evolution on Electric Grid, Real Time Prising, Solar PV Applications.

MEANS OF ASSESSMENT

- Assignments and Quiz/Class Tests
- Mid-term and End-term Written Tests
- Model/Prototype Making

RECOMMENDED BOOKS

1. Non-Conventional Energy Resources by B. H. Khan, The McGraw Hill Publications.
2. Non-Conventional Energy Sources by G.D. Rai, Khanna Publications.
3. Solar Energy – Principles of Thermal Collection and Storageb by S. P. Sukhatme and J.K. Nayak, Tata McGraw-Hill, New Delhi.
4. Solar Energy, Fundamentals and Applications by Garg, Prakash, Tata McGraw Hill.

SUGGESTED DISTRIBUTION OF MARKS

Topic	**Time Allotted (Periods)**	**Marks Allotted (%)**
1	12	20
2	12	20
3	10	12
4	18	24
5	18	24
Total	**Total 70**	**Total 100**

3.3 Renewable Energy Instrumentation Applications

L	T	P
4	1	2

RATIONALE

Renewable energy and energy efficiency are among industries where automation, controls, and instrumentation are being applied. These include biofuels, hydrogen and fuel cells, solar, wave energy, wind, and advanced vehicles.

LEARNING OUTCOMES

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

1. To learn efficient operation of various types of instruments utilized for renewable power applications.
2. To know the characteristics, measurement procedure and applications of different instruments.

DETAILED CONTENTS

1. Characteristics of Measurement System: (12 Periods)
   1.1 Concept of Static characteristics,
   1.2 Definition of different static characteristic – Accuracy, Precision, Sensitivity, Linearity, Repeatability, Reproducibility, Hysteresis, Resolution.
   1.3 Dynamic characteristics concept only.

2. Measurement of Displacement and Force: (12 Periods)
   2.1 Measurement of displacement: (i) Strain gauge, (ii) LVDT.
   2.2 Measurement of force: Load cell (column type).

3. Measurement of Level & Flow: (10

Periods)

3.1 Level measurement by Gauge glass, Displacer, Ultrasonic, D/p transmitter.

3.2 Bernoulli's theorem.

3.3 Principle of operation, advantages and disadvantages of different flow measuring instruments: (i) Orifice, (ii) Rotameter, (iii) Differential Pressure Transmitter.

4. Measurement of Temperature: (18 Periods)

4.1 RTD: Basic principle of operation, Equation, Construction, Types, Range, Specification.

4.2 Thermocouple: Basic principle of operation, Equation, Construction, Types, Range, Specification.

5. Measurement of Pressure: (18 Periods)

5.1 Units of pressure, Concept of Absolute pressure, gauge pressure and vacuum.

5.2 Basic principle of operation of different pressure measuring instruments – (i) U tube manometer, (ii) C type bourdon tube.

5.3 Concept of pressure transmitter.

5.4 Dead weight tester.

PRACTICAL EXERCISES

1. Study of different instruments specification for displacement, force, level, pressure, flow measuring system.
2. Experiment to plot and analyse the characteristics curve of strain gauge.
3. Experiment to plot and analyse the characteristics curve of LVDT with distance as input.
4. Experiment to plot the load cell characteristics using different load as input.
5. Experiment to measure level of a tank using Gauge glass, Rotameter and Differential Pressure Transmitter.
6. Experiment to measure level of a tank using Displacer, Ultrasonic level meter.
7. Experiment to measure the temperature using Thermocouple.
8. Identification of different parts of C type burdon tube pressure gauge.
9. Study of operation of dead weight tester and calibration of pressure gauge using it.

INSTRUCTONAL STRATEGY

The basic instructional strategy to teach Renewable Energy Instrumentation Applications, Measurement of Displacement and Force, Characteristics of Measurement System Measurement of Level & Flow, Measurement of Temperature , Measurement of Pressure, Miscellaneous Measurements

MEANS OF ASSESSMENT

- Assignments and Quiz/Class Tests
- Mid-term and End-term Written Tests
- Model/Prototype Making

RECOMMENDED BOOKS

1. Power Electronics for Renewable Energy Systems, Transportation and Industrial Applications (Wiley - IEEE) by Haitham Abu-Rub (Author), Mariusz Malinowski (Author), Kamal Al-Haddad.
2. Applications of Renewable Energy Sources by K P Prasad Rao
3. Renewable Energy and Future Power Systems by Singh, V.K., Bhoi, A.K., Saxena, A., Zobaa, A.F., Biswal, S.
4. Renewable Energy Resources, Challenges and Applications by Mansour Al Qubeissi.

SUGGESTED DISTRIBUTION OF MARKS

Topic	Time Allotted (Periods)	Marks Allotted (%)
1	12	20
2	12	20

3	10	12
4	18	24
5	18	24
Total	70	100

3.4 Fundamentals of Thermodynamics and Heat Transfer

L	T	P
5	1	3

RATIONALE

To understand the fundamental concepts of thermodynamics & fluid Mechanics applied in solar collectors and other devices used in renewable energy and to
Learn operations of various components used in Hydraulic System.

LEARNING OUTCOMES

After completing the course the student will be able to:
1. Apply fundamental concepts of thermodynamics to thermodynamic systems.
2. Understand various laws of thermodynamics.
3. Apply various gas laws & ideal gas processes to various thermodynamic systems.
4. Apply Fluid Mechanics in engineering applications in turbo machinery and flow measurement.
5. Identify and Know the working principle of various components used in Hydraulic System.
6. Select appropriate components required for simple Hydraulic System.

DETAILED CONTENTS

1. Fundamentals of Thermodynamics: (12 periods)

1.1 Pure substance

1.2 System, Boundary, Surrounding.

2. Classification of system (12 periods)

2..1 including open system, closed system, isolated system.

2.2 Properties of system, Intensive and Extensive properties with units and its conversion like Pressure (Atmospheric Pressure, Gauge Pressure and Absolute pressure), Volume, Sp-mass and Temperature. State of a system, change of state, Path, Process and thermodynamic cycle.

2.3 Equilibrium of a system, including Mechanical, Thermal, Chemical and Thermodynamic equilibrium.

3. Definition and units of Transient energy (Work and Heat) (10 periods)

3.1Stored energy (P.E., K.E and Internal energy).

3.2 Point Function & Path Function.

3.3 Displacement work & Flow work.

4. Laws of Thermodynamics and their Applications: (18 periods)

4.1 Zeroth Law of Thermodynamics and Temperature measurement.

4.2 First law of Thermodynamics, Simple Energy Equation for non-flow process (Q - W) = E, Steady Flow Energy Equation and its applications.

4.3 Second Law of Thermodynamics: Kelvin – Plank Statement & Clausius' Statement, Heat Engine, Heat Pump and Refrigerator, Thermal Efficiency, C.O.P., definition and units of Entropy.

5. Ideal gas processes: (12 periods)

5.1 Definition of Specific heat, Specific heat at constant pressure (Cp), Specific heat at constant volume (Cv) and Adiabatic Index (Cp/Cv).

5.2 Governing equation of processes (Pressure & Volume relations).

5.3 Representation of the processes on P-V and T-S diagram,

5.4 Deduce the expression to calculate Work transfer, Heat Transfer, Change of I.E., Change of Enthalpy and Change of Entropy for the following Processes: Constant Pressure Process, Constant volume Process, Constant temperature Process, Adiabatic Process & Polytropic Process (Simple numerical on Processes)

INSTRUCTONAL STRATEGY

The basic instructional strategy to teach Fundamentals of Thermodynamics, Laws of Thermodynamics and their Applications, Ideal gas processes, Properties of fluid and Fluid Flow, Fluid Power Systems and Components of Hydraulic Systems.

MEANS OF ASSESSMENT

- Assignments and Quiz/Class Tests
- Mid-term and End-term Written Test
- Model/Prototype Making

RECOMMENDED BOOKS

1. A Course in Thermal Engineering. Domkundwar V. M. Dhanpat Rai & Co.
2. A text book of Thermal Engineering. R. S. Khurmi S. Chand & co. Ltd.
3. Engineering Thermodynamics Dr. D.S.Kumar S.K. Kataria& Sons
4. A Course in Thermal Engineering. P. L. Ballaney Khanna Publishers
5. Hydraulic, fluid mechanics & fluid machines Ramamrutham S. DhanpatRai and Sons ,New Delhi
6. Fluid Mechanics & Hydraulic machines R.K.Rajput S.Chand
7. Fluid Mechanics & Hydraulic machines R.D.Bansal Laxmi Publication
8. Fluid Mechanics & Hydraulic machines Jagadishlal Metropolitan Book Company
9. Oil Hydraulic System- Principle and maintenance S.R. Majumdar Tata McGraw Hill
10. Fluid Power Generation Transmission & Control Jagadeesha Wiley 11 Industrial Hydraulic Control Peter Rhoner Prentice Hall

PRACTICAL EXERCISES (At least Eight experiments are to be performed)

1. Study the specification & different parts of a Pressure Gauge and its application.
2. Study & measure calorific value of solid fuel using Bomb Calorimeter.
3. Calculation of Characteristic Gas Constant of air based on some practical data (data to be taken from standard book or website).
4. Study of Two stroke Petrol Engine.

5. Study of Two stroke Diesel Engine.
6. Study of Four stroke Petrol Engine.
7. Study of Four stroke Diesel Engine.
8. Experiment to determine Brake power, Indicated power, Efficiencies of Four stroke cycle Diesel Engine.

SUGGESTED DISTRIBUTION OF MARKS

Topic	**Time Allotted (Periods)**	**Marks Allotted (%)**
1	12	20
2	12	20
3	18	24
4	18	24
5	12	12
Total	**Total 72**	**Total 100**

3.5 Renewable Energy Instrumentation Applications Laboratory

L	T	P
-	-	8

RATIONALE

Students will be able to learn efficient operation of various types of instruments utilized for renewable power applications and to know the characteristics of different instruments and their specific use..

LEARNING OUTCOMES

After completing the course the student will be able to:

1. Know the characteristics and specification of different instruments.

2. Know the principle of operation, advantages, disadvantages of different process parameter like Displacement, Force, Pressure, Temperature, Level, Flow etc.

3. Identify different measuring instruments related to specific plant.

4. Use instruments for specific applications.

5. Operate various types of instruments in renewable power applications. After learning the course, the students should be able to:

List of Practicals: (At least Eight experiments are to be performed)

1. Study of different instruments specification for displacement, force, level, pressure, flow measuring system.
2. Experiment to plot and analyse the characteristics curve of strain gauge.
3. Experiment to plot and analyse the characteristics curve of LVDT with distance as input.
4. Experiment to plot the load cell characteristics using different load as input.
5. Experiment to measure level of a tank using Gauge glass, Rotameter and Differential Pressure Transmitter.
6. Experiment to measure level of a tank using Displacer, Ultrasonic level meter.
7. Experiment to measure the flow of liquid using Rotameter, and Differential Pressure Transmitter.
8. Experiment to measure the temperature using Pt100 and Thermocouple.
9. Identification of different parts of C type burdon tube pressure gauge.
10. Study of operation of dead weight tester and calibration of pressure gauge using it

INSTRUCTONAL STRATEGY

The basic instructional strategy to teach Renewable Energy Instrumentation Applications Laboratory **to** Know the characteristics and specification of different instruments. Know the principle of operation, advantages, disadvantages of different process parameter like Displacement, Force, Pressure, Temperature, Level, Flow etc. Identify different measuring instruments related to specific plant.

MEANS OF ASSESSMENT

- Assignments and Quiz/Class Tests
- Mid-term and End-term PracticalTests
- Model/Prototype Making

SUGGESTED DISTRIBUTION OF MARKS

Topic	Time Allotted (Periods)	Marks Allotted (%)
1	12	20
2	12	20
3	10	12
4	18	24
5	18	24
Total	**Total 70**	**Total 100**

3.6 Communication Skill II

L	T	P
4	-	2

RATIONALE

Knowledge of English Language plays an important role in career development. This subject aims at introducing basic concepts of communication besides laying emphasis on developing listening, speaking, reading and writing skills as parts of Communication Skill.

LEARNING OUTCOMES

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

- Frame correct sentences with illustrations
- Comprehend the language correctly
- Interpret the language correctly
- Use given material in new situations.
- Correspond effectively using various types of writings like letters, memos etc.
- Communicate effectively in English with appropriate body language making use of
- correct and appropriate vocabulary and grammar in an organised set up and social context.

DETAILED CONTENTS

1. Functional Grammar (18 periods)
   - 1.1 Prepositions
   - 1.2 Framing Questions
   - 1.3 Conjunctions
   - 1.4 Tenses

2 Reading (18 periods)
   - 2.1 Unseen Passage for Comprehension (Vocabulary enhancement - Prefixes, Suffixes, one word substitution, Synonym and Antonym) based upon the passage should be covered under this topic.

3 Writing Skill (14 periods)
   - 3.1. Correspondence

a) Business Letters- Floating Quotations, Placing Orders, Complaint Letters.
b) Official Letters- Letters to Government and other Offices

3.2. Memos, Circular, Office Orders
3.3. Agenda & Minutes of Meeting
3.4. Report Writing

LIST OF PRACTICALS

Note: Teaching Learning Process should be focused on the use of the language in writing reports and making presentations. Topics such as Effective listening, effective note taking, group discussions and regular presentations by the students need to be taught in a project-oriented manner where the learning happens as a byproduct.

Speaking and Listening Skills
1. Debate
2. Telephonic Conversation: general etiquette for making and receiving calls
3. Offering- Responding to offers.
4. Requesting – Responding to requests
5. Congratulating
6. Exploring sympathy and condolences
7. Asking Questions- Polite Responses
8. Apologizing, forgiving
9. Complaining
10. Warning
11. Asking and giving information
12. Getting and giving permission
13. Asking for and giving opinions

INSTRUCTONAL STRATEGY

Student should be encouraged to participate in role play and other student centered activities in class room and actively participate in listening exercises

MEANS OF ASSESSMENT

- Assignments and Quiz/Class Tests

- Mid-term and End-term Written Tests
- Model/Prototype Making

RECOMMENDED BOOKS

1. Communicating Effectively in English, Book-I by RevathiSrinivas; Abhishek Publications, Chandigarh.
2. Communication Techniques and Skills by R. K. Chadha; DhanpatRai Publications, New Delhi.
3. High School English Grammar and Composition by Wren & Martin; S. Chand & Company Ltd., Delhi.
4. Excellent General English-R.B.Varshnay, R.K. Bansal, Mittal Book Depot, Malhotra.
5. The Functional aspects of Communication Skills – Dr. P. Prsad, S.K. Katria & Sons, New Delhi.
6. Q. Skills for success – Level & Margaret Books, Oxford University Press.

SUGGESTED DISTRIBUTION OF MARKS

Topic	**Time Allotted (Periods)**	**Marks Allotted (%)**
1	18	45
2	18	45
3	14	35
Total	**Total 40**	**Total 100**

4.1 Solar Energy

L	T	P
4	-	2

RATIONALE

Solar thermal has a broader range of uses than PV does, since the sun's heat can be collected and transferred in a medium, and that stored energy is then used for purposes including heating and cooling a home, heating water, cooking food, or creating electricity.

LEARNING OUTCOMES

1. Get concept on amount of solar radiation on earth & its measurement technique.
2. Learn different modes of solar energy collection.
3. Learn about characteristics of different types of solar collectors.
4. Apply the heating effect of solar energy in practical applications.
5. Know about different types of solar water heating systems.

DETAILED CONTENTS

1. Solar Radiation: (12 Periods)

1.1 The Sun as the source of radiation.

1.2 Spectral Distribution of Extraterrestrial Radiation, Variation of Extraterrestrial Radiation.

1.3 Beam, Diffuse & Global Radiation.

1.4 Solar geometry, Basic Earth-Sun angles & their relationship (Numerical).

1.5 The Solar Constant Solar time & Equation of time, Angles for Tracking Surfaces.

2. Measurement of Solar Radiation: (12 Periods)

2.1 Measurement of solar radiation using Pyranometers, Measurement of Direct, Diffuse & Global solar radiation.

2.2 Measurement of duration of Sunshine hours.

2.3 Average Solar Radiation, Clear Sky Radiation, Clear and Cloudy days and its distribution.

2.4 Measurement of Radiation on inclined surfaces.

2.5 Ratio of Beam radiation on Tilted surface to that on Horizontal surface.

3. Solar Collectors: (10 Periods)

3.1 Liquid Flat-Plate Collectors – Materials required, Collector efficiency, Overall heat loss coefficient, Bottom loss coefficient, Top loss coefficient, Side loss coefficient, Sky temperature.

3.2 Basic Flat-Plate Energy Balance Equation.

3.3 Temperature distribution in Flat-Plate Collectors, Collector Heat removal Factor and Flow Factor, Improvement of collector efficiency.

3.4 Evacuated tube collector – Basic principle, construction.

3.5 Testing of solar collectors.

3.6 Solar Concentrating Collector – Classification, Parameters of solar concentrators, Concentration Ratio, Thermal Performance of Concentrating Collectors.

3.7 Cylindrical Parabolic Collector.

3.8 Compound Parabolic Collector (CPC).

3.9 Paraboloid Dish Collector.

3.10 Central Receiver Collector.

4. Solar Air Heating and Solar Water Heating: (18 Periods)

4.1 Solar Air Heater – Types of Air Heaters.

4.2 Collector with Non-porous absorber, Collector with porous absorber.

4.3 Testing Procedure of Solar Air Heater, Performance Analysis of Solar Air Heater.

4.4 Solar Water Heating System, Forced-Circulation and Natural circulation.

4.5 Swimming Pool Heating.

4.6 Testing and Rating of Solar Water Heaters.

4.7 Economics of Solar Water Heating.

5. Solar Thermal Devices: (18 Periods)

5.1 Solar Cooker – Types, Basic principle.

5.2 Box type solar cooker – Design, Construction and Performance.

5.3 Paraboloid type solar cooker.

5.4 Testing of solar cooker.

5.5 Solar Dryers – Types, Basic principle, Cabinet type Dryer & Indirect Dryer, Applications.

5.6 Solar still – Basic principle, Components required, Schematic diagram, Applications.

PRACTICAL EXERCISES:

1. Experiment to measure beam, diffuse and global radiation on horizontal surface using Pyranometer and plot radiation vs. time characteristics for certain duration.
2. Experiment to measure beam, diffuse and global radiation on tilted surface at different angles of inclination and plot radiation vs. time characteristics for certain duration.
3. Study the different parts of a solar flat plate collector.
4. Experiment for characterization of a solar flat plate collector and evaluate its parameters.
5. Study of different parts of an evacuated tube collector.
6. Experiment for characterization of evacuated tube collector and evaluate its parameters.
7. Study of different parts of a solar concentrating collector.
8. Experiment for characterization of a solar concentrating collector and evaluate its parameters.
9. Experiment to measure thermal performance of a solar cooker with varying reflector.
10. Experiment to measure the parameters of a solar cooling system.
11. Experiment to measure the parameters of a solar dryer.

INSTRUCTONAL STRATEGY

The basic instructional strategy to teach Solar Thermal, Solar Radiation, Measurement of Solar Radiation, Solar Collectors, Solar Air Heating and Solar Water Heating, Solar Thermal Devices, Solar Thermal Applications.

MEANS OF ASSESSMENT

- Assignments and Quiz/Class Tests
- Mid-term and End-term Written Tests
- Model/Prototype Making

RECOMMENDED BOOKS

1. Solar thermal energy storage Book by H. P Garg.
2. Solar Energy: Principles of Thermal Collection and Storage Book by Suhas Pandurang Sukhatme.
3. Design of Solar Thermal Power Plants Book by Zhifeng Wang.
4. Modeling and Optimization of Solar Thermal Systems: Emerging Research and Opportunities Book by Agnimitra Biswas.
5. Solar Water Heating: A Comprehensive Guide to Solar Water and Space Heating Systems Book by Bob Ramlow.

SUGGESTED DISTRIBUTION OF MARKS

Topic	**Time Allotted (Periods)**	**Marks Allotted (%)**
1	12	20
2	12	20
3	10	12
4	18	24
5	18	24
Total	**Total 70**	**Total 100**

4.2 Hydraulics and Pneumatics

L	T	P
5	1	2

RATIONALE

Diploma holders in this course are required to deal with problems of fluid and use of hydraulics and pneumatics in power generation. For this purpose, knowledge and skills about fluid mechanics and machinery, hydraulics and pneumatics systems are required to be imparted for enabling them to perform above functions.

LEARNING OUTCOMES

After undergoing this course, the students will be able to:
- Explain fluid properties, their units and conversion.
- Measure different types of pressures.
- Maintain different types of pressure gauges.
- Calculate flow and discharge of various liquids.
- Apply Bernoulli's theorem for calculating pipe diameter and height of pipe from ground.
- Calculate pipe friction and losses in pipelines.
- Specify hydraulic machines for different applications.
- Apply Pascal's law in practical applications.
- Explain the functions of various components used in hydraulic and pneumatic system.
- Maintain hydraulic and pneumatic system.

DETAILED CONTENTS

1. Introduction (06 Periods)
   Fluid, types of fluid; properties of fluid viz mass density, weight density (specific weight), specific volume, capillarity, specific gravity, viscosity, compressibility, surface tension, kinematic viscosity and dynamic viscosity and their units.

2. Pressure and its Measurement (07 Periods)

2.1 Concept of pressure (Atmospheric Pressure, gauge pressure, absolute pressure)

2.2 Pascal's law, Pressure measuring devices: peizometer tube manometers - simple U-tube, differential single column, inverted U-tube, micro manometer including simple problems

2.3 Bourdon pressure gauge, Diaphragm pressure gauge, dead weight pressure gauge

3. Flow of Fluids (09 Periods)

Types of fluid flow – steady and unsteady, uniform and non-uniform, laminar and turbulent; rate of flow and their units; continuity equation of flow; potential energy of a flowing fluid; total head; Bernoulli's theorem (statement) and its applications. Discharge measurement with the help of venturi-meter, orifice meter, pitot-tube, limitations of Bernoulli's theorem simple problems.

4. Flow through Pipes (10 Periods)

4.1 Definition of pipe flow, wetted perimeter, hydraulic mean depth, hydraulic gradient; loss of head due to friction; Chezy's equation and Darcy's equation of head loss (without proof), Reynold's number and its effect on pipe friction; siphon, power developed. Water hammer, anchor block, syphon, surge tank (concept only).

4.2 Loss of head in pipes due to sudden enlargement, sudden contraction, obstruction on flow path, change of direction and pipe fittings (without proof)

5. Hydraulic System (05 Periods)

Description, operation and application of hydraulic systems – hydraulic ram, hydraulic jack, hydraulic brake, hydraulic accumulator, hydraulic door closer, hydraulic press.

6. Water Turbines and Pumps (14 Periods)

6.1 Concept of a turbine, types of turbines –impulse and reaction type (concept only), difference between impulse and reaction. Construction and working of pelton wheel, Francis turbine, Propeller and Kaplan turbines. Unit speed, unit power, unit discharge, specific speed of turbines

6.2 Concept of hydraulic pump, single acting reciprocating pump (construction and operation only), vane, screw and gear pumps.

6.3 Construction, working and operation of centrifugal pump. Performance, efficiencies and specifications of a centrifugal pump, pitting, cavitation, priming.

7. Oil Power Hydraulics and Pneumatics (05 Periods)

7.1 Introduction to oil power hydraulic and pneumatic system

7.2 Industrial applications of oil power hydraulic and pneumatic system

8. Components of Hydraulic Systems (06 Periods)

8.1 Basic components of hydraulic system, function of each component in a hydraulic circuit.
8.2 Oil reservoirs, couplings, motors and pumps – definition and functions of the parts,
8.3 Filters- definition and purpose, classification
8.4 Seals and packing- classification of seals, sealing materials.

9. Components of Pneumatic Systems (08 Periods)

9.1 Basic components – function of each component
9.2 Air compressors - Introduction
9.3 Air cylinder – types, function, single acting, double acting, rotating, non-rotating, piston type, diaphragm type, tanden cylinder, double ended cylinder, duplex cylinder.
9.4 Air filter, regulator and lubricator – their necessity in pneumatic circuit. 9.5 Installation, maintenance and application of air cylinders.

INSTRUCTONAL STRATEGY

1. Use computer based learning aids for effective teaching-learning

2. Expose students to real life problems

3. Plan assignments so as to promote problem solving abilities and develop continued learning skills.

MEANS OF ASSESSMENT

- Assignments and Quiz/Class Tests
- Mid-term and End-term Written Tests

RECOMMENDED BOOKS

1.Fluid Mechanics by KL Kumar; S Chand and Co Ltd., Ram Nagar, New Delhi.

2. Hydraulics and Fluid Mechanics Machine by RS Khurmi ;S.Chand& Co. Ltd., New Delhi.

3. Fluid Mechanics through Problems by RJ Garde; Wiley Eastern Ltd., New Delhi.

4. Fluid Mechanics by Dr AK Jain, Khanna Publishers, New Delhi.

5. Hydraulic and Pneumatic Control by K Shammuga Sundaram, S. Chand & Co. Ltd., New Delhi

6. Hydraulics and Hydraulic Machinery by Dr. Jagadish Lal; Metropolitan Book Company Ltd., Delhi.

7. Hydraulic and Pneumatic Power and Control Design, Performance and Application byYeaple, McGraw Hill, New York..

8. Pneumatic Controls by Festo Didactic; Bangalore.

9. Pneumatic Control: An Introduction to the Principles by Werner Deppert and Kurt Stoll; Vogel – Verlag.

PRACTICAL EXERCISES (At least Eight experiments are to be performed)

1. Measurement of pressure head by employing. i) Piezometer tube ii) Single and double column manometer
2. To find out the value of coefficient of discharge for a venturimeter.
3. Measurement of flow by using venturimeter.
4. Verification of Bernoulli's theorem.
5. To find coefficient of friction for a pipe (Darcy's friction).
7. Study the working of a Pelton wheel and Francis turbine.
8. To study a single stage centrifugal pump for constructional details and its operation to find out its normal head and discharge.
9.Operation of double acting cylinder with quick exhaust wall.

SUGGESTED DISTRIBUTION OF MARKS

Topic	Time Allotted (Periods)	Marks Allotted (%)
1	6	8
2	7	10
3	9	12
4	10	15
5	5	8
6	14	20
7	5	7
8	6	8
9	8	12
Total	**Total 70**	**Total 100**

4.3 WIND ENERGY

L	T	P
5	1	2

RATIONALE

This subject aims at introducing basic concepts wind energy conversion their component details & features of a wind turbine required for a wind mill. Concepts of wind power conversion technology and the economics relating to it and troubleshooting of a wind turbine.

LEARNING OUTCOMES

After completing the course the student will be able to:
1. Know about the components of a wind turbine and their functions.
2. Know the principle & components of wind energy conversion system.
3. Know different hybrid models associated with wind energy.
4. Generate electricity from a SWT system & measure the machine parameters.
5. Know the economics relating to wind power generation. 6. Interpret faults in a wind turbine and its remedy.

DETAILED CONTENTS

(12 periods)

1. Basics & Meteorology of Wind:

1.1 Wind resources, Wind energy scenario in India.
1.2 Types of Winds – Planetary or Permanent Winds, Trade Winds, Westerlies Winds, Polar Winds, Periodic Winds, Sea Breeze Winds, Land Breeze Winds.
1.3 Monsoon Winds: Summer, Winter.
1.4 Local & Regional Wind System.
1.5 Factors influencing Wind.
1.6 Pressure Gradient Force, Coriolis Force.
1.7 Power in the Wind, Power vs. Wind speed characteristics.

1.8 Guidelines for Wind turbine site selection.

2. Wind Turbine: (12 periods)

2.1 Parts of wind turbine – Nacelle, Rotor blades, Blade count, Blade materials, Hub, Low speed shaft, Gearbox, High speed shaft, Electrical generator, Yaw mechanism, Electronic controller, Hydraulics system, Cooling unit, Tower, Anemometer, Wind wane.
2.2 Classification of Wind Turbine:
2.2.1 Types, Drag force, Lift force.
2.2.2 Vertical axis Wind Turbine (VAWT) – Types, Constructional details, Operating principle, Advantage & Disadvantages of VAWT.
2.2.3 Horizontal axis Wind Turbine (HAWT) – Types, Constructional details, Operating principle, Advantage & Disadvantages of HAWT.
2.2.4 Direct drive Wind Turbine – Constructional details, Operating principle, Advantage & Disadvantages.
2.2.5 Geared drive Wind Turbine – Constructional details, Operating principle, Advantage & Disadvantages.

3. Wind Energy Conversion: (14 periods)

3.1 Principles of Wind Energy Conversion,
3.1.1 Lift force, Drag force, Pitch angle, Angle of attack,
3.1.2 Theory of energy extraction from Wind,
3.1.3 Wind turbine theory, Condition for maximum performance coefficient.
3.2 Characteristics of Windmill rotor –
3.2.1 Pitch, Tip Speed Ratio (TSR), Number of rotor blade, Solidity.
3.2.2 Rotor Torque equation, Co-efficient of Performance, Power co-efficient, Maximum torque. (Numerical)
3.2.3 Torque – TSR characteristics.
3.3 Working principle of generators used with wind turbine –
3.3.1 Induction generator (IG).
3.3.2 Permanent magnet alternators.
3.3.3 Synchronous generators.
3.3.4 DC generators.

4. Wind Power Generation & Hybrid Systems: (12 periods)

4.1 Fixed Speed Drive Scheme.
4.2 Variable Speed Drive Scheme.

4.3 load control.
4.4 Hybrid System Models.
4.4.1 Wind–Diesel Hybrid System.
4.4.2 Wind– Photovoltaic Hybrid System.
4.4.3 Battery Banks and Power Converters.
4.5 Cost components of wind power project, Fixed cost and variable costs.
4.6 Failure Analysis, Ageing and Rehabilitation:
4.6.1 Effective Operation of Wind Farm.
4.6.2 Central Monitoring System.
4.6.3 Modern Developments & SCADA.
4.6.4 Estimation of Energy Production, Capacity Factor, Capacity Credit.
4.6.5 Off shore Wind farm Development.
4.6.6 Operation & Supervision of Wind Farm.

5. Economics of Wind Energy & Environmental Impact: (12 periods)

5.1 Economics of Wind Energy:
5.1.1 Cost of energy, Return on Investment (ROI).
5.1.2 Life time cash flow and Internal rate of Return (IRR).
5.1.3 National & International Wind Energy Market.
5.2 Environmental Impact and safety Aspects:
5.2.1 Environmental Impact.
5.2.2 Aviation interaction.
5.2.3 Visual impact.
5.2.4 Noise, Radio waves interference.
5.2.5 Bird life, Land use, Impact on flora & fauna.

6. Installation & Maintenance of Wind Turbine: (10 periods)

6.1 Installation steps of small wind turbine.
6.2 Maintenance of different parts of wind turbine.

6.3 Common electrical faults in wind turbine.

INSTRUCTONAL STRATEGY

The basic instructional strategy to teach Fundamentals of wind energy, Wind Energy Conversion, Wind Power Generation & Hybrid Systems, Economics of Wind Energy & Environmental Impact.

MEANS OF ASSESSMENT

- Assignments and Quiz/Class Tests
- Mid-term and End-term Written Tests
- Model/Prototype Making

RECOMMENDED BOOKS

1. Non-Conventional Energy Resources B.H Khan McGraw-Hill
2. Non-Conventional Energy Sources G. D. Rai Khanna Publishers
3. Wind Energy System Gary L. Johnson Printice Hall Inc, New Jersy
4. Power Plant Technology E. I. Walil McGraw Hill Publishers, New York
5. Handbook of Wind Energy T. Burton John Wiley and Sons
6. Wind Electrical Systems S.N. Bhadra, D. Kasthaand S. Banerjee Oxford Univ. Press
7. Non-Conventional Energy Resources ShobhNath Singh Pearson
8. Non-Conventional Energy Resources S.H.Saeed, D.K.Sharma S.K.Kataria & Sons
9. Power Plant Engineering, 3rd Edition, P K. Nag Tata McGraw Hill, 2008.
10. Wind Energy Technology John F. Walker and Nicholas Jenkins John Wiley, 1997

PRACTICAL EXERCISES (At least experiments are to be performed)

1. Identify the specified components of a 1 KW Small Wind Turbine (SWT) system.
2. Experiment to test the performance of Permanent Magnet Synchronous Generator (PMSG) – a) No load test, b) Load test.
3. Study the performance of Direct Drive SWT.

4. Study the performance of Gear Drive SWT.
5. Simulate faults and its remedy in SWT system.
6. Interpret the wiring of a SWT system and its electrical – electronic control panel.
7. Estimate the generation from a 1kW SWT system and measure the parameters of generation.

SUGGESTED DISTRIBUTION OF MARKS

Topic	**Time Allotted (Periods)**	**Marks Allotted (%)**
1	12	20
2	12	20
3	14	24
4	12	12
5	12	12
6	10	12
Total	**Total 72**	**Total 100**

4.4 BIO ENERGY

L	T	P
4	-	6

RATIONALE

Knowledge of biomass resources in our surroundings and conversion of electrical energy from those resources. As production of electricity from a biogas Plant is environment friendly option and it is widely available.

LEARNING OUTCOMES

After completing the course the student will be able to:
1. Know various sources of biomass, their fuel value & applications in biomass energy conversion.
2. Learn the design parameters and applications of different gasifiers.
3. Know about the components of a bio-gas plant and their functions.
4. Get concept on bio-gas production technology.
5. Produce biogas from a small biogas plant and generate electricity there from.
6. Measure parameters of the biogas plant.

DETAILED CONTENTS

1. Fundamentals of Bio-Mass: (12 periods)

1.1 Biomass resources.
1.2 Energy farming.
1.3 Different forms of Biomass, their composition & fuel properties.
1.4 Indian scenario for Biomass resources.
1.5 Bio-Fuel quality assessment studies.
1.6 Advantages of biomass energy.

2. Bio mass Conversion Technology Methods: (12 periods)

2.1 Physical method.
2.2 Incineration.
2.3 Thermo-chemical method.
2.4 Bio-chemical method.
2.5 Urban waste to energy conversion – Municipal solid waste incineration plant, Sewage to energy conversion.

3. Bio-Mass Gasification: (12 periods)

3.1 Theory of Gasification.
3.2 Pre-Treatment methods of Biomass.
3.3 Physical Treatment – Mechanically Grinding & Chipping, Moisture Removing or Adding, Application of Binding Agent, Steaming, Torrefaction.
3.4 Low temperature & High temperature Gasification.
3.5 Chemistry of Gasification & its products.

4. Classification of Gasifier: (16 periods)

4.1 Updraft Gasifier – Principles, Design & Application.
4.2 Downdraft Gasifier – Principles, Design & Application.
4.3 Cross Draft Gasifier – Principles, Design & Applications.
4.4 Open core Gasifier – Principles, Design & Applications.
4.5 Fluidized Bed Gasifier – Principles, Design & Applications.
4.6 Advantages & disadvantages of different gasifiers.
4.7 Gasifier Biomass feed parameters.
4.8 Different Models of Gasifiers.

5. Bio-Gas Production: (18 periods)

5.1 Biogas & its composition.
5.2 Materials used for Biogas generation.
5.3 Anaerobic digestion – Basic process, advantages.
5.4 Constructional details of a Biogas plant.
5.5 Working principle of a Biogas plant.
5.6 Operational parameters of Biogas plant.
5.7 Types of Biogas plant –
5.7.1 Fixed dome type.
5.7.2 Floating type.
5.8 Comparison between the two types, Their advantages & disadvantages.
5.9 Different models of Biogas plant in India – Construction & advantages.
5.10 Constructional details of Digester.
5.11 Design parameters of Digester.
5.12 Benefits of Biogas, Utilization of Biogas.
5.13 Maintenance of Biogas plant.
5.14 Numerical on Biogas plant

INSTRUCTONAL STRATEGY

The basic instructional strategy to teach Fundamentals of Bio-Mass, Bio mass Conversion Technology Methods, Bio-Mass Gasification, Classification and
Bio-Gas Production.

MEANS OF ASSESSMENT

- Assignments and Quiz/Class Tests
- Mid-term and End-term Written Tests

RECOMMENDED BOOKS

1. Non-Conventional Energy Resources B. H. Khan The McGraw Hill Publications.
2. Non-Conventional Energy Sources G.D. Rai Khanna Publications
3. Non-Conventional Energy Resources ShobhNath Singh Pearson
4. Non-Conventional Energy S.H.Saeed, S.K.Kataria& Sons Resources D.K.Sharma
5. Understanding Clean Energy and fuels from biomass Mukunda HS. Wiley-India Pvt. Ltd, 2011
6. Hand book of plant based bio fuel Pandey A. CRC Press, Taylor & Francis, 2008
7. Biogas Systems, Principle and Applications Mital KM. New Age International Ltd. 1996
8. Biomass, Energy and Environment, A developing country perspective from India. Ravindranath NH. Hall DO. Oxford University Press, 1995

PRACTICAL EXERCISES (At least Five experiments are to be performed)

1. Identify the components of Biogas and measure the quantity in percentage.
2. Set up a one cubic meter Anaerobic Digestion Biogas plant.
3. Measure the calorific value of the Biogas.
4. Measure the yield of the Biogas changing the input parameters e.g. temperature, input raw materials.
5. Measure the yield of the Biogas after cleaning.
6. Calculate the efficiency of the Biogas plant.
7. Measure the efficiency of the gas engine with Biogas input.
8. Generate electricity from a Bio gas plant and use it for lighting load.

SUGGESTED DISTRIBUTION OF MARKS

Topic	**Time Allotted (Periods)**	**Marks Allotted (%)**
1	12	20
2	12	20
3	12	20
4	16	20

5	18	20
Total	**Total 70**	**Total 100**

4.5 ENVIRONMENTALSTUDIES

L T P
3 - 2

RATIONALE

A diploma holder must have knowledge of different types of pollution caused due to industries and constructional activities so that he may help in balancing the ecosystem and controlling pollution by various control measures. He should also be aware of environmental laws related to the control of pollution. He should know how to manage the waste. Energy conservation is the need of hour. He should know the concept of energy management and its conservation.

LEARNING OUTCOMES

After undergoing the subject, the student will be able to:
• Comprehend the importance of ecosystem and sustainable
• Demonstrate interdisciplinary nature of environmental issues
• Identify different types of environmental pollution and control measures.
• Take corrective measures for the abatement of pollution.
• Explain environmental legislation acts.
• Define energy management, energy conservation and energy efficiency
• Demonstrate positive attitude towards judicious use of energy and environmental protection
• Practice energy efficient techniques in day-to-day life and industrial processes.
• Adopt cleaner productive technologies
• Identify the role of non-conventional energy resources in environmental protection.

• Analyze the impact of human activities on the environment

DETAILED CONTENTS

1. Introduction (04 Periods)
   1.1 Basics of ecology, eco system- concept, and sustainable development, Resources renewable and non renewable.

2. Air Pollution (04 Periods)
   2.1 Source of air pollution. Effect of air pollution on human health, economy, plant, animals. Air pollution control methods.

3. Water Pollution (08 Periods)
   3.1 Impurities in water, Cause of water pollution, Source of water pollution. Effect of water pollution on human health, Concept of dissolved O2, BOD, COD. Prevention of water pollution- Water treatment processes, Sewage treatment. Water quality standard.

4. Soil Pollution (06 Periods)
   4.1 Sources of soil pollution
   4.2 Types of Solid waste- House hold, Hospital, From Agriculture, Biomedical, Animal and human, excreta, sediments and E-waste
   4.3 Effect of Solid waste
   4.4 Disposal of Solid Waste- Solid Waste Management

5. Noise pollution (06 Periods)
   Source of noise pollution, Unit of noise, Effect of noise pollution, Acceptable noise level, Different method of minimize noise pollution.

6. Environmental Legislation (08 Periods)
   Introduction to Water (Prevention and Control of Pollution) Act 1974, Introduction to Air (Prevention and Control of Pollution) Act 1981 and Environmental Protection Act 1986, Role and Function of State Pollution Control Board and National Green Tribunal (NGT), Environmental Impact Assessment (EIA).

7. Impact of Energy Usage on Environment (06 Periods)
   Global Warming, Green House Effect, Depletion of Ozone Layer, Acid Rain. Eco friendly Material, Recycling of Material, Concept of Green Buildings.

INSTRUCTONAL STRATEGY

In addition to theoretical instructions, different activities pertaining to Environmental Studies like expert lectures, seminars, visits to green house, effluent treatment plant of any industry, rain water harvesting plant etc. may also be organized.

MEANS OF ASSESSMENT

– Assignments and quiz/class tests,
− Mid-term and end-term written tests

RECOMMENDED BOOKS

1. Environmental and Pollution Awareness by Sharma BR; Satya Prakashan, New Delhi.
2. Environmental Protection Law and Policy in India by Thakur Kailash; Deep and Deep Publications, New Delhi.
3. Environmental Pollution by Dr. RK Khitoliya; S Chand Publishing, New Delhi
4. Environmental Science by Deswal and Deswal; Dhanpat Rai and Co. (P) Ltd. Delhi.
5. Engineering Chemistry by Jain and Jain; Dhanpat Rai and Co. (P) Ltd. Delhi.
6. Environmental Studies by ErachBharucha; University Press (India) Private Ltd., Hyderabad.
7. Environmental Engineering and Management by Suresh K Dhamija; S K Katariaand Sons, New Delhi.
8. E-books/e-tools/relevantsoftware to be used as recommended by AICTE/BTE/NITTTR, Chandigarh.

PRACTICAL EXERCISES (At least Eight experiments are to be performed)

1. Determination of pH of drinking water
2. Determination of TDS in drinking water
3. Determination of TSS in drinking water
4. Determination of hardness in drinking water
7. Determination of acidity in drinking water
9. Determination of pH of soil 10. Determination of N&P (Nitrogen & Phosphorus) of soil
8. To measure the noise level in classroom and industry.
9. To Study segregate the various types of solid waste in a locality.
10.To study the waste management plan of different solid waste

14. To study the effect of melting of floating ice in water due to global warming

SUGGESTED DISTRIBUTION OF MARKS

Topic	Time Allotted (Periods)	Marks Allotted (%)
1	4	10
2	4	10
3	8	20
4	6	14
5	6	14
6	8	20
7	6	12
Total	**Total 42**	**Total 100**

4.6 ENERGY CONSERVATION

L T P
3 – 2

RATIONALE

The requirement of energy has increased manifolds in last two decades due to rapid urbanization and growth in industrial/service sector. It has become challenging task to meet ever increasing energy demands with limited conventional fuels and natural resources. Due to fast depletion of fossil fuels and a tremendous gap between supply and demand of energy, it is essential to adopt energy conservation techniques in almost every field like industries, commercial and residential sectors etc. Energy conservation has attained priority as it is regarded as additional energy resource. Energy saved is energy produced. This course covers the concepts of energy management and its conservation. It gives the insight to energy conservation opportunities in general industry and details out energy audit methodology and energy audit instruments.

LEARNING OUTCOMES

After undergoing this subject, the students will be able to:
• define principles and objectives of energy management and energy audit.
• understand Energy Conservation Act 2001 and its features.
• understand various forms & elements of energy.
• identify electrical and thermal utilities. Understand their basic principle of operation and assess performance of various equipments.
• identify areas of energy conservation and adopt conservation methods in various systems.
• evaluate the techno economic feasibility of the energy conservation technique adopted.

DETAILED CONTENTS

1. Basics of Energy (4 Period)
   1.1 Classification of energy- primary and secondary energy, commercial and noncommercial energy, non-renewable and renewable energy with special reference to solar energy, Capacity factor of solar and wind power generators.
   1.2 Global fuel reserve
   1.3 Energy scenario in India and state of U.P. Sector-wise energy consumption (domestic, industrial, agricultural and other sectors)
   1.4 Impact of energy usage on climate

2. Energy Conservation and EC Act 2001 (4 Period)

2.1 Introduction to energy management, energy conservation, energy efficiency and its need
2.2 Salient features of Energy Conservation Act 2001 & The Energy Conservation (Amendment) Act, 2010 and its importance. Prominent organizations at centre and state level responsible for its implementation.
2.3 Standards and Labeling: Concept of star rating and its importance, Types of product available for star rating

3. Electrical Supply System and Motors (8 Period)

3.1 Types of electrical supply system
3.2 Single line diagram
3.3 Losses in electrical power distribution system
3.4 Understanding Electricity Bill: Transformers Tariff structure, Components of power (kW, kVA and kVAR) and power factor, improvement of power factor, Concept of sanctioned load, maximum demand, contract demand and monthly minimum charges (MMC)
3.5 Transformers: Introduction, Losses in transformer, transformer Loading, Tips for energy savings in transformers
3.6 Electric Motors Types of motors, Losses in induction motors Features and characteristics of energy efficient motors, Estimation of motor loading, Variation in efficiency and power factor with loading, Tips for energy savings in motors.

4. Energy Efficiency in Electrical Utilities (6 Period)

4.1 Pumps: Introduction to pump and its applications, Efficient pumping system operation, Energy efficiency in agriculture pumps, Tips for energy saving in pumps
4.2 Compressed Air System: Types of air compressor and its applications, Leakage test, Energy saving opportunities in compressors.
4.3 Energy Conservation in HVAC and Refrigeration System: Introduction, Concept of Energy Efficiency Ratio (EER), Energy saving opportunities in Heating, Ventilation and Air Conditioning (HVAC) and Refrigeration Systems.

5. Lighting and DG Systems (6 Period)

5.1 Lighting Systems: Basic definitions- Lux, lumen and efficacy, Types of different lamps and their features, Energy efficient practices in lighting
5.2 DG Systems: Introduction, Energy efficiency opportunities in DG systems, Loading estimation

6. Energy Efficiency in Thermal Utilities (8 Period)

6.1 Thermal Basics: Thermal energy, Energy content in fuels, Energy Units and its conversions in terms of Metric Tonne of Oil Equivalent (MTOE)

6.2 Energy Conservation in boilers and furnaces : Introduction and types of boilers, Energy performance assessment of boilers, Concept of stoichiometric air and excess air for combustion, Energy conservation in boilers and furnaces, Do's and Don'ts for efficient use of boilers and furnaces

6.3 Cooling Towers: Basic concept of cooling towers, Tips for energy savings in cooling towers

6.4 Efficient Steam Utilization

7. Energy Conservation Building Code (ECBC) (6 Period)

7.1 ECBC and its salient features

7.2 Tips for energy savings in buildings: New Buildings, Existing Buildings

PRACTICAL EXERCISES

1. To conduct load survey and power consumption calculations of small building.
2. To check efficacy of different lamps by measuring power consumption and lumens using lux meter.
3. To measure energy efficiency ratio (EER) of an air conditioner.
4. To measure effect of valve throttling and variable frequency drive (VFD) on energy consumption by centrifugal pump.
5. To measure and calculate energy saving by arresting air leakages in compressor.
6. To measure the effect of blower speed on energy consumed .

INSTRUCTIONAL STRATEGY

Teachers are expected to lay considerable stress on understanding the basic concepts in energy conservation, principles and their applications. For this purpose, teachers are expected to give simple problems in the class room so as to develop necessary knowledge for comprehending the basic concepts and principles. As far as possible, the teaching of the subject must be supplemented by demonstrations and practical work in the laboratory. Visits to industries must be carried out. Expert from industry must be invited to deliver talks on energy conservation to students and faculty.

RECOMMENDED BOOKS

1. Guide book on General Aspects of Energy Management and Energy Audit by Bureau of Energy Efficiency, Government of India. Edition 2015
2. Guide book on Energy Efficiency in Electrical Utilities, by Bureau of Energy Efficiency, Government of India. Edition 2015
3. Guide book on Energy Efficiency in Thermal Utilities, by Bureau of Energy Efficiency, Government of India. Edition 2015
4. Handbook on Energy Audit & Environmental Management by Y P Abbi &Shashank Jain published by TERI. Latest Edition

SUGGESTED DISTRIBUTION OF MARKS

Topic	Time Allotted (Periods)	Marks Allotted (%)
1	4	10
2	4	10
3	8	20
4	6	14
5	6	14
6	8	20
7	6	12
Total	**Total 42**	**Total 100**

4.7 Constitution of India

L	T	P
2	-	-

LEARNING OUTCOMES

After completing the course the student will be able to:
1. To know The History of the Making of the Indian Constitution.
2. To understand Structure of the Indian Union.
3. To understand State Government, Local Administration and Election Commission.

DETAILED CONTENTS

1. The Constitution – Introduction: (6 periods)
   - 1.1 The History of the Making of the Indian Constitution
   - 1.2 Preamble and the Basic Structure, and its interpretation
   - 1.3 Fundamental Rights and Duties and their interpretation
   - 1.4 State Policy Principles

2. Union Government: (6 periods)
   - 2.1 Structure of the Indian Union
   - 2.2 President – Role and Power
   - 2.3 Prime Minister and Council of Ministers
   - 2.4 Lok Sabha and Rajya Sabha

3. State Government: (6 periods)
   - 3.1 Governor – Role and Power
   - 3.2 Chief Minister and Council of Ministers
   - 3.3 State Secretariat

4. Local Administration: (6 periods)
   4.1 District Administration
   4.2 Municipal Corporation
   4.3 Zila Panchayat

5. Election Commission: (6 periods)
   5.1 Role and Functioning
   5.2 Chief Election Commissioner
   5.3 State Election Commission

INSTRUCTONAL STRATEGY

The basic instructional strategy to teach Constitution of India is Introduction to Constitution, Union Government, State Government, Local Administration, Election Commission.

MEANS OF ASSESSMENT

- Assignments and Quiz/Class Tests
- Mid-term and End-term Written Tests
- Model/Prototype Making

RECOMMENDED BOOKS

1. Ethics and Politics of the Indian Constitution Rajeev Bhargava Oxford University Press, New Delhi, 2008
2. The Constitution of India B.L. Fadia Sahitya Bhawan; New edition (2017)
3. Introduction to the Constitution of India DD Basu Lexis Nexis; TwentyThird 2018 edition

SUGGESTED DISTRIBUTION OF MARKS

Topic	Time Allotted (Periods)	Marks Allotted (%)
1	6	20
2	6	20
3	6	20
4	6	20
5	6	20
Total	**Total 30**	**Total 100**

INDUSTRIAL TRAINING

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

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

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

An external assessment of 50 marks has been provided in the study and evaluation scheme of 5th Semester. Evaluation of professional industrial training report through viva-voce/presentation aims at assessing students understanding of materials, industrial
process, practices in industry/field organization and their ability to engage in activities related to problem solving in industrial setup as well as understanding of application of knowledge and skills learnt in real life situations.

Teachers and students are requested to see the footno te below the study and evaluation scheme of 4th semester for further details.

The teacher along with field supervisors will conduct performance assessment of students. The components of evaluation will include the following

a) Punctuality and regularity 15%
b) Initiative in learning new things 15%
c) Presentation and Viva 15%
d) Industrial training report 55%

5.1 Energy Efficiency, Economics and Audit

L	T	P
5	-	-

RATIONALE

This method of building auditing is used to assess all equipment and the associated operational systems and generate more elaborate calculations of energy use. It primarily identifies areas of potential technical improvements and makes recommendations based on their projected energy and cost savings.

LEARNING OUTCOMES

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

1. To learn energy efficiency and energy conservation opportunities for different load conditions.
2. To select appropriate tariff system and methods for reducing electricity consumption and energy saving.
3. To know methods of energy conservation in buildings.
4. To apply tools for energy audit and recommend measures for energy conservation.

DETAILED CONTENTS

(12 periods)

1. Introduction to Energy Efficiency:
   - 1.1 Concepts of Energy Efficiency and Energy Conservation.
   - 1.2 Indian Electricity Act 2001.
   - 1.3 Relevant clauses of energy conservation.
   - 1.4 Star Labelling – Need and its benefits.

2. Energy Conservation: (12 periods)

   2.1 Lighting Energy: Techniques of energy efficient lighting, Components of energy efficient lighting system. Periodic survey and adequate

maintenance programs.

2.2 Heating: Techniques of energy saving in Furnaces, Ovens and Boilers.

2.3 Cooling: Techniques of energy saving in Ventilating systems and Air Conditioners.

2.4 Motive power.

2.5 Energy Efficient Motors.

2.6 Energy Conservation Equipment: Soft starters, Automatic star delta convertor.

2.7 Variable Frequency Drives.

2.8 Automatic p. f. controller (APFC).3. Materials for Photovoltaic Cells:

3. Energy Conservation in Buildings: (10 periods)

3.1 Introduction.

3.2 Orientation and Planning for Environment.

3.3 Indoor Air Quality (IAQ) requirements.

3.4 Thermal Comfort of Building, Thermal Comfort Improvement Methods, Thermal Insulation, Control of Humidity and Condensation.

3.5 Thermal Admittance Method.

3.6 Building energy Simulation, Load Calculation.

3.7 Use of daylighting integrated artificial lighting system

4. Tariff and Energy Conservation in Industries: (18 periods)

4.1 Energy cost and Recent WBSEB/CESC tariffs.

4.2 Application of Tariff System to reduce Energy bill.

4.3 Prosumer tariff.

4.4 Availability Based Tariff (ABT).

4.5 Time of Day (TOD) tariff.

4.6 Indian Energy Exchange (IEX).

4.7 Energy conservation by improving load factor and power factor. (Numerical)

5. Energy Conservation In Transmission and Distribution Systems: (18 periods)

5.1 Reactive power compensation.

5.2 Demand side management, system voltage optimization and phase current balancing.

5.3 Losses in transmission and distribution system and its minimization.

INSTRUCTONAL STRATEGY

The basic instructional strategy to teach Energy Efficiency, Economics and Audit, Introduction to Energy Efficiency, Energy Conservation In Transmission, Tariff and Energy Conservation in Industries and Distribution Systems.

MEANS OF ASSESSMENT

- Assignments and Quiz/Class Tests
- Mid-term and End-term Written Tests
- Model/Prototype Making

RECOMMENDED BOOKS

5. Generation Distribution and Utilization of Electrical Energy C.L. Wadhawa New Age 2004
6. Electric system M.J. Steinburg and T.H. Smith John Willey and sons.
7. Energy conservation Guide book Steven R. Patrick, Dale R. Patric Stephen W. Fardo Fairmont Press.
8. Industrial Energy Management: Principles and applications Giovanni Petrecca Kluwer Academic Publisher.
9. Handbook of Energy Engineering. Fifth ed.Thumann, Mehta.The Fairmount Press, 2001.

SUGGESTED DISTRIBUTION OF MARKS

Topic	Time Allotted (Periods)	Marks Allotted (%)
1	12	20
2	12	20
3	10	12
4	18	24
5	18	24
Total	**Total 70**	**Total 100**

5.2 Marine and Geothermal Energy

L	T	P
5	-	-

RATIONALE

The movement of water in the world's oceans creates a vast store of kinetic energy, or energy in motion. Some of this energy can be harnessed to generate electricity to power homes, transport and industries

LEARNING OUTCOMES

After completing this module, students should be able to answer the following questions:

1. Understand the warmest temperature in the oceans now a days.
2. What factors impact salinity of surface ocean waters?
3. What is primary productivity and what controls it?
4. What factors control dissolved oxygen contents of ocean waters?
5. What factors control dissolved CO2 contents of ocean waters?
6. What drives surface ocean circulation?
7. What are the Coriolis effect, gyres, upwelling and downwelling?
8. How do deep water masses form?

.

DETAILED CONTENTS

1. Introduction to Geothermal Energy: (12 Periods)

1.1 What is geothermal energy

1.2 Historical background

1.3 Review of the geothermal activities worldwide

1.4 Origin of geothermal energy

2. Geological Background: (12 Periods)

2.1 Origin of geothermal energy

2.2 Terrestrial heat flow, geothermal gradient

2.3 Relationship of plate tectonics and terrestrial heat flow

2.4. Geothermal field vs geothermal reservoir

3. The Geothermal System: (10 Periods)

3.1 Geothermal reservoir, Production well

3.2 Surface facilities, Injection well

3.3 Hydrothermal systems

3.4 Saturated steam systems, Enhanced Geothermal Systems EGS

4. Introduction to the ocean environment: (18 Period)

4.1 Ocean circulation and stratification

4.2 Ocean habitat

4.3 Ocean economy

4.4 Ocean surface wave

5. Ocean tidal currents: (18 Periods)

5.1 Current measurement

5.2 Current turbulence

5.3 Current energy resource

5.4 Site selection and characterization for ocean energy systems

INSTRUCTONAL STRATEGY

The basic instructional strategy to teach Energy from Ocean & Earth, Fundamentals of Earth System Science, Atmosphere, Ecosystems, Introduction to the ocean environment, Ocean tidal currents.

MEANS OF ASSESSMENT

- Assignments and Quiz/Class Tests
- Mid-term and End-term Written Tests
- Model/Prototype Making

RECOMMENDED BOOKS

5. Energy Transfers in Atmosphere and Carsten Eden, Armin Iske · 2019.
6. Ocean Energy: Tide and Tidal Power R. H. Charlier, Charles W. Finkl.
7. Ocean Energy Laura K. Murray · 2016.
8. Fundamentals of Ocean Renewable Energy: Generating Simon P. Neill, M Reza Hashemi.

SUGGESTED DISTRIBUTION OF MARKS

Topic	Time Allotted (Periods)	Marks Allotted (%)
1	12	20
2	12	20
3	10	12
4	18	24
5	18	24
Total	**Total 70**	**Total 100**

5.3 Electric and Hybrid Vehicle

L	T	P
5	2	-

RATIONALE

According to a recent study by WHO, India is home to 14 out of 20 most polluted cities in the world. Electric vehicles (EVs) can improve that scenario by reducing local concentrations of pollutants in cities

LEARNING OUTCOMES

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

1. Develop the electric propulsion unit and its control for application of electric vehicles.
2. Analyze different power converter topology used for electric vehicle application.

DETAILED CONTENTS

1. Introduction to electric, and hybrid electric vehicles: (12 Periods)
   1.1 Introduction to Hybrid Electric Vehicles: History of hybrid and electric vehicles,
   1.2 Social and environmental importance of hybrid and electric vehicles.
   1.3 Hybrid Electric Drive-trains: Basic concept of hybrid traction,

2. Conventional Vehicles: (12 Periods)

2.1 Basics of vehicle performance,
2.2 vehicle power source characterization, transmission characteristics.

3. Hybrid Electric Drive-trains: (10 Periods)
3.1 Basic concept of hybrid traction,
3.2introduction to various hybrid drive-train topologies
3.3 power flow control in hybrid drive-train topologies, fuel efficiency analysis..

4. Electric Propulsion unit: (18 Periods)
4.1 Introduction to electric components used in hybrid and electric vehicles.
4.2 Configuration and control of DC Motor drives, Configuration and control of Induction Motor drives, configuration and control of Permanent
4.3Magnet Motor drives, Configuration and control of Switch Reluctance Motor drives, drive system efficiency.

5. Energy Storage: (18 Periods)
5.1 Introduction to Energy Storage Requirements in Hybrid and Electric Vehicles,
5.2 Battery based energy storage and its analysis, Fuel Cell based energy storage.
5.3 Super Capacitor based energy storage.

INSTRUCTONAL STRATEGY

The basic instructional strategy to teach Electric Vehicles, Introduction to electric, and hybrid electric vehicles, Hybrid Electric Drive-trains, Energy Storage.

MEANS OF ASSESSMENT

- Assignments and Quiz/Class Tests
- Mid-term and End-term Written Tests
- Model/Prototype Making

RECOMMENDED BOOKS

1. Electric and Hybrid Vehicles Tom Denton
2. Electric Vehicle Technology James Larminie, John Lowry ·
3. Electric and Hybrid Vehicles: Power Sources, Gianfranco Pistoia
4. Electric and Hybrid Vehicles: Power Sources, Models, Gianfranco Pistoia

SUGGESTED DISTRIBUTION OF MARKS

Topic	Time Allotted (Periods)	Marks Allotted (%)
1	12	20
2	12	20
3	10	12
4	18	24
5	18	24
Total	**Total 70**	**Total 100**

5.4 Distributed Generation Systems

L	T	P
6	-	8

RATIONALE

Existing cost-effective distributed generation technologies can be used to generate electricity at homes and businesses using renewable energy resources such as solar and wind. Distributed generation can harness energy that might otherwise be wasted—for example, through a combined heat and power system.

LEARNING OUTCOMES

On successful completion of this course students will be able to:

1. Understanding modern power system components and transformation
2. The types and roles of distributed energy resources
3. Principles and features Photo Voltaic (PV) Systems
4. Formulation of the mathematical models and the principles of maximum power point tracking
5. Control of PV Converter topologies and their connection
6. Principles of wind power, energy conversion and formulation
7. Control and connection of of wind power systems
8. Battery storage systems and their applications

9. Industrial experiences in renewable energy integration.

DETAILED CONTENTS

1. Distributed Generation and Microgrid: (12 Periods)
   1.1 Introduction.
   1.2 Integration of distributed generation to Grid.
   1.3 Concepts of Micro Grid.
   1.4 Typical Microgrid configurations, AC and DC micro grids.
   1.5 Interconnection of Microgrids.
   1.6 Technical and Economical advantages of Microgrid.
   1.7 Concept of Electric Grid..
2. Distributed Energy Resources: (12 Periods)
   2.1 Introduction.
   2.2 Combined heat and power (CHP) generation.
   2.3 Solar photovoltaic (PV) systems.
   2.4 Wind energy conversion systems (WECS).
   2.5 Small-scale hydroelectric power generation.
3. Protection Issues for Microgrids: (10 Periods)
   3.1 Introduction.
   3.2 Islanding, Different islanding scenarios.
   3.3 Major protection issues of standalone Microgrid.
   3.4 Adaptive protection for Microgrid.
   3.5 Impact of DG integration on electricity market, environment and distribution system.
4. Protection Issues for Microgrids: (18 Periods)
   4.1 Electricity tariff – one part tariff, two part tariff, maximum demand tariff, power factor tariff.
   4.2 Concept of Dynamic pricing, Time of-use (TOU) pricing, Critical-peak pricing (CPP), Real Time Pricing.
   4.3 Automatic Meter Reading (AMR).

4.4 Plug in Hybrid Electric Vehicles (PHEV).
4.5 Intelligent Electronic Devices (IED) and their application for monitoring & protection.

5. Introduction of Energy efficient end use devices: (18 Periods)

5.1 Energy efficient end use devices.

5.2 Load Curves, Load Shaping Objectives, Load Shaping methodologies

5.3 Types of power quality disturbances – Voltage sag (or dip), Transients, Short and Long duration voltage variation

5.4 Voltage imbalance, Waveform distortion, Harmonic sources. (Numerical Problems)

PRACTICAL EXERCISES:

1. Transmission Line Parameter Calculations
2. Reactive power compensation using series and shunt devices
3. Bus Admittance Matrix Formulation
4. Load Flow Analysis
5. Z-bus Formation
6. Symmetrical Fault Analysis
7. Unsymmetrical Fault Analysis

INSTRUCTONAL STRATEGY

The basic instructional strategy to teach Distributed Generation Systems, Distributed Generation and Microgrid, Distributed Energy Resources Introduction of Energy efficient end use devices.

MEANS OF ASSESSMENT

- Assignments and Quiz/Class Tests
- Mid-term and End-term Written Tests
- Model/Prototype Making

RECOMMENDED BOOKS

1. Design of Smart Power Grid Renewable Energy Systems Ali Keyhani Wiley
1. Smart Grid: Fundamentals of Design and Analysis James Momoh Wiley.
2. Electrical Power System Quality R. C. Durgan, M. F. Me Granaghen, H. W. Beaty McGraw-Hill.

SUGGESTED DISTRIBUTION OF MARKS

Topic	Time Allotted (Periods)	Marks Allotted (%)
1	12	20
2	12	20
3	10	12
4	18	24
5	18	24
Total	**Total 70**	**Total 100**

5.5 Installation, Maintenance & Monitoring of Renewable Energy Power Plant

L	T	P
4	-	2

RATIONALE

For all renewable-energy systems, it is proper maintenance practice to inspect the integrity of mechanical and electrical connections at least once each year. Corroded or loose connections can result in decreased performance, and in extreme cases, they can create safety hazards.

LEARNING OUTCOMES

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

1. Prepare profile with an appropriate accuracy as per drawing following safety precaution.
2. Prepare electrical wire joints, carry out soldering and crimping.
3. Construct and test various characteristics of electrical and magnetic circuits.

DETAILED CONTENTS

1. Introduction (12 periods)

1.1 Identify the trade tools; practice their uses with safety, care & maintenance.
1.2 Identification of danger, warning, caution & safety signs.
1.3 Preventive measures for electrical accidents and use of fire extinguishers
1.4 Tenses

2 Prepare electrical wire joints, carry out soldering and crimping (12 periods)

2.1 Practice on skinning, twisting and crimping.
2.3 Identify various types of cables and measure conductor size using SWG and micrometer.
2.4 Make joints on single strand conductors.
2.5 Practice in crimping and soldering of joints / lugs..

3 Construct and test various characteristics of electrical and magnetic circuits. (10 periods)

3.1. Measure parameters in combinational DC circuits by applying Ohm's Law for different resistor values and voltage sources.
3.2 Measure current and voltage in DC circuits to verify Kirchhoff's Law.
3.3 Verify laws of series and parallel circuits with voltage source in different combinations.
3.4 Measure current and voltage and analyse the effects of shorts and opens in series and parallel circuits.
3.5 Measure power, energy for lagging and leading power factors in single phase circuits.

4 Assemble, install and test wiring system. (18 periods)

4.1 Identification various conduits and different electrical accessories.

4.2 Practice cutting, threading of different sizes & laying Installations.

4.3 Prepare test boards / extension boards and mount accessories like lamp holders, various switches, sockets, fuses, relays, MCB, ELCB.

4.4 Wire up PVC conduit wiring to control one lamp from two different places using two way switches.

4.5 Practice control panel wiring using wiring accessories and mounting of control elements, e.g. meters, fuses, relays, switches, push buttons, MCB, ELCB etc.

5 Perform basic Electric energy calculations and understand transmission and distribution of electrical power. (18 periods)

.

5.1 Measure power consumption for different loads with various times of use and calculate watt-hour.

5.2 Find out power ratings from product label and prepare a load calculation chart.

5.3 Perform OC and SC test to determine and efficiency of single phase transformer.

5.4 Draw circuit diagram of substation and indicate various components.

LIST OF PRACTICALS

1. Coil Winding Machine: Bench mounted, power driven with clutch and brake built into winding head, electromagnetic traverse clutch system for setting winding length of wire range .05 to 1.5 mm dia.
2. Bench Drilling Machine: Drilling capacity 13 mm, slotted and adjustable drilling, Table size 250 x 250 mm app. Belt driven with 4 speed ranges from 50 to 2000 rpm
3. Portable Drilling Machine: Hand electric drill machine with speed control.
4. Multi meter: Laboratory service type with large and easy to read mirror scale with over head protection high accuracy.

INSTRUCTONAL STRATEGY

Student should be encouraged to participate in role play and other student centered activities in class room and actively participate in listening exercise

MEANS OF ASSESSMENT

- Assignments and Quiz/Class Tests
- Mid-term and End-term Written Tests
- Model/Prototype Making

RECOMMENDED BOOKS

1. Electricity from Renewable Resources: Status, Prospects, and National Research Council.
2. Solar Power Generation Problems, Solutions and Monitoringbooks.google.co.in › books Peter Gevorkian.
3. Advanced Concepts for Renewable Energy Supply of Data Centres books Jaume Salom, Thorsten Urbaneck, Eduard Oró · 2017.

SUGGESTED DISTRIBUTION OF MARKS

Topic	Time Allotted (Periods)	Marks Allotted (%)
1	12	20
2	12	20
3	10	12
4	18	24
5	18	24

Total	**Total 70**	**Total 100**

5.6 Fuel cell & Hydrogen Energy

L	T	P
4	-	4

RATIONALE

Hydrogen is considered an alternative fuel. It is due to its ability to power fuel cells in zero-emission electric vehicles, its potential for domestic production, and the fuel cell's potential for high efficiency. Hydrogen can also serve as fuel for internal combustion engines.

LEARNING OUTCOMES

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

1. The students will have the general knowledge of Fuel Cells as a promising technology in the context of clean power sustainability and alternative fuels for shipping.
2. The students will know different specific developments on Fuel Cells which are available today.
3. The students will have the knowledge of how to produce electricity cleanly and efficiently from water and heat as the only products by using fuel cell.

DETAILED CONTENTS

1. Introduction (12 periods)
   1.1 Overview of Hydrogen Energy and Fuel Cells.
   1.2 Low and high temperature fuel cells. Fuel Cell performance
   1.3 Polymer electrolyte fuel cells, Alkaline fuel cells, Phosphoric fuel cells
   1.4 Molten carbonate fuel cells, Solid oxide fuel cells, Fuel cell systems and Sample calculations.

2 Fuel cell thermodynamics (12 periods)
   2.1 heat, work potentials..
   2.3 Prediction of reversible voltage.
   2.4 fuel cell efficiency.

3 Fuel cell reaction kinetics. (10 periods)
   4.1 Identification various conduits and different electrical accessories.
   4.2 Practice cutting, threading of different sizes & laying Installations.
   4.3 Prepare test boards / extension boards and mount accessories like lamp holders, various switches, sockets, fuses, relays, MCB, ELCB.
   4.4 Wire up PVC conduit wiring to control one lamp from two different places using two way switches.
   4.5 Practice control panel wiring using wiring accessories and mounting of control elements, e.g. meters, fuses, relays, switches, push buttons, MCB, ELCB etc.

4 Fuel cell reaction kinetics. (18 periods).
   a. electrode kinetics, overvoltages, Tafel equation, charge transfer reaction
   b. exchange currents, electrocatalyses - design, activation kinetics
   c. Fuel cell charge and mass transport - flow field
   d. transport in electrode and electrolyte

5 Fuel cell characterization. (18 periods).

5.1 in-situ and ex-situ characterization techniques, i-V curve.
5.2frequency response analyses Process Safety and Process Design.
5.3 Materials Science and Engineering LIST OF PRACTICALS.

PRACTICAL EXERCISES:

1. Determination of Fuel Value
2. Performance Characteristics of Polymer Electrolyte Fuel Cell
3. Properties of Proton Exchange Membranes Used in Fuel Cells
4. Performance Characteristics of a Dissolved Methanol Fuel Cell
5. Borohydride Fuel Cell Performance Characteristics
6. Solar Electrolyzer Fueled Polymer Electrolyte Membrane Fuel Cell
7. Hydrogen Storage Capacity of Hydrogen-Containing Compounds

INSTRUCTONAL STRATEGY

The basic instructional strategy to teach Fuel cell & Hydrogen Energy, Introduction to Energy Efficiency, Fuel cell thermodynamics , Fuel cell reaction kinetics. Fuel cell characterization

MEANS OF ASSESSMENT

- Assignments and Quiz/Class Tests
- Mid-term and End-term Written Tests
- Model/Prototype Making

RECOMMENDED BOOKS

1. Fuel Cells and Hydrogen: From Fundamentals to Applied Researchbooks Viktor Hacker, Shigenori Mitsushima.
2. Electrocatalysts for Fuel Cells and Hydrogen Evolution Abhijit Ray, Indrajit Mukhopadhyay, Ranjan Kumar Pati · 2018.
3. Fuel Cells: Technologies for Fuel Processingbooks.Dushyant Shekhawat, J.J. Spivey, David A Berry · 2011.

SUGGESTED DISTRIBUTION OF MARKS

Topic	Time Allotted (Periods)	Marks Allotted (%)
1	12	20

APPROVED IN CDC COMMITTEE MEETING OF BTE,UP,LUCKNOW DATED:26-09-2021

2	12	20
3	10	12
4	18	24
5	18	24
Total	**Total 70**	**Total 100**

6.1 Renewable Energy Power Plant

L	T	P
6	-	2

RATIONALE

Environmental and economic benefits of using renewable energy include: Generating energy that produces no greenhouse gas emissions from fossil fuels and reduces some types of air pollution. Diversifying energy supply and reducing dependence on imported fuels..

LEARNING OUTCOMES

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

1. Understand solar radiation, solar power plant
2. Understand wind mill and power generation system
3. Understand Hydro electric power plant
4. Understand Biomass based power plant

DETAILED CONTENTS

1: SOLAR POWER PLANT (12 Periods)

1.1Solar Map of India: Global solar power radiation.
1.2 Solar PV system and its utilization.
1.3 Concentrated Solar Power (CSP) plants, Construction and working of: Power Tower.
1.4 Parabolic Trough, Parabolic Dish, Fresnel Reflectors.
1.5 Solar Photovoltaic (PV) power plant: Components Layout, Construction, Working principle.
1.6 Rooftop/Ground solar PV power system.
1.7 Safety factors in Solar PV and concentrated solar power plants.

2: WIND POWER PLANT (12 Periods)

2.1 Wind Map of India: Wind power density in watts per square meter, Lift and drag principle, Long path theory.
2.2 Geared type wind power plants: components, layout and working.
2.3 Direct drive type wind power plants: components, layout and working.
2.4 Use of Variable Speed and Constant Speed Electric Generators: Squirrel Cage Induction Generators (SCIG), Wound Rotor Induction Generator (WRIG), Doubly- fed induction generator (DFIG), Wound rotor synchronous generator (WRSG), Permanent magnet synchronous generator (PMSG).
2.5 Safety factors in large wind power plants.

3 Small Wind Turbines: (10 Periods)

3.1 Horizontal axis small wind turbine: Direct drive type, components and working.
3.2 Horizontal axis small wind turbine: Geared type, components and working.
3.3 Vertical axis small wind turbine: Direct drive and geared, components and working.
3.4 Types of towers and installation of small wind turbines on roof tops and open fields.
3.5 Description of the Electric generators used in small wind power plants.

4 .Micro-hydro Power Plants: (18Periods)

4.1 Energy conversion process of hydro power plant.
4.2 Classification of hydro power plant: High, medium and low head. Lay outs of micro-hydro power plants
4.3 Construction and working of hydro turbines used in different types of hydro Power plant:
4.3.1 High head – Pelton turbine
4.3.2 Medium head–Francis turbine
4.3.3 Low head–Kaplan turbine.
4.4 Safety factors in Micro-hydro power plants

5. Biomass-based Power Plants: (18Periods)

5.1 Properties of solid fuel for biomass power plants: Bagasse, Woodchips, Rice husk, Municipal waste.
5.2 Properties of liquid and gaseous fuel for biomass power plants: Jatropha, Bio- diesel, Gobar gas.
5.3 Layout of a Bio-chemical based (e.g. biogas) power plant and components required.
5.4 Layout of a Thermo-chemical based (e.g.Municipal waste) power plant and components required.
5.5 Layout of an Agro-chemical based (e.g. bio-diesel)power plant and components required.
5.6 Limitations of Biomass-based power plants.

INSTRUCTIONAL STRATEGY

The basic instructional strategy to teach Renewable Energy Power Plant, various type of power plants of renewable energy viz solar energy , wind energy, bio energy, biomass energy

MEANS OF ASSESSMENT

- Assignments and Quiz/Class Tests
- Mid-term and End-term Written Tests
- Model/Prototype Making

RECOMMENDED BOOKS

1- **Power Generation from Renewable Energy Sources** by **N.S. Rathore (Author), Kothari Surendra (Author), Jain Sudhir (Author)**

2- Renewable Energy Sustainable Energy Concepts for the Energy Change By Roland Wengenmayr

3- Renewable Energy: Sources for Fuels and Electricity Thomas B. Johansson, Henry Kelly, Laurie Burnham ·

SUGGESTED DISTRIBUTION OF MARKS

Topic	Time Allotted	Marks Allotted

	(Periods)	(%)
1	12	20
2	12	20
3	10	12
4	18	24
5	18	24
Total	**Total 70**	**Total 100**

Practical Exercises (At least five)

1.Set up the solar PV plant to produce electricity.

2.Set up the wind power plant of with a Small Wind Turbine to produce electricity.

3.Set up the Bio gas power plant to produce electricity.

4.Integrate electrical power from solar PV plant, wind power plant and bio gas power plant.

5.Apply the integrated power from different sources to Micro grid system.

6.Identify the trouble shooting of Micro grid system components.

7.Identify the routine maintenance parts of Micro grid system.

8. Identify the trouble shooting of solar PV plant.

9.Identify the trouble shooting of wind power plant.

10.Identify the trouble shooting of bio gas power plant.

6.2 ENTREPRENEURSHIP & START – UPS

L	T	P
5	-	4

RATIONALE

Students advance their skills in customer development, customer validation, competitive analysis, and iteration while utilizing design thinking and process tools to evaluate in real-world problems and projects.

LEARNING OUTCOMES

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

1. Have the ability to discern distinct entrepreneurial traits.
2. Know the parameters to assess opportunities and constraints for new business ideas
3. Understand the systematic process to select and screen a business idea
4. Design strategies for successful implementation of ideas
5. Knowledge of patent

DETAILED CONTENTS

1: Introduction (12 Periods)

1.1 Definitions, Tra its of an entrepreneur, Intrapreneurship, Motivation.
1.2 Types of Business Structures, Similarities/differences betweenen trepreneurs and managers.

2. Business Ideas and their implementation: (12 Periods)
2.1 Discovering ideas and visualizing the business.
2.2 Activity map.
2.3 Business Plan.

3. Idea to Start-up: (10 Periods)

3.1 Market Analysis–Identifying the target market.
3.2 Competition evaluation and Strategy Development.
3.3 Marketing and accounting.
3.4 Risk analysis.

4. Management: (18 Periods)

4.1 Company's Organization Structure.
4.2 Recruitment and management of talent.
4.3 Financial organization and management.

5. Financing and Protection of Ideas: (18 Periods)

5.1 Financing methods available for start-ups in India.
5.2 Communication of Ideas to potential investors–Investor Pitch.
5.3 Patenting and Licenses.
5.4 Exit strategies for entrepreneurs, bankruptcy, and succession

INSTRUCTONAL STRATEGY

The basic instructional strategy to teach Entrepreneurship development, customer validation, competitive analysis, and iteration while utilizing design thinking and process tools to evaluate in real-world problems and projects.

MEANS OF ASSESSMENT

- Assignments and Quiz/Class Tests
- Mid-term and End-term Written Tests
- Model/Prototype Making

RECOMMENDED BOOKS

1- Entrepreneurship Development and Small Business Enterprises by CHARANTIMATH

2- Exploring Entrepreneurship By Richard Blundel, Nigel Lockett, Catherine Wang

3- Entrepreneurship Management: Practices and Policies by Babar Khan

4- Entrepreneurship, Innovations and Start-ups in India by Savita Joshi

SUGGESTED DISTRIBUTION OF MARKS

Topic	Time Allotted (Periods)	Marks Allotted (%)
1	12	20
2	12	20
3	10	12
4	18	24
5	18	24

APPROVED IN CDC COMMITTEE MEETING OF BTE,UP,LUCKNOW DATED:26-09-2021

Total	**Total 70**	**Total 100**

6.3 Electrical Machine and Measurement

L	T	P
4	-	4

RATIONALE

Electrical machine can be used for different ranges of speed particularly in traction, electrical vehicle, generator etc

LEARNING OUTCOMES

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

1 To introduce the concepts of ideal synchronous machines and poly-phase induction machines.
2 Applications which will be utilized in the electrical machines with its performance
3 Theory of operation.
4 Study of special machines

DETAILED CONTENTS

1.Electro-MechanicalEnergyConversion: (12 Periods)

1.1 Mechanism of Electro-Mechanical energy conversion for generator and motor mode.
1.2 D.C. Generator: Construction, Working principle, Types, E.M.F. equation, O.C. Characteristics. (Numerical)
1.3 D.C. Motor: Construction, Working principle, Types, Torque equation, Load Characteristics (Numerical)
1.4 Commutation method in DC machine.
1.5 Applications of different types of D.C. generators and motors.

2.Transformer: (12 Periods)

2.1 Single phase Transformer:
2.1.1 Working principle ,E.M.F. equation, Transformation ratio, Specification.
2.1.2 Losses, Efficiency, Voltage Regulation. (Numerical)

2.2 Three phase Transformer:
2.2.1 Construction, Different connections.
2.2.2 Synchronisation of two3- phase transformers.
2.2.3 Parallel operation of two 3-phase transformers.

3. AC Generator: (10 Periods)

3.1 Three Phase Synchronous Generator (Alternator):
3.1.1 Construction, Working principle.
3.1.2 Methods of excitation systems.
3.1.3 E.M.F. equation. (no derivation)
3.1.4 Terminal voltage at different power factor loads (no derivation), Voltage regulation, Load angle.(Numerical)
3.1.5 Synchronization & Parallel operation of an alternator with infinite busor with another alternator.

3.2 Permanent Magnet Synchronous Generator (PMSG):
3.2.1 Construction, Working principle,
3.2.2 No load test of PMSG, Load test of PMSG, Characteristics,
3.2.3 Advantages and disadvantages of PMSG.
3.2.4 Applications in renewable power plant.

4.Three Phase Induction Machine: (18 Periods)

4.1 Three phase Induction Motor:
4.1.1 Construction, Types, Working principle,
4.1.2 Synchronous Speed, Slip.
4.1.3 Torque equation, Torque-Slip characteristics.
4.1.4 Starting methods.
4.1.5 Methods of Speed control.
4.2 Induction Generator (IG):
4.2.1 Construction, Principle of operation.
4.2.2 Excitation.
4.2.3 Active power Off-grid IG, Capacitor Start IG.
4.2.4 Torque-Slip characteristics ,Torque–Speed characteristics.

4.2.5 High efficiency IG.
4.2.6 Applications in renewable power plant.

4.3 Squirrel Cage Induction generator (SCIG):
4.3.1 Construction, Principle of operation.
4.3.2 Power equation.
4.3.4 Torque-Slip characteristics.
4.3.5 Active power Off-grid IG, Capacitor Start IG.
4.3.6 Applications in renewable power plant.
4.4 Doubly Fed Induction generator (DFIG):
4.4.1 Construction, Principle of operation.
4.4.2 Equivalent Circuit of DFIG.
4.4.3 Sub-and Super-synchronous modes.
4.4.4 Torque-slip curve for DFIG in sub-and super-synchronous modes.
4.4.5 Advantages and disadvantages of DFIG.
4.4.6 Principle of slip control for induction generators. .
4.4.7 Applications of DFIG in renewable power plant.

5.Measurement of Electrical Power and Energy: (18Periods)

5.1 Measurements of 3-phase power for balanced and unbalanced load by wattmeter method.
5.2 Electronic Energy Meter –Construction, Basic circuit diagram, Principle of operation
5.3 Measurements of electrical energy by3-phase energy meter.
5.4 Current Transformer (CT): Working principle, Burden on CT, Phase angle error, Ratio error, Specifications.
5.5 Potential Transformer (PT): Working principle, Phase angle error, Ratio error, Specifications.

INSTRUCTONAL STRATEGY

The basic instructional strategy to teach electrical machine and measurements, Various high voltage generation and measuring techniques. Quality evaluation through testing methodologies in high voltage engineering

MEANS OF ASSESSMENT

- Assignments and Quiz/Class Tests
- Mid-term and End-term Written Tests
- Model/Prototype Making

RECOMMENDED BOOKS

1- I. J. Nagrath & D.P. Kothari, “Theory and problems of Electrical Machines”, TMH Publication, New Delhi.

2- B.L.Theraja & A.K.Theraja, “A Text Book of Electrical Technology”, Volume II, S. Chand & Company Ltd.

3- P. S. Bhimbra, “Electrical Machinary”, Khanna Publishers, New Delhi.

Practical Exercises

1. Measurement of Low Resistance by Kelvin's Double Bridge Method.
2. Measurement of Self Inductance and Capacitance using Bridges.
3. Study of Galvanometer and Determination of Sensitivity and Galvanometer Constants.
4. Calibration of Voltmeters and Ammeters using Potentiometers.
5. Testing of Energy meters (Single phase type).
6. Measurement of induced emf and magnetising currentunder open circuit condition in D.C. generators.
7. Determination of the relationship between terminalvoltage and load current keeping speed constant for(a) Separately excited generator keeping excitationconstant(b) D.C. shunt generator.
8. To determine the insulation resistance of a transformer at no load and at full load condition
9. Measurement of the speed of a d.c. series motor as afunction of the load torque.
10. Load test on single phase/three phase transformers.

SUGGESTED DISTRIBUTION OF MARKS

Topic	Time Allotted (Periods)	Marks Allotted (%)
1	12	20
2	12	20
3	10	12
4	18	24
5	18	24
Total	**Total 70**	**Total 100**

6.4 Internet of Things

L	T	P
5	-	

RATIONALE

The goal behind the Internet of things is to have devices that self-report in real-time, improving efficiency and bringing important information to the surface more quickly than a system depending on human intervention.

LEARNING OUTCOMES

After learning the course the students should be able to:

1- ·Able to understand the application areas of IOT

2- Able to realize the revolution of Internet in Mobile Devices, Cloud & Sensor Networks

3- Able to understand building blocks of Internet of Things and characteristics

4- Able to do basic calculations involving heat transfer as is typical for a mechanical engineer.

DETAILED CONTENTS

1. : Internet of Things (IoT): (12 Periods)

1.1- Vision, Definition

1.2-Conceptual Framework

1.3- Architectural view, technology behind IoT, Sources of the IoT, M2M Communication, IoT Examples

2. Design Principles for Connected Devices: (12 Periods)

2.1 IoT/M2M systems layers and design standardization,

2.2 communication technologies

2.3 data enrichment and consolidation, ease of designing and affordability

3. Hardware for IoT: (10Periods)

3.1 Sensors, Digital sensors, actuators

3.2 radio frequency identification (RFID) technology

3.3 wireless sensor networks, participatory sensing technology

4. Programming the Ardunio: (18 Periods)

4.1 Ardunio Platform Boards Anatomy, Ardunio IDE

4.2 coding, using emulator, using libraries, additions in ardunio

4.3 programming the ardunio for IoT

5. Challenges in IoT Design challenges, IoT Applications: (18 Periods)

5.1 Development Challenges, Security Challenges, Other challenges

5.2 Smart Metering, E-health, City Automation, Automotive Applications

5.3 home automation, smart cards,

5.4 Communicating data with H/W units, mobiles, tablets,

5.5 Designing of smart street lights in smart city

INSTRUCTONAL STRATEGY

The basic instructional strategy to teach Internet of Things is to Design Principles for Connected Device Hardware for IoT Challenges in IoT Design challenges, IoT Applications

MEANS OF ASSESSMENT

- Assignments and Quiz/Class Tests
- Mid-term and End-term Written Tests

- Model/Prototype Making

RECOMMENDED BOOKS

1. Olivier Hersent,DavidBoswarthick, Omar Elloumi“The Internet of Things key applications and protocols”, willey
2. Jeeva Jose, Internet of Things, Khanna Publishing House
3. Michael Miller “The Internet of Things” by Pearson
4. Raj Kamal “INTERNET OF THINGS”, McGraw-Hill, 1ST Edition, 2016
5. ArshdeepBahga, Vijay Madisetti “ Internet of Things(A hands on approach)” 1ST edition, VPI publications,2014 6. Adrian McEwen,Hakin Cassimally “Designing the Internet of Things” Wiley India

SUGGESTED DISTRIBUTION OF MARKS

Topic	Time Allotted (Periods)	Marks Allotted (%)
1	12	20
2	12	20
3	10	12
4	18	24
5	18	24
Total	**Total 70**	**Total 100**

6.4 Operations Research

L	T	P
5	-	-

RATIONALE

Operations research is important because it is a helpful tool used to solve complex problems under uncertainty. In business, very few things are certain, and managers must often make decisions based on their instincts instead of being able to use reliable data

LEARNING OUTCOMES

After learning the course the students should be able to:

1- Methodology of Operations Research.

2- Linear programming: solving methods, duality, and sensitivity analysis. Integer Programming.

3- Network flows. Multi-criteria decision techniques.

4- Decision making under uncertainty and risk

5- Able to do basic calculations involving heat transfer as is typical for a mechanical engineer.

.

DETAILED CONTENTS

1. Introduction: (12 Period)
   1.1- Definition and scope of operations research (OR)
   1.2- OR model, solving the OR model, art of modeling, phases of OR study
2. Linear Programming:: (12Periods)

2.1 Two variable Linear Programming model and Graphical method of solution

3. Transportation Problems: (10Periods)

3.1 Types of transportation problems, mathematical models

4. Assignment: (18 Periods)

4.1 Allocation and assignment problems and models, processing of job through machines

5. Inventory Control: (18 Periods)

5.1 Models of inventory

5.2 operation of inventory system, quantity discount.,

5.3 Replacemen

INSTRUCTONAL STRATEGY

The basic instructional strategy to teach Operations Research is dentify and develop operational research models from the verbal description of the real system. Understand the mathematical tools that are needed to solve optimisation problems. Use mathematical software to solve the proposed models.

MEANS OF ASSESSMENT

- Assignments and Quiz/Class Tests
- Mid-term and End-term Written Tests
- Model/Prototype Making

RECOMMENDED BOOKS

1. Wayne L. Winston,"Operations Research" Thomson Learning,2003.

2. Hamdy H. Taha, “Operations Research-An Introduction” Pearson Education,2003.
3. R. Panneer Seevam, “Operations Research” PHI Learning, 2008.
4. V.K.Khanna, “Total Quality Management” New Age International, 2008.

SUGGESTED DISTRIBUTION OF MARKS

Topic	Time Allotted (Periods)	Marks Allotted (%)
1	12	20
2	12	20
3	10	12
4	18	24
5	18	24
Total	**Total 70**	**Total 100**

6.4 Engineering Economics and Accountancy

L	T	P
5	-	-

RATIONALE

Engineering economics accomplishes several objectives. It presents the aspects of traditional economics that are relevant for business and engineering decision making in real life.

LEARNING OUTCOMES

After learning the course the students should be able to:

1- describe the factors that shape the economic environment of engineering companies

2- analyse the financial condition of companies based on the financial statements

3- apply the basic cost accounting techniques in the planning and control of engineering and production activities

4- analyse issues relating to professional ethics..

.

DETAILED CONTENTS

1. Principles of Economics (12 Periods)
   - 1.1- Concept of scarcity, resources allocation, and opportunity cost
   - 1.2- Theory of demand and supply; Utility, value, and value adding; Price system
   - 1.3 Organisation of industry; Relationship between economics and engineering industry

2. Firm's Competitive Environment and Economic Policies: (12Periods)

2.1 Two Firm objective; Market structure

2.2 perfect competition, monopoly, and oligopoly

2.3Fiscal policy and monetary policy;

2.4 Role of government spending and taxation; International trade

3. Accounting and Engineering Economics (10Periods)

3.1 Financial statements such as balance sheets and income statements

3.2 Investment and source of finance; Ratio analysis

3.3 Return on investment

4. Planning and Control: (10Periods)

4.1 planning and control techniques

5. Professional Ethics (10 Periods)

5.1 Professional codes of conduct for engineers

INSTRUCTONAL STRATEGY

The basic instructional strategy to teach Engineering Economics and Accountancy is to provide students with the fundamental concepts of micro- and macro-economics related to engineering industry. This subject helps students to develop the fundamental understanding of finance and costing **for engineering operations, budgetary planning, and control**

MEANS OF ASSESSMENT

- Assignments and Quiz/Class Tests
- Mid-term and End-term Written Tests
- Model/Prototype Making

RECOMMENDED BOOKS

1. Engineering Economics and Costing Mishra Sasmita · 2010.
2. MANAGERIAL ECONOMICS AND FINANCIAL ACCOUNTING M. KASI REDDY, S. SARASWATHI · 2007
3. V.K.Khanna, "Total Quality Management" New Age International, 2008.

SUGGESTED DISTRIBUTION OF MARKS

Topic	Time Allotted (Periods)	Marks Allotted (%)
1	12	20
2	12	20
3	10	12
4	10	24
5	10	24
Total	**Total 54**	**Total 100**

6.4 Heat Transfer

L	T	P
5	-	-

RATIONALE

The course is prepared to provide the detailed understating of heat transfer principles.

LEARNING OUTCOMES

After learning the course the students should be able to:

5- Understand basic concept of heat transfer

6- Able to do basic calculations involving heat transfer as is typical for a mechanical engineer.

7- This includes conduction, convection and radiation heat transfer as well as heat exchanger design.

8- Apply scientific and engineering principles to analyze and design aspects of engineering systems that• relate to conduction, convection and radiation heat transfer.

.

DETAILED CONTENTS

1.Introduction: (12 Periods)

1.1- Modes of heat transfer

1.2- Effect of temperature on thermal conductivity of different solids, liquids and gases,

2. Conduction: (12 Periods)

2.1 Fourier's law, One dimensional steady state conduction,
2.2 heat conduction through plane and composite walls like cylinders, sphere and electrical analogy
2.3 cylinders and spheres, electrical analogy, critical radius of insulation for cylinder and sphere
2.4 overall heat transfer coefficient
2.5 Biot Number, Transient heat conduction- lumped heat capacity analysis,
2.6 time constant, transient heat conduction in solids with finite conduction and convective resistances
2.7 Heat transfer from extended surface
    2.7.1 Types of fin
    2.7.2 heat flow through rectangular fin
    2.7.3 infinitely long fin, fin effectiveness and efficiency

3. Convection: (10Periods)

3.1 Newton's law of cooling.
3.2 Dimensional analysis applied to forced and free convection
3.3 dimensionless numbers and their physical significance

4. Radiation: (18Periods)

4.1 Absorptivity, reflectivity and transmissivity
4.2 black, white and grey body
4.3 emissive power and emissivity
4.4 laws of radiation – Planck
4.5 Stefan-Boltzmann Law
4.6 Wein's displacement law
4.7 Radiation heat exchange between black bodies

5. Heat exchanger: (18 Periods)

5.1 Classification, heat exchanger analysis

5.2 LMTD for parallel and counter flow exchanger

5.3 condenser and evaporator

5.4 overall heat transfer coefficient,

5.5. correction factors for multi pass arrangement

INSTRUCTONAL STRATEGY

The basic instructional strategy to teach heat transfer is to monitor and analyze of different machines which is used in renewable energy resources .

MEANS OF ASSESSMENT

- Assignments and Quiz/Class Tests
- Mid-term and End-term Written Tests
- Model/Prototype Making

RECOMMENDED BOOKS

1. Heat & Mass Transfer by P.K. Nag, McGraw Hill
2. Heat and Mass Transfer: Fundamentals and Application by Yunus Cengel, McGraw Hill
3. Fundamental of Heat and Mass Transfer by Incropera and Dewitt, Wiley Publication
4. Heat Transfer by Mills and Ganesan, Pearson Education
5. Heat Transfer by J P Holman , McGraw Hill
6. Heat and Mass Transfer by R K Rajput, S.Chand Publication
7. Heat Transfer: Principles and Applications by Dutta, Binay K, PHI Publication

SUGGESTED DISTRIBUTION OF MARKS

Topic	Time Allotted (Periods)	Marks Allotted (%)
1	12	20
2	12	20
3	10	12
4	18	24
5	18	24
Total	**Total 70**	**Total 100**

6.5 PROJECT WORK

L T P
- - 12

RATIONALE

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

LEARNING OUTCOMES

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

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

• Develop understanding regarding the size and scale of operations and nature of fieldwork in which students are going to play their role after completing the courses of study

- Develop understanding of subject based knowledge given in the classroom in the context of its application at work places.
- Develop first-hand experience and confidence amongst the students to enable them to use and apply polytechnic/institute based knowledge and skills to solve practical problems related to the world of work.
- Develop abilities like interpersonal skills, communication skills, positive attitudes and values etc.
-

General Guidelines

The individual students have different aptitudes and strengths. Project work, therefore, should match the strengths of students. For this purpose, students should be asked to identify the type of project work, they would like to execute. The activity of problem identification should begin well in advance (say at the end of second year). Students should be allotted a problem of interest to him/her as a major project work. It is also essential that

the faculty of the respective department may have a brainstorming session to identify suitable project assignments for their students. The project assignment can be individual assignment or a group assignment. There should not be more than 3 students if the project work is given to a group. The project work identified in collaboration with industry should be preferred.

This practical training cum project work **should not be considered** as merely conventional industrial training in which students are sent at work places with either minimal or no supervision. This experience is required to be planned in advance and supervised on regular basis by the polytechnic faculty. For the fulfilment of above objectives, polytechnics may establish close linkage with 8-10 relevant organization for providing such an experience to students. It is necessary that each organization is visited well in advance and activities to be performed by students are well defined. The chosen activities should be such that it matches with the curricula interest to students and of professional value to industrial/ field organizations. Each teacher is expected to supervise and guide 5-6 students.

The projects given to students should be such for which someone is waiting for solution. Some of the suggested project activities are given below:

1. Projects connected with repair and maintenance of machines.
2. Estimating and costing projects.
3. Design of jigs / fixtures.
4. Projects related to quality control.
5. Project work related to increasing productivity.
6. Projects relating to installation, calibration and testing of machines.
7. Projects related to wastage reduction.
8. Project, related to fabrication.
9. Energy efficiency related projects.
10. Projects related to improving an existing system

NOTE: Each student has to take one project individually and one to be shared with a group of four-five students depending upon cost and time involved. There is no binding to take up the above projects as it is only a suggestive list of projects.

A suggestive criterion for assessing student performance by the external (person from industry) and internal (teacher) examiner is given in table below:

Sr. No.	Performance Criteria	Max.** Marks	Rating Scale				
			Excellent	Very Good	Good	Fair	Poor
1.	Selection of project assignment	10%	10	8	6	4	2
2.	Planning and execution of considerations	10%	10	8	6	4	2
3.	Quality of performance	20%	20	16	12	8	4
4.	Providing solution of the problems or production of final product	20%	20	16	12	8	4
5.	Sense of responsibility	10%	10	8	6	4	2
6.	Self expression/ communication skills	5%	5	4	3	2	1
7.	Interpersonal skills/human relations	5%	5	4	3	2	1
8.	Report writing skills	10%	10	8	6	4	2
9	Viva voce	10%	10	8	6	4	2
Total marks		**100**	**100**	**80**	**60**	**40**	**20**

The overall grading of the practical training shall be made as per following table.

In order to qualify for the diploma, students must get “Overall Good grade” failing which the students may be given one more chance to improve and re-evaluate before being disqualified and declared “not eligible to receive diploma ”. It is also important to note that the students must get more than six “goods” or above “good” grade in different performance criteria items in order to get “Overall Good” grade.

Range of maximum marks Overall grade

i) More than 80 **Excellent**

ii) 79 <> 65 Very good

iii) 64 <> 50 Good

iv) 49 <> 40 Fair

v) Less than 40 Poor

Important Notes

1. This criteria must be followed by the internal and external examiner and they should see the daily, weekly and monthly reports while awarding marks as per the above criteria.

2. The criteria for evaluation of the students have been worked out for 200 maximum marks. The internal and external examiners will evaluate students separately and give marks as per the study and evaluation scheme of examination.

3. The external examiner, preferably, a person from industry/organization, who has been associated with the project-oriented professional training of the students, should evaluate the students’ performance as per the above criteria.

4. **It is also proposed that two students or two projects which are rated best be givenmerit certificate at the time of annual day of the institute. It would be better if specific nearby industries are approached for instituting such awards.**

The teachers are free to evolve other criteria of assessment, depending upon the type of project work.

It is proposed that the institute may organize an annual exhibition of the project work

10. RESOURCE REQUIREMENT

10.1 PHYSICAL RESOURCES

(A) Space requirement

Norms and standards laid down by All India Council for Technical Education (AICTE) are to be followed to work out space requirement in respect of class rooms, tutorial rooms, drawing halls, laboratories, space required for faculty, student amenities and residential area for staff and students.

(B) Equipment requirement:

Following Laboratories are required for Diploma Programme in Mechanical Engineering:

- Communication Laboratory
- Applied Physics Laboratory
- Applied Chemistry Laboratory
- Engineering Drawing
- Applied Mechanics
- Basics of Information Technology/Computer Laboratory
- Carpentry Shop
- Painting and Polishing Shop
- Electrical Shop
- Smithy Shop
- Fitting and Plumbing Shop
- Sheet Metal Shop
- Welding Shop
- Foundry Shop
- Machine Shop
- Material and Metallurgy Laboratory

- Mechanical Engineering Drawing
- **Renewable Energy**
- Solar Photovoltaic Laboratory
- Strength of Material Laboratory
- Electrical and Electronics Engineering Laboratory
- Mechanical Workshop
- Hydraulic and Pneumatic Laboratory
- Thermal Engineering Laboratory
- Metrology Laboratory
- Refrigeration and Air Conditioning Laboratory
- Theory of Machine Laboratory
- Automobile Engineering Lab
- Maintenance Lab (fot Repair & Maintenance)
- Environment Engineering
- Energy Conservation Lab

EQUIPMENT REQUIREMENT FOR RENEWABLE ENERGY

Sr. No.	Description	Qty	Total Price (Rs)
COMMUNICATION LABORATORY			
1.	Stools	40	10,000
2.	Display Board/Screen	2	6,000
3.	Sound recording and playing system	1	6,000
4.	Audio cassettes	60	2,000
5.	Overhead Projector	1	5,000
6.	Transparencies slides	100	500
7.	TV, VCR and camera for video recording	1 each	20,000
8.	English spoken course	1	2,000

9.	A Quiz room equipped with two way audio system, back projection system and slide projector	1	30,000
10.	Miscellaneous	LS	1,500
	APPLIED PHYSICS LABORATORY		
1.	Vernier calipers Working length 160 mm, Internal and external dia with locking arrangement	12	2,000
2.	Screw Gauges Working length 15 mm, pitch 0.5 mm, least count .005 mm	12	2,000
3.	Spherometers Distance between legs 2.5 mm, pitch 0.5 mm, least count .005 mm.	12	2,000
4.	Mirrors (convex, concave)	5 Each	1,500
5.	Pendulum Setup	02	4,000
6.	Gravesand's Apparatus	02	3,000
7.	Inclined Plane Setup	02	2,000
8.	Flywheel Setup	02	4,000
9.	Prism	05	1,500
10.	Spectrometer	02	25,000
11.	DC Ammeters Moving coil weston-type ammeter with ebonite stand	10	3,500
12.	DC Miliammeters	2	1,000
13.	DC Microammeters	2	700
14.	DC voltmeters	10	700
15.	DC Millivoltmeters	10	2,000
16.	Sensitivity Galvanometer	2	800
17	Student Galvanometers	10	4,000
18.	Demonstration type DC Ammeters Range; 0 to 1 Amp.	2	1,000
19.	D type DC Voltmeter	2	1,000

	Range : 0 to 1 Volt		
Sr. No.	Description	**Qty**	**Total Price (Rs)**
20.	D type Galvanometers Sensitivity : 20 microamperes per scale division,	8	8,000
21.	Resistance boxes (dial type) assorted	8	8,000
22.	Rheostats	10	4.000
23.	Miscellaneous items (Spring, Pan, Glycerine, Optic fibre, Ferromagnetic material)	LS	2,000
24.	Fortin's Barometer (Wall type)	2	20,000
25.	Stoke's Apparatus	2	10,000
26.	Gumther's Apparatus	2	16,000
27.	Resonance Tube Apparatus with accessories and Tuning fork set	2	14,000
28.	Sodium Lamp setup with Biprism	2	10,000
29.	Ohmic resistance coil	10	5,00
30.	Slide wire bridge	2	8,000
31.	PN Junction diode Apparatus	2	10,000
32.	Laser (as per requirement)	1	1,00,000
33.	Numerical aperture setup	1	25,000
34.	Miscellaneous	LS	3,000
APPLIED CHEMISTRY LABORATORY			
1.	Digital Balance	1	80,000

2.	Burette 50ml	30	3,000
3.	Pipette 25ml	60	4,000
4.	Beakers 100ml	60	4,000
5.	Burette stand	30	30,000
6.	Glazed tile	30	1,000
7.	Conical flask 50ml (Titration flask)	60	4,000
8.	Standard (Measuring) flask (to prepare standard solution) 250ml/100ml	30	6,000
9.	Able's Flash Point apparatus	2	10,000
10.	(1/10)°C thermometer	06	6,000
11.	Candles	20	100
12.	Crucible with lid	06	2,000
13.	Muffle furnace	1	18,000
14.	Decicators	06	8,000
15.	Pair of tongue (small and big)	24 (small) 2 (big)	2,000
Sr. No.	Description	**Qty**	**Total Price (Rs)**
16.	Chemicals - EDTA-1 kg - Eriochrome Black-T(solochrome black T)-200g - Buffer solution (NH_3 - 2.5 ltr, NH_4Cl – 1 kg) - Zinc sulphate- 500g - H_2SO_4- 2.5 ltr - Phenolphthalein indicator (as per requirement) - Methyl orange indicator (as per requirement) - Charcoal (as per requirement) - Kerosene- 1 ltr	LS	20,000
17.	Miscellaneous	LS	2,000

ENGINEERING DRAWING			
1.	Drawing Boards (700 x 500mm)	60	25,000
2.	Draughtsman Tables	60	1,80,000
3.	Draughtsman Stools	60	40,000
4.	Computer Aided Drawing (CAD) Software	30 User	5,00,000
5.	Model of different wooder joints	1	1,000
6.	Model of different screw threads	1	1,000
7.	Model of various locking devices	1	1,000
8.	Model of various joints	1	1,000
9.	Cut section Model of various couplings	1	3,000
10.	Miscellaneous	LS	5,000
APPLIED MECHANICS LABORATORY			
1.	Polygon law of forces apparatus	1	2,000
2.	Jib crane	1	4,000
3.	Apparatus for reaction at supports	1	5,000
4.	Inclined plane and friction apparatus	1	2,500
5.	Screw jack	1	1,000
6.	Worm and worm wheel	1	3,500
7.	Single Purchase Winch Crab	1	4,000
8.	Miscellaneous	LS	1,000
BASICS OF IT LABORATORY/COMPUTER LABORATORY			
1.	Computer System with latest configuration	30	8,00,000
2	Printer (MFP)	1	25,000
3	Printer (Laser)	1	35,000
4.	Plotter	1	75,000
5.	Digitiser	1	50,000
6.	Antivirus Software	LS	10,000
7.	Internet Facility on Computers	LS	2,00,000

Sr. No.	Description	Qty	Total Price (Rs)
8.	AutoCAD/Solid Works/Unigraphics/Pro-C (any one software)	30 user	5,00, 000
9.	LCD Projector	1	35,000
10.	UPS	60	1,20,000
11.	Software (latest windows, latest MS Office)	1	1,00,000
12.	Scanner	1	10,000
13.	Miscellaneous	LS	5,000
	CARPENTRY SHOP		
1	Work benches fitted with carpenter vices	5	20,000
2.	Circular saw grinder	1	6,000
3.	Wood cutting band saw-vertical	1	10,000
4.	Bench grinder	1	5,000
5.	Drilling machine	1	8,000
6.	Wood turning lathe	1	40,000
7.	Wood Planner	1	20,000
8.	Tool accessories measuring and marking Instruments	25	25,000
9.	Band saw blade brazing unit	1	10,000
10.	Miscellaneous	LS	1,500

PAINTING AND POLISHING SHOP			
1.	Spray gun with hose pipe	1	1,000
2.	Paint brushes	20	2,000
3.	Paint/Varnish	LS	2,000
4.	Air Compressor with 2 hp motor	1 set	10,000
5.	Miscellaneous	LS	2,000
ELECTRICAL SHOP			
1.	Tool kit (Plier, Srew driver, Knife, Steel rule, hammer, sciber, pincer steel tape etc.)	20	20,000
2.	Fuses, Switches, Plugs, Sockets, Ceiling rose, Wires, cleats, Clamps, Test lamp, Tester.(as per requirement)		8,000
3.	Electric Iron	1	1,500
4.	Electric kettle	1	1,500
5.	Ceiling fan/table fan	1	2,500
6.	Desert cooler	1	5,000
7.	Lead acid battery	2	8,000
8.	Battery Charger	1	6,000
9.	Miscellaneous		3,000

Sr. No.	Description	**Qty**	**Total Price (Rs)**
SMITHY SHOP			
1.	Black smithy forge (with open hearths, accessories to match the forge)	20	40,000
2.	Wrought iron anvils	20	20,000
3.	Swage blocks	4	8,000
4.	Blower with accessories, motor switch etc	1	6,000

5.	Work benches with vices	2	6,000
6.	Power hammer	1	20,000
7.	Tools and accessories – hammers, swages, tongs, pokers, pullers etc	20	10,000
8.	Miscellaneous	LS	1,500
FITTING AND PLUMBING SHOP			
1.	Work benches with vices (4 vices on each bench)	5	30,000
2.	Marking tables with scribers	4	24,000
3.	Surface plates	5	20,000
4.	Accessories like calipers, V blocks, height, gauges steel rules and scribers	25	50,000
5.	Tool kits – taps, dies, drills	25	40,000
6.	Tool kits – chiesels, hammers, files, hacksaw	25	25,000
7.	Drilling machine	2	12,000
8.	Pipe vice	4	1,000
9.	Chain wrenches	5	1,250
10.	Ring spanner set	5	600
11.	Pipe die set 2”	2 set	1,000
12.	Pipe bending device	1	5,000
13.	Various plumbing fittings	LS	2,000
14.	Miscellaneous	LS	1,500
SHEET METAL			

1.	Hammers	8	3,000
2.	Mallets (Hard & Soft)	5	2,000
3.	Sheet and wire Ganges	LS	8,00

Sr. No.	Description	Qty	Total Price (Rs)
4.	Shearing Machine	1	20,000
5.	Bar folding Machine	1	20,000
6.	Burring machine	1	10,000
7.	Various sheet (black plain, galvanized iron, corrugated, Aluminium)	1 Each	1,000
8.	Hand Shears/Snippers	4	2,000
9.	Nuts, Bolts, Rivets, Screw	LS	5,00
10.	Miscellaneous	LS	1,000
	WELDING SHOP		
1.	Electrical welding transformer set with accessories	3	30,000
2.	Gas Cutting Unit	1	3,000
3.	Work benches with vices	3	5,000
4.	Welding generator set	1	10,000
5.	Oxy acetylene welding set with accessories	1	7,000

6.	Acetylene generating set	1	6,000
7.	Electric welder tool kit	10	10,000
8.	Projection welding machine	1	15,000
9.	Brazing equipment with accessories	1	10,000
10.	Soldering irons	3	1,000
11.	Pedestal grinder	1	10,000
12.	Metal spraying gun	1	10,000
13.	Spot welder	1	25,000
14.	TIG welding set	1	1,00,000
15.	MIG welding set	1	1,00,000
16.	Welding Partition Screen	5	2,500
17.	Miscellaneous	LS	3,000

Sr. No.	Description	**Qty**	**Total Price (Rs)**
FOUNDRY SHOP			
	Moulding boxes		8,000
	Ladles		2,000

	Tool Kits		5,000
	Quenching tanks		5,000
	Portable grinder		3,000
	Pit furnace with blower		10,000
	Miscellaneous	LS	1,000
	MACHINE SHOP		
1.	Centre lathes	10	6,00,000
2.	Grinder	1	10,000
3.	Universal milling machine	1	1,25,000
4.	Shaper	2	1,20,000
5.	Plainer	2	1,20,000
6.	Work bench	3	10,000
7.	Precision instruments	1	10,000
8.	Hand tools and accessories	2	8,000
9.	CNC trainer lathe	1	4,00,000
10.	Miscellaneous	LS	5,000
	ENGINEERING MATERIAL LAB		

1.	Electric furnace muffle type	1	60,000
2.	Forced circulation tempering furnace	1	30,000
3	Quenching tank	2	5,000
4.	Grinder	2	4,000
5.	Pyrometers	1	10,000
6	Specimen Kit (Ferrous and Non-ferrous Metals (25 Nos)	1	5,000
7.	Metallurgical microscope	3	35,000 each
8	Abrasive cut off machine	1	50,000
9	Specimen Polishing Machine (Double Disk type)	1	50,000
10	Thermocouples	2	5,000
11	Set of Specimen of different alloys	1	5,000
12	Brinnel Hardness Tester	1	80,000

Sr. No.	Description	**Qty**	**Total Price (Rs)**

MECHANICAL ENGINEERING DRAWING			
1	Working Model of Oldham's Coupling	1	3,000
2	Working Model of Universal Coupling	1	3,000
3	Plummer Block	1	2,000
4	Screw Jack	1	3,000
5	Connecting Rod	1	3,000
6	Set of Ball and Roller bearing	01 set	1,000
Solar PHOTO VOLTAIC LABORATORY			
1	**Solar Energy Trainer Kit**	01	32,500
2	Solar smart metering system	01	6,726
3	Solar water pump (1 H.P.)	01	53,000
4	Solar street lighting system 9watts	01	1,000
5	Solar inverter system (12 volts)	01	7,000
Renewable Energy Instrumentation Applications			
1	LVDT transducer	01	8,000
2	Strain Gauges	04	400
3	Thermocouple	02	3300
4	Burdon tube pressure gauge	02	900
5	Weight tester	1	3500

Thermodynamics and Heat Transfer			
1	Two stroke Petrol Engine	1	1500
2	Two stroke Diesel Engine	1	1500
3	Bomb Calorimeter	1	1500
4	Four stroke Petrol Engine	1	1600
5	Four stroke Diesel Engine	1	1600
6	Pressure gauge parts	5	200
	Solar Energy Lab		
1	Solar Flat Plate Collector	1	16000
2	Solar cooker	1	5000
3	solar cooling system	1	12,529
4	solar dryer	1	4000
5	Evacuated tube collector	1	10,000
	Wind energy Lab		
1	Wind Turbine generator kit	1	2652
2	Permanent Magnet Synchronous Generator	1	40000
3	Domestic wind turbine	1	8159
	BIO ENERGY LAB		
1	Biogas plant model	1	1500
2	Bomb Calorimeter for lab	1	1500
	Installation, Maintenance & Monitoring Lab		
1	Coil Winding Machine	1	12000
2	Bench Drilling Machine	1	15000
3	Portable Drilling Machine	1	25000
4	Multi meter	1	1900
	Fuel cell & Hydrogen Energy Lab		
1	Polymer Electrolyte Fuel Cell	1	20000
2	Dissolved Methanol Fuel Cell	1	22000
STRENGTH OF MATERIALS LABORATORY			
1.	Brinell and Rockwell hardness tester	1	60,000

2.	Impact testing machine (Izod and charpy)	1	50,000
3.	Microprocessor based universal testing machine	1	4,00,000
4.	Torsion testing machine (fully computerized)	1	2,00,000
5	Spring Stiffness Tester	1	50,000
6.	SFD & BMD apparatus	2	5,000
ELECTRICAL AND ELECTRONICS ENGINEERING LABORATORY			
1.	Wattmeter	5	10,000
2.	Ammeter	5	10,000
3.	Voltmeter	5	7,500
4.	DC shunt motor	1	5,000
5.	Single phase variac	1	2,500
6.	Single phase transformer	1	5,000
7.	Resistive load	1	4,000
8.	Multimeter	1	4,000
9.	CRO	1	15,000
10.	Regulated supply	1	8,000
11.	Signal generator	1	5,000
12.	3-phase inductor motor	1	5,000
13.	3-phase variac	1	8,000
14.	DC shunt generator coupled with motor and starter	1	25,000
15.	Rheostat	2	2,500

16.	Tachometer	1	5,000
	MECHANICAL WORKSHOP		
1.	Centre lathes	10	5,00,000
2.	Tool room lathe	1	1,00,000

Sr. No.	Description	**Qty**	**Total Price (Rs)**
3.	Lathe with copy turning attachment and other attachments	1	1,50,000
4.	Universal milling machine	1	1,25,000
5.	Vertical milling machine	1	75,000
6.	Shapers	2	1,00,000
7.	Radial drilling machine	1	25,000
8.	Upright drilling machine	1	20,000
9.	Gear Shaper	1	75,000
10.	Centreless grinder	1	80,000
11.	Universal cylindrical grinder	1	75,000
12.	Hydraulic surface grinder	1	50,000
13.	Tool and Cutter grinder	1	50,000
14.	Power hacksaw	1	25,000
15.	Pedestal grinder	1	5,000
16.	Electro discharge machine	1	4,00,000
17.	Work bench	3	6,000

18.	Precision instruments	1	5,000
19.	Surface plates	2	15,000
20.	Hand tools and accessories	2	6,000
21.	CNC trainer lathe	1	3,00,000
22.	CNC trainer milling machine	1	4,00,000
23.	PC Computer	2	1,00,000
24.	Computer based NC Programming Software	1	1,50,000
25.	CNC Simulation software	1	1,00,000
26.	CNC Milling machine accessories and holding devices	LS	1,00,000
HYDRAULICS & PNEUMATIC LABORATORY			
1.	Piezometer tube	2	100
2.	U tube differential manometer	2	2,000
3.	Bourdon's Tube pressure gauge	1	1,000
5.	Hydraulic jack	1	4,000
6.	Hydraulic press Working Model	1	5,000
7.	Bernoulli's apparatus	1	15,000
Sr. No.	Description	**Qty**	**Total Price (Rs)**
8.	Venturimeter apparatus with differential manometer	1	10,000
9.	Pipe friction apparatus	1	15,000
10.	Reciprocating pump- single and Double Acting	1	50,000
11.	Centrifugal pump	1	25,000

12	Working Model of Pelton Wheel Turbine	1	20,000
13	Working Model of Francis Turbine	1	20,000
14	Working Model of Kaplan Turbine	1	20,000
15	Hydraulic Circuit Trainer Kit	1	50,000
16	Pneumatic Circuit Trainer Kit	1	50,000
17	Working Model of Hydraulic Brake system	1	50,000
18	Working Model of Hydraulic Ram	1	5,000
THERMAL ENGINEERING LABORATORY			
1.	Throttling Calorimeter	2	10,000
2.	Testing for Determination of Dryness fraction of steam	1	50,000
3.	Cut section model of 4-stroke single cylinder Petrol and Diesel engine	1	30,000
4.	Gravimetric Analysis	1 each	20,000 each
5.	Model of Various Boiler Mounting and Accessories -Steam Stop Valve, Safety Valves, Blow off Cock, Water Level Indicator, Low Water High Pressure Safety Valve, Pressure Gauge, Economiser, Pre Heater (Air), Super Heater Model only.	1 each	10,000
6.	Exhaust Analyser for Petrol and Diesel engine	1 each	25,000 each
7.	Single Stage Reciprocating Air Compressor	1	50,000
8.	Rotary Compressor, Air Compressor	1	25,000
9.	Flash Point Apparatus	1	10,000
10.	Pyrometer, Infrared, Thermocouple	2	5,000 each

11.	Lancashire boiler model, Nestler Boiler Model	1 each	10,000
12.	Model of impulse turbine	1	5,000
13.	Model of reaction turbine	1	5,000
14.	Model of surface condenser	1	5,000
15.	Bab Cox & Wilcox Boiler Model	1	10,000
16.	Heat Transfer apparatus for conduction , convection and Radiation	1 set	45,000
17.	Model of 2 stroke, 4 stroke engines	01 set	6000
18.	Steam Separating & Throttling calorimeter fully instrumented to determine, quality of steam of 10-15 kg/cm^2 . Pressure with steam condensing arrangement	01	30,000
Sr. No.	Description	**Qty**	**Total Price (Rs)**
16.	Single cylinder 2 stroke petrol engine test rig	1	45,000
17.	Single cylinder 4 stroke petrol engine test rig	1	50,000
18.	Multicylinder petrol engine test rig (Morse test rig)	1	2,00,000
	METROLOGY LABORATORY		
1.	Digital vernier calliper / Vernier calliper	4	8,000
2.	Digital micrometer / micrometer	4	10,000
3.	Height gauge	2	1,500
4.	Depth gauge	2	1,000
5.	Combination set	1	1,000
6.	Bevel protractor	1	1,000
7.	Sine bar	1	1,000

8.	Precision balls and rollers	1	500
9.	Surface plate	2	15,000
10.	Slip gauges set	1	10,000
11.	Comparator – Mechanical , Pneumatic	2	40,000
12.	Gear tooth vernier	1	2,000
13.	Snap and ring gauges, Plug gauge, Thread gauge	2 each	1,500
14.	Feeler gauge, radius gauge	1	1,000
15.	Angle plate	1	1,000
16.	Tool makers microscope	1	40,000
17.	Optical Profile projector	1	75,000
18.	Surface roughness tester	1	60,000
19.	Dial Bore Gauge with Accessories	1	10,000
20	Autocollimator	1	50,000
21	Thermocouple , Pyrometer apparatus	1	10,000
REFRIGERATION AND AIR CONDITIONING LABORATORY			
1.	Refrigeration trainer to determine C.O.P.	1	6,000
2.	Air conditioner trainer / Test rig window type and split type air conditioner	1	1,00,000
3.	Water cooler	1	6,000
5.	Refrigeration compressor	1	3,000
6.	Safety controls (HP, LP Cut outs, oil pressure controls), solenoid valve, expansion valves, thermostats,	1 set	3,000

	charging board		
7.	Gas charging equipment kit	1	15,000
8.	Vacuum pump	1	3,000
9	Cut-Section model of thematically sealed compressor	1	6,000
10	Hand tools for cutting , flaring, swaging and brazing of tubes	1 set	5,000

AUTOMOBILE ENGINEERING LAB.			
1.	Battery Charger 0-12 V, 0-6 Amp.	1	2,000
2	Batteries 6 V & 12 V	1each	4,000
3	Hydrometer	1	1,000
4	Cell Tester	1	1,000
5.	Working Model of Battery Ignition System, Magneto Ignition System Fitted on board	1	2,000
6.	Fuel Injection Pump	1	15,000
7	Calibration Machine with Fuel Injection Pump & Coupling	1	25,000
8.	Electrical Testing Bench	1	2,000
9	Condemned petrol engine of light petrol vehicle	1	5,000
10.	Condemned Diesel engine of medium and heavy vehicles	1	5,000
11	Tyre inflator with twin hose assembly and small hose assembly	1	2,500
12	Spark plug cleaning machine and Testing machine	1	5,000

13	Condemned chassis frame of any light motor vehicle	1	5,000
14	Sectioned working model of a single cylinder two stroke petrol engine	1	1,000
15	Sectioned working model of single cylinder two stroke diesel engine	1	1,000
16	Sectioned working model of a single cylinder four stroke diesel engine	1	1,000
17	Sectioned working model of a single cylinder four stroke petrol engine fitted with ignition system Hand Operated Motor Operated	 1 1	 4,000 6,000
18	Work bench	2	2,500
19	Mechanical Jack	2	3,000
20	Tool Kit (Spanner, socket set, screw driver, plier, file, wrench, drill, tap set, hammer etc.)	4 sets	2,000
21	Miscellaneous	LS	4,000
22	Study and sketch of models of rear axle and differential	1	10,000
REFRIGERATION AND AIRCONDITIONING LAB (for RAC)			
1	Refrigeration Cycle Demonstration Unit-With Condenser & Evaperator Made of toughened glass & Instrumented to measure Temperature & Pressurse, Refrigerant flow at All Suitable Locations. Arangement for Using Different Expansion Devices.	2	@75000 =15000
2	Experimental Air Conditioner Window Type-1 Ton Capacity With Proper Instrumentation For Studying its performance.	2	@45000 =90000
3	PSYCHROMETERS		

	Sling Psychrometer. Aspiratior Psychrometer. Hygrometer Dry & Wet bulb wall hygrometer. Dial type hygrometer Fortin's barometer Manometers	2 2	LS. Rs.24000 LS. Rs.12000
4	Anemometer Hand Hold	2	4000
5	Misc.	Ls	20000
	1. Above items are for 2 batches of 30 students each.		
MAINTENANCE LAB (for Repair & Maintenance)			
1	Benchwise 10cm jaw	4 @1000	Rs.4000
2	Centre Punch	4 @100	Rs. 400
3	Pin Punch	4 @100	400
4	Callipers Inside (spring)	10 @200	2000
5	Callipers outside (spring)	10 @200	2000
6	V. Callipers 30 Cm.	2 @600	1200
7	Micrometer 0-25 Cm.	2@250	500
	25-50 Cm.	2@250	500
8	V.Depth gauge	2@700	1400
9	Feeler gauge 15 Blades	2@100	200
10	Radious gauge	2@150	300

11	Angle Gauge	2@150	300
12	Thread Gauge	2@150	300
13	Tap set	2 @3000	6000
14	Allen Key Set	2@700	1400
15	Adjustable Wrench	2 @2500	5000
16	Double Spanners		
	i. Size (6x7,8x9,...18x19,20x22 24x27,30x32mm)	4 @500	2000
	ii. Size (32x36, 36x41, 41x46, 46x50, 50x55mm)	2 @500	1000
17	Misc. Files, Scrapers, Dieset Hexaframe as per need	LS	5000
18	Pipe Vice 5cm	2 @500	1000
19	Chain Rinch	2 @500	1000
20	Ring Spanner Set	2 @250	500
21	Ball Peen Hammer	6 @100	600
22	Claw Hammer	2 @100	200
23	Battery Charger 0-12v,6 Amp.Call Tester Hydrometer Lead Acid Battery 12V,6V	2 @7000	14000
24	T-socket wrench Set	2 @1000	2000
25	Off socket wrench Set	2 @1000	2000
26	Old Jacks Hydraulic mechanical	2 Each	10000

		@ LS 5000	
27	Automobile Gear Box Old	2 @5000	10000
28	Refrigerator Old	2	LS 8000
29	Airconditioner (Window Type)old	2 @7000	Ls. 14000
30	Water cooler (old)	2 @5000	Ls. 10000
31	Digital Multimeter Portable 4-5 digits, 0.5 LCD Auto zeroing and Auto polarity DC Voltage 10MV-1000V DC Currient 0.1MA-10A Ac Voltage 10MV-750V AC Current 0.1MA-10A Batter Operated with connection Leads	2 @2000	4000
32	Clipon ammeter/Voltmeter Measuring rang 0-12A, 0-500V Opening 40mm for round conductors Set of spare fuses and connecting Leads.	2 @2000	4000
33	Pulley Pullers 2 2000 4000 (One two legged, One three Legged)	4 @2000	8000
34	Bearing Assorted	Ls.	4000
35	Couplings Assorted	Ls.	8000
36	Air compressor (old unit)	Ls.	
37	Portable tools - Pneumatic & Electrical (For Servicing	2	8000

	& Repairing Work - Old).	@4000	
38	Old lathe Machine/Grinding Machine.	2 @20000	40000
39	Miscellaneous Needs and for the items ommited hear if any	Ls	35000
40	Apparatus for checking of slip of belt	1	Ls. 25000
41	Toolkit for dismantling of sub assembly for example pullers , pneumatic wrenches	1	LS.10,000

NOTE:-

If the items other then tools and instruments mentioned above are available in the institute, they should be used for the purpose alternatively they should be procured from other institutions from where they may be made available for the purpose . For the facilities which cannot be made available in the institution visits of repair and maintenance shops in the vicinity be arranged according to need.

Note:

1. Above items are for 2 batches of 30 students each.

ENVIRONMENT ENGINEERING LABORATORY			
1.	pH Meter	01	500
2.	Turbidity Meter	01	5000
3.	Oven with Temperature Controller and Forced Air Circulation Type	01	20000
4.	B.O.D. Incubator	01	25000
5.	Water Analysis Kit	01	5000
6.	High Volume Sampler	01	40000
7.	Electrical Balance for weighing upto 1/10 of milligram (capacity)	01	1000
ENERGY CONSERVATION LABORATORY			

1	Clamp meter	02	5000
2	Multimeter	02	2000
3	Power Analyser	01	20000
4	Different types of lamps (LS) – 60 W lamp, 230 V , 100 V – 200 W lamp – 500 W lamp – 100 W lamp, 110 V, 150 V	10	500
5	Lux meter	02	5000
6	Centrifugal pump, 1 kW	1	15,000
7	Standard window A.C.	01	20000
8	Anemometer	02	5000
9	Thermometer	03	2000
10	Flow meter	02	10000
11	Pumping set with at least two pumps of different capacity.	1 set	10000
12	Pressure gauge fitted on discharge lines	1 set	2000
13	Variable Frequency Drive	02	50000
14	A small compressor with a small network of pipe line fitted with suitable pipeline, pressure gauge, safety valve and loading / unloading pressure switch.	1	3000
15	Stop watch	2	1000
16	Small blower (1.5 kW motor) with inlet and outlet ducts of approximately one meter length on both sides	1	10000
17	Black Box (for checking lamp efficacy including stand and luxmeter)	1	25000
Sr. No.	Description	**Qty**	**Total Price (Rs)**

STRUCTURAL MECHANICS			
1.	Universal Testing Machine, 20 Ton Including loading arrangement apparatus for flexural beam test as per IS 516:1949	01	2, 50,000
2.	Searl's Apparatus	01	15,000
3.	Cast Iron Moulds for casting 15x15x70 cm and 10x10x10 cm beans	1 each	8,000
4.	Deflection of Beam Apparatus	01	12,000
5.	Pin Jointed Frame Apparatus (Working)	01	20,000

Note:

1. The specifications and price of equipment mentioned above used as broad guidelines for purchase of equipment.
2. Any other items not mentioned in the lit of equipment can be purchased as provision has been made for purchase under the item miscellaneous for each lab/shop.
3. Any additional equipment, already available in the institute, may be used for demonstration to the students, and for experiments / practical's of other Lab's / Shops

NOTE:

In addition to the above, laboratories in respect of physics, chemistry, Computer Centre etc will be required for effective implementation of the course. Provision for photocopiers, PC facilities along with LCD Projection System etc. has also to be made.

(C) Furniture Requirement

Norms and standards laid down by AICTE be followed for working out furniture requirement for this course.

10.2 Human Resources Development:

Weekly work schedule, annual work schedule, student teacher ratio for various group and class size, staffing pattern, work load norms, qualifications, experience and job description of teaching staff workshop staff and other administrative and supporting staff be worked out as per norms and standards laid down by the AICTE.

11. EVALUATION STRATEGY

11.1 INTRODUCTION

Evaluation plays an important role in the teaching-learning process. The major objective of any teachinglearning endeavor is to ensure the quality of the product which can be assessed through learner's evaluation.

The purpose of student evaluation is to determine the extent to which the general and the specific objectives of curriculum have been achieved. Student evaluation is also important from the point of view of ascertaining the quality of instructional processes and to get feedback for curriculum improvement. It helps the teachers in determining the level of appropriateness of teaching experiences provided to learners to meet their individual and professional needs. Evaluation also helps indiagnosing learning difficulties of the students. Evaluation is of two types: Formative and Summative (Internal and External Evaluation)

Formative Evaluation

It is an on-going evaluation process. Its purpose is to provide continuous and comprehensive feedback to students and teachers concerning teaching-learning process. It provides corrective steps to be taken to account for curricular as well as co-curricular aspects. Summative Evaluation It is carried out at the end of a unit of instruction like topic, subject, semester or year. The main purpose of summative evaluation is to measure achievement for assigning course grades, certification of students and ascertaining accountability of instructional process. The student evaluation has to be done in a comprehensive and systematic manner since any mistake or lacuna is likely to affect the future of students. In the present educational scenario in India, where summative evaluation plays an important role in educational process, there is a need to improve the standard of summative evaluation with a view to bring validity and reliability in the end-term examination system for achieving objectivity and efficiency in evaluation.

11.2 STUDENTS' EVALUATION AREAS

The student evaluation is carried out for the following areas:

- Theory
- Practical Work (Laboratory, Workshop, Field Exercises)
- Project Work
- Professional Industrial Training

A. 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 sessional /class-tests, home-assignments, tutorial-work,

seminars, and group discussions etc. For end-term evaluation of theory, the question paper may comprise of three sections.

Section-I

It should contain objective type items e.g. multiple choice, matching and completion type. Total weightage to Section-1 should be of the order of 20 percent of the total marks and no choice should be given in this section. The objective type items should be used to evaluate students' performance in knowledge, comprehension and at the most application domains only.

Section-II

It should contain short answer/completion items. The weightage to this section should be of the order of 40 percent of the total marks. Again, no choice should be given in section-II

Section-III

It may contain two to three essay type questions. Total weightage to this section should be of the order of 40 percent of the total marks. Some built-in, internal choice of about 50 percent of the questions set, can be given in this section

Table II : Suggested Weightage to be given to different ability levels

Abilities Weightage to be assigned	Abilities Weightage to be assigned
Knowledge 10-30 percent	Knowledge 10-30 percent

Comprehension 40-60 percent	Comprehension 40-60 percent
Application 20-30 percent	Application 20-30 percent
Higher than application i.e. Analysis, Synthesis and Evaluation Upto 10 percent	Higher than application i.e. Analysis, Synthesis and Evaluation Upto 10 percent

B. Practical Work

Evaluation of students performance in practical work (Laboratory experiments, Workshop practicals/field exercises) aims at assessing students ability to apply or practice learnt concepts, principles and procedures, manipulative skills, ability to observe and record, ability to interpret and draw conclusions and work related attitudes. Formative and summative evaluation may comprise of weightages to performance on task, quality of product, general behaviour and it should be followed by viva-voce.

C. Project Work

The purpose of evaluation of project work is to assess students ability to apply, in an integrated manner, learnt knowledge and skills in solving real life problems, manipulative skills, ability to observe, record, creativity and communication skills. The formative and summative evaluation may comprise of weightage to nature of project, quality of product, quality of report and quality of presentation followed by viva-voce. D. Professional Industrial Training Evaluation of professional industrial training report and viva-voce/ presentation aims at assessing students' understanding of materials, 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. The formative and summative evaluation may comprise of weightages to performance in testing, general behaviour, quality of report and presentation during viva-voce.

12. RECOMMENDATIONS FOR EFFECTIVE CURRICULUM IMPLEMENTATION

This curriculum document is a Plan of Action and has been prepared based on exhaustive exercise of curriculum planning and design. The representative sample comprising selected senior personnel (lecturers and HODs) from various institutions and experts from industry/field have been involved in curriculum design process. The document so prepared is now ready for its implementation. It is the faculty of polytechnics who 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 a proper mix of different teaching methods in all these places of instruction only can bring the changes in stipulated students behaviour as in the curriculum document. It is important for the teachers to understand curriculum document holistically and further be aware of intricacies of teaching-learning process (T-L) for achieving curriculum objectives. Given below are certain suggestions which may help the teachers in planning and designing learning experiences effectively. These are indicative in nature and teachers using their creativity can further develop/refine them. The designers of the programme suggest every teacher to read them carefully, comprehend and start using them.

(A) Broad Suggestions:

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 and made available to all polytechnics well in advance. The Principals have a great role to play in its dissemination and, percolation upto grass-root level. Polytechnics, in turn are supposed to prepare institutional academic plan. 3. HOD of every Programme Department along with HODs and incharges of other departments are required to prepare

academic plan at department level referring to institutional academic plan. 4. All lecturers/Senior lecturers are required to prepare course level and class level lesson plans referring departmental academic plan.

(B) Course Level Suggestions

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. Polytechnic 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 of time. It is essential for them to use the given time judiciously by planning all above activities properly and ensure execution of the plan effectively. Following is the gist of suggestions for subject teachers to carry out T-L process effectively:

1. Teachers are required to prepare a course plan, taking into account departmental academic plan, number of weeks available and courses to be taught.

2. 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. They may follow steps for preparing lesson plan e.g. drawing attention, state instructional objectives, help in recalling pre-requisite knowledge, deliver planned subject content, check desired learning outcomes and reinforce learning etc.

3. Teachers are required to plan for expert lectures from field/industry. Necessary steps are to plan in advance, identify field experts, make correspondence to invite them, take necessary budgetary approval etc.

4. 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.

5. Concept and content based field visits may be planned and executed for such content of course which is abstract in nature and no other requisite resources are readily available in institute to impart them effectively.

6. There is a dire need for planning practical experiences in right perspective. These slots in a course are the avenues to use problem based learning/activity learning/ experiential learning approach effectively. The development of lab instruction sheets for the course is a

good beginning to provide lab experiences effectively.

7. Planning of progressive assessment encompasses periodical assessment in a semester, preparation of proper quality question paper, assessment of answer sheets immediately and giving constructive feed back to every student
8. The student centred activities may be used to develop generic skills like task management, problem solving, managing self, collaborating with others
9. Where ever possible, it is essential to use activity based learning rather than relying on delivery based conventional teaching all the time.
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 for wastage of energy and other resources etc.
12. Students may be given relevant and well thought out project assignments, which are purposeful and develop practical skills. This will help students in developing creativity and confidence for their gainful employment.
13. A Project bank may be developed by the concerned department of the polytechnics in consultation with related Industry, research institutes and other relevant field organizations in the state

13. LIST OF PARTICIPANTS

The following experts participated in workshop for Developing the Curricula Structure and Contents of Diploma Programmes in Renewable Energy for UP State on 6th August, 2021 at IRDT, U.P. Kanpur:

1. Sh. Pankaj Singh, Lecturer, Mechanical Engineering, MMIT, Auraiya.
2. Sh. Garima Singh, Lecturer, Mechanical Engineering, Government Polytechnic, Fatehpur.
3. Sh. Madhavi Kushwaha, Lecturer, Mechanical Engineering, Government Polytechnic, Bindki, Fatehpur.
4. Sh. P. K. Mall, Assistant Professor, Mechanical Engg., BBDEC, Lucknow.
5. Sh. Saurabh Bhutani, Assistant Professor, Electronics and Communication Engg., BBDEC, Lucknow.