NEP-2020 ALIGNED
CURRICULUM FOR DIPLOMA PROGRAMME IN

RENEWABLE ENERGY

(3rd to 4th Semester)

==========
Semester System
==========

Prepared By:

INSTITUTE OF RESEARCH DEVELOPMENT & TRAINING, U.P., KANPUR

CONTENTS

THIRD SEMESTER

FOURTH SEMESTER

PREFACE

An important issue generally debated amongst the planners and educators world over is how technical education can contribute to sustainable development of the societies struggling hardto come in the same bracket as that of the developed nations. The rapid industrialization and globalization has created an environment for free flow of information and technology throughfast 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 42 diploma programmes as per the needs of the industry and making them NEP-2020/AICTE 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 of 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.

Director
Institute of Research Development & Training

ACKNOWLEDGEMENTS

We gratefully acknowledge the guidance and contribution received from the following Persons

1. Sh. Narendra Bhooshan, IAS, Additional Chief Secretary, Department of Technical Education, Govt. of UP, for his exemplary vision & approach.

2. Sh. Avinash Krishna Singh, IAS, Secretary, Directorate General, Department of Technical Education, Govt. of U.P.

3. Sh. F.R. Khan, Director, I.R.D.T. Kanpur for continually motivating, guiding and taking keen interest in the review of curriculum..

4. All the participants from industries, Polytechnics and other technical institutions for their professional inputs during curriculum workshops.

5. CDC Officer and other concerning staff of IRDT for their support and assistance in conducting curriculum workshops.

6. In the last but not least would like to thanks management of the industries who spare not only their precious time but also allowed the visit of their industries to the team making the curriculum

Vikas Kulshreshtha
CDC Officer
IRDT Kanpur

1. SALIENT FEATURES

1)	Name of the Programme	:	Diploma 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)	Pattern of the Programme	:	Semester Pattern
5)	NSQF Level	:	Level - 5
6)	Ratio between theory and Practical	:	40: 60 (Approx.)

7) **Industrial Training**

Four and six weeks of industrial training is made mandatory after the II and IV semesters during summer vacation.Total marks allotted to industrial training will be respectively 50 & 100.

In the last (6^{th} Semester) we have made the one semester Industrial training/Internship as optional along with usual classroom training.

8) **Ecology and Environment**

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

9) **Entrepreneurship and Start-ups**

A full subject Entrepreneurship & Start-ups has been incorporated in the curriculum.

10) **Student Centred Activities**

A provision of 2-4 hrs per week has been made for organizing Student Centered 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, library and other cultural activities.

11) **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- PROGRAM OUTCOMES (POs)

PO1: Basics and Discipline specific Knowledge
Assimilate knowledge of basic mathematics, science, engineering fundamentals.

PO2: Problem's Analysis and solution
Identify, analyse and solve problems using standard methods and established techniques.

PO3: Design and Development
Design solutions for technical problems.
Assist in designing components, systems, or processes to meet specific requirements.

PO4: Engineering Tools, Experimentation, and Testing
Use modern engineering tools and appropriate techniques to conduct experiments as per BIS standard.

PO5: Socio/ Economic /Environmental impact assessment/remedy.

Apply relevant technologies while considering societal needs, environmental impact keeping in view sustainable and ethical responsibilities.

PO6: Project Management and Communication
Apply engineering management principles, work effectively as an individual or in a team, and communicate clearly on activities.

PO7: Lifelong Learning
Recognize the importance of continuous learning and actively pursue self-improvement to keep pace with technological developments.

3-EMPLOYMENT OPPORTUNITIES

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.

4-LEARNING OUTCOMES

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

5- ABSTRACT OF CURRICULUM AREAS

HUMANITIES & SOCIAL SCIENCES COURSES [HS]

- Communication Skills in English
- Sports and Yoga
- Entrepreneurship and Start-ups

BASIC SCIENCES COURSE [BS]

- Mathematics
- Applied Physics
- Applied Chemistry

ENGINEERING SCIENCE COURSES [ES]

- Engineering Graphics
- Engineering Workshop Practice
- Introduction to IT Systems
- Fundamentals of Electrical & Electronics Engineering
- Engineering Mechanics

PROGRAM CORE COURSES [PC]

- Fundamentals of Renewable energy Resources
- Solar Photovoltaic
- Fundamental of Thermodynamics and Heat Transfer
- Renewable Energy Instrumentation Applications
- Renewable Energy Instrumentation Applications Laboratory
- Solar Energy
- Solar Energy (Lab)
- Hydraulics and Pneumatics
- Wind Energy
- Bio-Energy
- Bio-Energy (Lab)
- Mass Transfer Operations-I

OPEN ELECTIVE COURSES [OE]

Open Elective -1

- Project Management
- Artificial Intelligence

PROJECT WORK, SEMINAR AND INTERNSHIP IN INDUSTRY OR ELSEWHERE

- Summer Internship – I (4 weeks) after IInd Sem
- Summer Internship – II (6 weeks) after IVth Sem
- Major Project(In-House) / Internship / Industrial Training

AUDIT COURSES [AU]

- Environmental Science
- Essence of Indian Knowledge and Tradition
- Indian Constitution

6- STUDY AND EVALUATION SCHEME FOR DIPLOMA PROGRAMME IN RENEWABLE ENERGY

THIRD SEMESTER

Sr. No.	SUBJECTS	Category & Course Type	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	Program Core (Theory)	3	1	-	4	40	-	**40**	60	3	-	-	**60**	**100**
3.2	Solar Photovoltaic	Program Core (Practicum)	2	-	4	4	40	-	**40**	60	3	-	-	**60**	**100**
3.3	Fundamental of Thermodynamics and Heat Transfer	Program Core (Practicum)	2	-	4	4	40	-	**40**	60	3	-	-	**60**	**100**
3.4	Renewable Energy Instrumentation Applications	Program Core (Theory)	4	-	-	4	40	-	**40**	60	3	-	-	**60**	**100**
3.5	Renewable Energy Instrumentation Applications Laboratory	Program Core (Practical)	-	-	8	4	-	60	**60**	-	-	40	3	**40**	**100**
3.6	**Summer Internship -I (4 Weeks after 2nd Sem.)		-	-	-	1	-	50	**50**	-	-	-	-	**-**	**50**
#Student Centred Activities (SCA)			-	-	8	-	-	50	**50**	-	-	-	-	**-**	**50**
Total			**11**	**1**	**24**	**21**	**160**	**160**	**320**	**240**	**-**	**40**	**-**	**280**	**600**

** SUMMER INTERNSHIP (4 WEEKS) duration to be organized after second semester exam. Evaluation will be done in third semester.

Student Centered 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, library, Cultural Activities and self-study etc.

1) Each period will be 60 minutes duration.
2) Each session will be of 16 weeks.
3) Effective teaching will be at least 14 weeks.

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

Sr.No.	SUBJECTS	Category & Course Type	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	Program Core (Theory)	2	-	-	2	40	-	40	60	3		-	60	100
4.2	Solar Energy (Lab)	Program Core (Practical)	-	-	6	3	-	60	60	-	-	40	3	40	100
4.3	Hydraulics and Pneumatics	Program Core (Practicum)	1	-	4	3	-	60	60	-	-	40	3	40	100
4.4	Wind Energy	Program Core (Practicum)	2	-	4	4	40	-	40	60	3	-	-	60	100
4.5	Bio-Energy	Program Core (Theory)	2	-	-	2	40	-	40	60	3	-	-	60	100
4.6	Bio-Energy (Lab)	Program Core (Practical)	-	-	6	3	-	60	60	-	-	40	3	40	100
4.7	(Q) Open Elective -1 a) Project Management b) Artificial Intelligence **OR**	Open Elective	2	-	-	2	50*	-	-	-	-	-	-	-	-
	*Advance Skill Development	Certification Course	-	-	-		-	-	-	-	-	-	-	-	-
4.8	(Q) Essence of Indian Knowledge and Tradition	Audit Course	2	-	-	-	50*	-	-	-	-	-	-	-	-
#Student Centred Activities (SCA)			-	-	5	-	-	50	**50**	-	-	-	-	-	**50**
Total			**11**	**-**	**25**	**19**	**120**	**230**	**350**	**180**	**-**	**120**	**-**	**300**	**650**

Note -(Q) - It is compulsory to appear & to pass in examination, But marks will not be included for division and percentage of obtained marks.

* Advance skill development mention at **4.7** in the table provide the scope of selecting the course as per choice from the elective list provided in the syllabus conducted by various agency of repute of duration not less than 20 Hrs (Offline/Online).

#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

Sr No	Name of Courses	L	T	P	Credit
1	**Open Elective -1 (Select any one subject of the given list)**				
	a) Project Management	2	-	-	2
	b) Artificial Intelligence	2	-	-	2

OR

OPEN ELECTIVE-1 (Advance Skill Development)

SR.NO.	**CERTIFICATE COURSES**
1.	COURSES CONDUCTED BY CENTRE OF EXCELLENCE (ESTABLISHED BY THIRD PARTY AS: - TATA TECHNOLOGIES. etc)
2.	COURSES CONDUCTED BY INFOSYS PRINGBOARD
3.	COURSES CONDUCTED BY TCS ION
4.	COURSES CONDUCTED BY OTHER RELEVANT GOVERNMENT, INTERNATIONAL/NATIONAL ORGANIZATION OR PLATFORMS OF REPUTE
5.	COURSES CONDUCTED BY AICTE-ELIS AND CENTRALLY FUNDED TECHNICAL INSTITUTES
6.	COURSES CONDUCTED BY C-DAC
7.	COURSES CONDUCTED BY NEILIT

7- GUIDELINES FOR ASSESSMENT OF STUDENT-CENTRED ACTIVITIES (SCA)

It was discussed and decided that the maximum marks for SCA should be 50 as it involves a lot of subjectivity in the evaluation. The marks may be distributed as follows-

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

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

a) 75 - 80% 06 Marks

b) 80 - 85% 08 Marks

c) Above 85% 10 Marks

25 Marks maximum for Sports/NCC/Cultural/Co-curricular/NSS activities as per following:
(by In-charge Sports/NCC/Cultural/Co-curricular/NSS)

a) 25 - State/National Level participation

b) 20 - Participation in two of above activities

c) 15 - Inter-Polytechnic level participation

THEORY	3.1 Fundamentals of Renewable Energy Resources	L	T	P
		3	1	-

COURSE OBJECTIVES

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.

COURSE 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.

COURSE CONTENTS

1. Solar cell fundamentals (07 Periods)

   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: (07 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: (06 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 Dieseline.

3.4 Multifunction 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: (12 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: (10 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	7	20
2	7	20
3	6	12
4	12	24
5	10	24
Total	**42**	**100**

Program Core (Practicum)	3.2 Solar Photovoltaic	L	T	P
		2	-	4

COURSE OBJECTIVES

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.

COURSE 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.

COURSE CONTENTS

1. Solar Photovoltaic Systems:

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:

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:

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:

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:

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	07	20
2	05	20
3	05	20
4	05	20
5	06	20
Total	**28**	**100**

Program Core (Practicum)	3.3 Fundamentals of Thermodynamics and Heat Transfer	L	T	P
		2	-	4

COURSE OBJECTIVES

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.

COURSE 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.

COURSE CONTENTS

1. Fundamentals of Thermodynamics:
   - 1.1 Pure substance
   - 1.2 System, Boundary, Surrounding.

2. Classification of system
   - 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)
   - 3.1 Stored 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:
   - 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:
   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.

Program Core (Theory)	3.4 Renewable Energy Instrumentation Applications	L	T	P
		4	-	-

COURSE OBEJECTIVES

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.

COURSE OUTCOMES

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

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

COURSE CONTENTS

1. **Characteristics of Measurement System** **(10 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** **(10 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,

4. **Measurement of Temperature:** **(10 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:** **(16 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.

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	10	20
2	10	20
3	10	20
4	10	20
5	16	20
Total	**56**	**100**

Program Core (Practical)	3.5 Renewable Energy Instrumentation Applications (Lab)	L	T	P
		-	-	8

COURSE OBEJECTIVES

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.

COURSE OUTCOMES

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

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

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.

Program Core (Theory)	4.1 Solar Energy	L	T	P
		2	-	-

COURSE OBJECTIVES

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.

COURSE 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.

COURSE CONTENTS

1. **Solar Radiation:** **(05 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:** **(05 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:** **(08 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: (05 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: (05 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.

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	5	20
2	5	20
3	8	20
4	5	20
5	5	20
Total	**28**	**100**

Program Core (Practical)	4.2 Solar Energy (Lab)	L	T	P
		-	-	6

COURSE OBJECTIVES

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.

COURSE OUTCOMES

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

COURSE CONTENTS

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.

Program Core (Practicum)	4.3 Hydraulics and Pneumatics	L	T	P
		1	-	4

COURSE OBJECTIVES

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.

COURSE OUTCOMES

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

1. Calculate pressure, flow and losses using Bernoulli's theorem in dairy pipelines.
2. Select and maintain centrifugal, reciprocating and positive-displacement pumps.
3. Design and troubleshoot pneumatic circuits (compressor, FRL units, actuators).
4. Measure flow with venturi meters and manometers.
5. Apply Pascal's law in hydraulic actuators for milk-handling equipment.

COURSE CONTENTS

1- INTRODUCTION TO FLUID MECHANICS

- Fluids, Types of fluids; properties: mass density, viscosity- kinematic and dynamic, specific gravity, surface tension, compressibility, etc. and their units.
- Relevance of fluid properties in dairy processing equipment.

PRESSURE AND ITS MEASUREMENT

- Pressure, Types of pressure: atmospheric, gauge, absolute.
- Pressure measuring Devices: **digital pressure sensors**, piezometer, U-tube and differential manometers, bourdon pressure gauge, diaphragm pressure gauge.
- Smart gauges and IoT-enabled sensors in fluid systems

Practicals

1. Measurement of pressure head by employing.
   i) Piezometer tube
   ii) Single and double column manometer

2- FLUID FLOW AND BERNOULLI'S APPLICATIONS

- Flow types on basis of Reynolds Number: steady/unsteady, laminar/turbulent.
- Rate of flow and their units; continuity equation of flow;
- Bernoulli's Theorem – derivation and applications.
- Discharge Measurement: venturi meter, orifice meter, pitot tube, rotameter.

Practicals

1- To find out the value of coefficient of discharge for a venturi meter.
2- Measurement of flow by using venturi meter.
3- Verification of Bernoulli's theorem

3- **PUMPS AND DAIRY APPLICATIONS**

- Pumps: Classification- centrifugal, reciprocating, rotating, gear, screw, diaphragm pumps.
- Operation, efficiency, priming, and cavitation.
- Pump selection for CIP, chilling, and liquid milk transfer

Practicals

1- To study a single stage centrifugal pump for constructional details and its operation to find out its normal head and discharge.
2- Direct operation of single and double acting cylinder.
3- Automatic operation of double acting cylinder in single cycle using limit switch.
4- Operation of double acting cylinder with quick exhaust wall.

4- INTRODUCTION TO PNEUMATICS

- Compressed air: properties, generation, and treatment
- Basic pneumatic components and their functions: compressor, air dryer, Filter, Regulator and Lubrication unit.

Practicals

1. Study and Demonstration of Compressed Air Generation Using a Compressor
2. Demonstration of Air Treatment Using Filter, Regulator, and Lubricator (FRL) Unit
3. Identify components such as compressors, air dryers, filters, regulators, and lubricators.
4. Assemble and operate a basic pneumatic circuit.

INSTRUCTIONAL STRATEGY

Use computer based learning aids for effective teaching-learning

1- Expose students to real life problems
2- Plan assignments so as to promote problem solving abilities and develop continued learning skills

MEANS OF ASSESSMENT

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

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 by Yeaple, McGraw Hill, New York..
8- Pneumatic Controls by Festo Didactic; Bangalore.
9- Pneumatics Control: An Introduction to the Principles by Werner Deppert and Kurt Stoll; Vogel – Verlag.
10- e-books/e-tools/relevant software to be used as recommended by AICTE/BTE/NITTTR, Chandigarh.

WEBSITES FOR REFERENCE:

1- http://swayam.gov.in

Program Core (Practicum)	4.4 Wind Energy	L	T	P
		2	-	4

COURSE OBJECTIVES

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.

COURSE 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.

COURSE CONTENTS

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:**

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:**

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**:

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:**

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**:

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 6 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.

Program Core (Theory)	4.5 Bio- Energy	L	T	P
		2	-	-

COURSE OBJECTIVES

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.

COURSE 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.

COURSE CONTENTS

1. **Fundamentals of Bio-Mass:** **(05 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:** **(05 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:** **(05 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, Torre faction.
3.4 Low temperature & High temperature Gasification.
3.5 Chemistry of Gasification & its products.

4. **Classification of Gasifier:** **(05 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:** **(08 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	5	20
2	5	20
3	5	20
4	5	20
5	8	20
Total	**28**	**100**

Program Core (Practical)	4.6 Bio- Energy (Lab)	L	T	P
		-	-	6

COURSE OBJECTIVES

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.

COURSE 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.

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

OPEN ELECTIVE -1

THEORY	4.7 (a). PROJECT MANAGEMENT	L	T	P
		2	-	-

COURSE OBJECTIVES

To develop the idea of project plan, from defining and confirming the project goals and objectives, identifying tasks and how goals will be achieved. To develop an understanding of key project management skills and strategies.

COURSE OUTCOMES

CO 1: Understand the Project Management Principles.

CO 2: Able to prepare project plans.

CO 3: Able to estimate effective cost of a project.

CO 4: Create risk report and cost benefit analysis.

CO 5: Prepare project scheduling through time-cost trade off.

COURSE CONTENT

UNIT-I: **Concept of a project:** (5 Periods)

Classification of projects- importance of project management- The project life cycle- establishing project priorities (scope-cost-time) project priority matrix- work break down structure.

UNIT-II: **Capital budgeting process:** (6 Periods)

Planning- Analysis-Selection-Financing-Implementation-Review. Generation and screening of project ideas- market and demand analysis- Demand forecasting techniques. Market planning and marketing research process- Technical analysis

UNIT-III: **Financial estimates and projections:** (5 Periods)

Cost of projects-means of financing-estimates of sales and production-cost of production-working capital requirement and its financing-profitability projected cash flow statement and balance sheet. Break even analysis.

UNIT-IV: **Basic techniques in capital budgeting:** (6 Periods)

Non discounting and discounting methods- payback period- Accounting rate of return-net present value-Benefit cost ratio-internal rate of return. Project risk. Social cost benefit analysis and economic rate of return. Non-financial justification of projects.

UNIT-V: **Project administration**: (6 Periods)

Progress payments, expenditure planning, project scheduling and network planning, use of Critical Path Method (CPM), schedule of payments and physical progress, time-cost trade off. Concepts and uses of PERT cost as a function of time, Project Evaluation and Review Techniques/cost mechanisms. Determination of least cost duration. Post project evaluation. Introduction to various Project management software's.

Reference Books:

1. Project planning, analysis, selection, implementation and review – Prasanna Chandra – Tata McGraw Hill
2. Project Management – the Managerial Process – Clifford F. Gray & Erik W. Larson - McGraw Hill 3. Project management - David I Cleland - McGraw Hill International Edition, 1999
4. Project Management – Gopala Krishnan – McMillan India Ltd.
5. Project Management-Harry-Maylor-Peason Publication

SUGGESTED DISTRIBUTION OF MARKS

Topic No.	Time Allotted (Periods)	Marks Allocation (%)
1.	05	14
2.	06	14
3.	05	24
4.	06	24
5.	06	24
Total	**28**	**100**

OPEN ELECTIVE -1

THEORY	4.7 (b). Artificial Intelligence	L	T	P
		2	-	-

Course Content:

Unit 1 – Introduction to Artificial Intelligence

- Artificial Intelligence (AI) definition
- Goals of AI
- History of AI
- Applications of AI

Unit 2 – Agents and Environments

- Agent Terminology, Types of Agents – Simple Reflex Agents, Model Based Reflex Agents, Goal
- Based Agents
- Nature of Environments, Properties of Environments

Unit 3 – Search Algorithms Terminology

- Brute Force Search Strategies – Breadth First Search, Depth First Search.
- Heuristic Search Strategies, Local Search Algorithms.

Unit 4 – Fuzzy Logic Systems

- Introduction to Fuzzy Logic and Fuzzy systems,
- Membership functions,
- Fuzzification/Defuzzification

Unit 5 – Neural Networks

- Basic structure of Neural Networks
- • Perceptron
- • Back-propagation

Suggested Learning Resources:

Artificial Intelligence By Example: Develop machine intelligence from scratch using real artificial intelligence use cases Denis Rothman Packt Publishing ISBN – 978-1788990547

AUDIT COURSE	4.8 ESSENCE OF INDIAN KNOWLEDGE AND TRADITION	L	T	P
		2	-	-

COURSE OBJECTIVES:

Understand the fundamental aspects of the Indian Knowledge System, its integration with modern science, principles of Yoga and holistic healthcare, and practical applications in contemporary contexts.

COURSE OUTCOMES

Upon completion of the course, the student will be able to demonstrate knowledge of the following topics:

1. Overview, importance, and relevance of the Indian Knowledge System, including Vedas, Upavedas, Vedangas, and Upangas.
2. Relevance of science and spirituality, and contributions of ancient Indian science and technology.
3. Basic principles of Yoga, benefits of holistic healthcare, and integration with modern healthcare.
4. Practical applications and case studies of the Indian Knowledge System's relevance today.

COURSE CONTENTS

Unit 1: Introduction to Indian Knowledge System (16 Periods)

Overview of Indian Knowledge System

Importance and relevance

1. Introduction to the Vedas
2. Upavedas
3. Vedangas
4. Upangas

Unit 2: Modern Science and Indian Knowledge System (06 Periods)

1. Relevance of Science and Spirituality,
2. Science and Technology in Ancient India,

Unit 3: Yoga and Holistic Healthcare (04 Periods)

1. Basic principles of Yoga
2. Benefits of holistic healthcare practices
3. Integration with modern healthcare

Unit 4: Case Studies / Assignment (02 Periods)

Practical Applications / Case studies demonstrating the relevance of Indian Knowledge System in modern times

EQUIPMENT REQUIREMENT FOR RENEWABLE ENERGY

Sr. No.	Description	Qty Required	Aprox. Cost
Solar PHOTO VOLTAIC LABORATORY			
1	Solar Energy Trainer Kit	01	32500
2	Solar smart metering system	01	6726
3	Solar water pump (1 H.P.)	01	53000
4	Solar street lighting system 9watts	01	1000
5	Solar inverter system (12 volts)	01	7000

Renewable Energy Instrumentation Applications			
1	LVDT transducer	01	8000
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	12529
4	solar dryer	1	4000
5	Evacuated tube collector	1	10000

	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

	HYDRAULICS & PNEUMATIC LABORATORY		
1.	Piezometer tube	2	200
2.	U tube differential manometer	2	2000
3.	Bourdon's Tube pressure gauge	1	1000
5.	Hydraulic jack	1	4000

6.	Hydraulic press Working Model	1	5000
7.	Bernoulli's apparatus	1	15000
8.	Venturimeter apparatus with differential manometer	1	10000
9.	Pipe friction apparatus	1	15000
10.	Reciprocating pump- single and Double Acting	1	50000
11.	Centrifugal pump	1	25000
12	Working Model of Pelton Wheel Turbine	1	20000
13	Working Model of Francis Turbine	1	20000
14	Working Model of Kaplan Turbine	1	20000
15	Hydraulic Circuit Trainer Kit	1	50000
16	Pneumatic Circuit Trainer Kit	1	50000
17	Working Model of Hydraulic Brake system	1	50000
18	Working Model of Hydraulic Ram	1	5000

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 list 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.

(A) 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.

1. EVALUATION STRATEGY

1.1 INTRODUCTION

Evaluation plays an important role in the teaching-learning process. The major objective of any teaching learning 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 in diagnosing 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.

1.2 STUDENTS' EVALUATION AREAS

The student evaluation is carried out for the following areas:

- Theory
- Practicum/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.

2. 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

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 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.

EVALUATION SCHEME

a. For Theory Courses:

(The weightage of Internal assessment is 40% and for End Semester Exam is 60%) The student has to obtain at least 40% marks individually both in internal assessment and end semester exams to pass.

b. For Practical Courses:

(The weightage of Internal assessment is 60% and for End Semester Exam is 40%) The student has to obtain at least 40% marks individually both in internal assessment and end semester exams to pass.

c. For Summer Internship / Projects / Seminar etc.

Evaluation is based on work done, quality of report, performance in viva-voce, presentation etc.

Note: The internal assessment is based on the student's performance in mid semester tests (two best out of three), quizzes, assignments, class performance, attendance, viva-voce in practical, lab record etc.